

GLOBAL CAPABILITIES

An Open Source Assessment



SECURE
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FOUNDATION

ABOUT SECURE WORLD FOUNDATION



Secure World Foundation (SWF) is a private operating foundation that promotes cooperative solutions for space sustainability and the peaceful uses of outer space. The mission of the Secure World Foundation is to work with governments, industry, international organizations, and civil society to develop and promote ideas and actions to achieve the secure, sustainable, and peaceful uses of outer space benefiting Earth and all its peoples.

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LIST OF ACRONYMS

AAD Advanced Area Defense	AI Artificial Intelligence	APSSO Asia-Pacific Space Science Observatories	ATBM Anti-Tactical Ballistic Missile
ABL Airborne Laser	AID Agence de l'Innovation de Défense	APT Advanced Persistent Threat	AUKUS Australia, the United Kingdom, and the United States
ABM Anti-Ballistic Missile	AIS Automated Identification System	ARES Action et Résilience Spatiale	AWACS Airborne Early Warning and Control Systems
ACCRES Advisory Committee on Commercial Remote Sensing	AKM Apogee Kick Motor	ARIES Arabhatta Research Institute of Observational Sciences	BEM Bâtiment d'Essais et de Mesures
ADD Agency for Defense Development	ALCOR ARPA Lincoln C-band Observables Radar	ASAT Anti-satellite	BMD Ballistic Missile Defense
ADF Australian Defence Force	AMS Academy of Military Sciences	ASCA Advanced Strategic Capabilities Accelerator	BMEWS Ballistic Missile Early Warning System
ADRV Advanced Debris Removal Vehicle	ANGELS Automated Navigation and Guidance Experiment for Local Space	ASFPC Air Force Space Command	C2 Command and Control
AEHF Advanced Extremely High Frequency	APOSOS Asia-Pacific Ground- Based Space Object Observation System	ASSDF Air and Space Self-Defence Force	C4ISR Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
AEOS Advanced Electro- Optical System	APSCO Asia-Pacific Space Cooperation Organization	ASPOS OKP Automated Warning System on Hazardous Situations in Outer Space	
AFSPC Air Force Space Command			

C40S

Centre de commandement, de contrôle, de communication et de calcul des opérations spatiales

CAMRa

Chilbolton Advanced Meteorological Radar

CASC

China Aerospace Science and Technology Corporation

CASIC

China Aerospace Industrial Corporation

CCAFS

Cape Canaveral Air Force Station

CCD

Charge-coupled Device

CCS

Counter Communications System

CDI

Center for Defense Information

CDE

Commandement de l'espace

CFC

Combat Forces Command

cFS

Core Flight System

CFSCC

Combined Force Space Component Command

CHESS

Centre for High Energy Systems and Sciences

CIC

Commercial Integration Cell

CMC

Central Military Commission

CMOS

Complementary Metal-oxide Semiconductor

CNE

Computer Network Exploitation

CNES

Centre national d'études spatiales

COIL

Chemical Oxygen Iodine Laser

COMINT

Communications Intelligence

COMSAT

Communications Satellite

COMSPOC

Commercial Space Operations Centre

COP

Common operational picture

COPUOS

Committee on the Peaceful Uses of Outer Space

COSMOS

Centre Opérationnel de Surveillance Militaire des Objets Spatiaux

CSpO

Combined Space Operations

CSpOC

Combined Space Operations Center

CSRS

Counter Surveillance and Reconnaissance System

CSSHQ

Chongfu Shiyong Shiyang Hangtian Qi

DA-ASAT

Direct-Ascent ASAT

DAAS

Data as a Service

DAPA

Defense Acquisition Program Administration

DARC

Deep Space Advanced Radar Capability

DARPA

Defense Advanced Research Projects Agency

DART

Demonstration for Autonomous Rendezvous Technology

DDOS Distributed Denial of Service	DSR Defence Strategic Review	EKV Exoatmospheric Kill Vehicle	FBI Federal Bureau of Investigation
DDR&D Directorate of Defense Research & Development	DSSAM Directorate of SSA and Management	ELINT Electronic Intelligence	FSB Federal Security Service
DEW Directed Energy Weapons	DST Department of Science and Technology	EMP Electromagnetic Pulse	FSOA French Space Operations Act
DHS Department of Homeland Security	DURGA Directionally Unrestricted Ray-Gun Array	EMS Electromagnetic Spectrum	FY Fiscal Year
DIA Defense Intelligence Agency	EAGLE ESPA Augmented Geostationary Laboratory Experiment	EO Earth Observation	GAO Government Accountability Office
DNS Domain Name System	ECS Environmental Control Systems	EOSAT Electronic Ocean Surveillance Satellite	GBI Ground-based Interceptor
DRDO Defence Research and Development Organisation	EEAS European External Action Service	ESA European Space Agency	GBOSS Ground-Based Electro- Optical Deep Space Surveillance
DSA Defence Space Agency	EELV Evolved Expendable Launch Vehicle	ESPA EELV Secondary Payload Adapter	GEO Geostationary Earth Orbit
DSC Defensive Space Control	EGIDE Engin géodérivant d'intervention et de découragement	ESPC Earth System Prediction Capability	GEODSS Ground-based Electro-Optical Deep Space Surveillance
DSS Defence Space Strategy		EW Electronic Warfare	

GLONASS Global Navigation Satellite Systems	HPM High-Power Microwave	ILRS International Laser Ranging Service	ISES International Space Environmental Service
GMD Ground-based Missile Defense	HTK Hit-to-kill	IMDO Israel Missile Defense Organization	ISON International Scientific Optical Network
GNSS Global Navigation Satellite Systems	IADC Inter-Agency Space Debris Coordination Committee	IMO International Maritime Organization	ISA Israeli Space Agency
GPS Global Positioning System	IAF Indian Air Force	IMOD Israeli Ministry of Defense	ISR Intelligence, Surveillance, and Reconnaissance
GRAVES Grand Réseau Adapté à la Veille Spatiale	IAI Israel Aerospace Industries	IN-SPACE Indian National Space Promotion and Authorization Center	ISRO Indian Space Research Organisation
GSO Geosynchronous Orbit	ICBM Intercontinental Ballistic Missile	IRBM Intermediate Range Ballistic Missile	ITU International Telecommunication Union
GSSAP Geosynchronous Space Situational Awareness Program	ICAO International Civil Aviation Organization	IRDE Instruments Research and Development Establishment	JASDF Japanese Air Self-Defense Force
GTO Geosynchronous Transfer Orbit	iCET Initiative on Critical and Emerging Technology	IRGC Islamic Revolutionary Guard Corps	JAXA Japan Aerospace Exploration Agency
HEO Highly Elliptical Orbit	ICS Industrial Control Systems	IS40M ISRO System for Safe and Sustainable Space Operations Management	JCO Joint Commercial Operations
HIMARS High Mobility Artillery Rocket System	IDF Israeli Defense Forces		

JCO-UK Joint Task Force-Space Defence Commercial Operations Cell-United Kingdom	KCNA Korean Central News Agency	LEO Low Earth Orbit	MISSE Materials International Space Station Experiment
JDAM Joint Direct Attack Munition	KEPLER Korea Enhanced Platform for Lowering spacE Risk	LPAR Large Phased-Array Radar	Mi-TEx Micro-satellite Technology Experiment
JFSCC Joint Force Space Component Command	KIAM Keldysh Institute of Applied Mathematics	MDA Missile Defense Agency	MITM Man-in-the-middle
JICSpOC Joint Interagency Combined Space Operations Center	KKV Kinetic Kill Vehicle	MDO Multidomain Operations	MMW Millimeter Wave
JNWC Joint Navigation Warfare Center	KM Kilometers	MEO Medium Earth Orbit	MNF-OOD Multinational Force Operation Olympic Defender
JSpOC Joint Space Operations Center	KRIT Korea Research Institute for Defense Technology Planning and Advancement	METIS Materials Exposure and Technology Innovation in Space	MoD Ministry of Defense
JTF-SD Joint Task Force Space Defense	KW Kilowatt	MICA Maritime Informa- tion Cooperation and Awareness	MOSSAIC Maintenance of Space Situational Awareness Integrated Capabilities
KARI Korea Aerospace Research Institute	LAC Line of Actual Control	MIRV Multiple Independently Targetable Reentry Vehicles	MOST Ministry of Science and Technology
KASA Korea AeroSpace Administration	LACE Low-Power Atmospheric Compensation Experiment	MIRACL Mid-Infrared Advanced Chemical Laser	MOTIF Maui Optical Tracking and Identification Facility

MOTR Multiple Object Tracking Radar	NOAA National Oceanic and Atmospheric Administration	OCS Offensive Counterspace	PAVE PAWS Precision Acquisition Vehicle Entry Phased Array Warning System
MUBLCOM Multiple Path Beyond Line of Site Communication	NOTAM Notice to Air Missions	OKN Integrated Observation Complex	PDV Prithvi Defence Vehicle
NASA National Aeronautics and Space Administration	NPT Nuclear Non-Proliferation Treaty	OSC Offensive Space Control	PGM Precision-Guided Munitions
NASIC National Air and Space Intelligence Center	NRL Naval Research Laboratory	OTTI Operational Test & Training Infrastructure	PLA People's Liberation Army
NATA National Aerospace Technology Administration	NSA National Security Agency	OTV Orbital Test Vehicle	POLSA Polish Space Agency
NavIC Navigation with Indian Constellation	NSDC National Space Defense Center	OW Orbital Warfare	PMO Purple Mountain Observatory
NAVWAR Navigation Warfare	NSIC National Space Intelligence Center	OWL-Net Optical Wide-field patrol Network	PNT Positioning, Navigation, and Timing
NESDIS National Environmental Satellite, Data, and Information Service	NSIL NewSpace India Limited	PAD Prithvi Air Defence	PRAM Photovoltaic Radio-frequency Antenna Module
NETRA Network for Space Object Tracking and Analysis	NSpOC National Space Operations Centre	PALADIN Positioning and Autonomous Laser Assisted Detection in Near-space	QZSS Quasi Zenith Satellite System
	NSS National Space Strategy	PARCS Perimeter Acquisition Radar Attack System	RAAF Royal Australian Air Force

RAF Royal Air Force	RPO Rendezvous and Proximity Operations	SBSS Space-Based Surveillance System	SHF Super-High Frequency
RAT Remote Access Tool	SAASM Selective Availability Anti-Spoofing Module	SCADA Supervisory Control and Data Acquisition	SIGINT Signals Intelligence
RDT&E Research, Development, Testing, and Evaluation	SAKURA SsA Key technology Unified Research and Analysis	SCOT Space Camera for Object Tracking	SIP Satellite Interceptor Program
RF Radiofrequency	SAM Surface-to-air Missile	SDF Self-Defense Forces	SIPC Space Intelligence Production Cell
RFI Radiofrequency Interference	SAMP/T Surface-to-Air Missile Platform/Terrain	SDI Strategic Defense Initiative	SKKP Центр контроля космического пространства, tr. Tsentr kontrolya kosmicheskogo prostranstva ("Space Surveillance System")
RKA Relativistic Klystron Amplifier	SAR Synthetic Aperture Radar	SDIO Strategic Defense Initiative Organization	SLBM Submarine-launched Ballistic Missile
RLV LEX Reusable Launch Vehicle Autonomous Landing Mission	SAST Shanghai Academy of Spaceflight Technology	SDMU Space Domain Mission Unit	SLR Satellite Laser Ranging
RORSAT Radar Ocean Reconnaissance Satellite	SATAM Système d'Acquisition et de Trajectographie des Avions et des Munitions	SDOAC Space Debris Observation and Data Application Center	SLV Space Launch Vehicle
ROSACE Radiometry for Ocean colour Satellites Calibration and Community Engagement	SATCOM Satellite Communications	SFDD Space Force Doctrine Document	SoS System of Systems
	SBCL Space-based Chemical Laser	SFIA Space Force Intelligence Activity	SPACEFOR-KOR US Space Forces – Korea

SPOC Système Probatoire pour l'Observation du Ciel	TAROT Télescope à Action Rapide pour les Objets Transitoires	TTP Tactics, Techniques, and Procedures	USSPACECOM United States Space Command
SPR Space Strategic Portfolio Review	TEL Transporter Erector Launcher	UAS Unmanned Aerial Systems	USSR Union of Soviet Socialist Republics
SSA Space Situational Awareness	THAAD Terminal High Altitude Area Defense	UAV Unmanned Aerial Vehicle	VHA Very High Altitude
SSC Space Systems Command	TOUTATIS Test en Orbite d'Utilisation de Techniques d'Action contre les Tentatives d'Ingérences Spatiales	UHF Ultra-High Frequency	VORTEX Véhicule Orbital Réutilisable de Transport et d'Exploration
SSI Space Security Initiative	TRADEX Target Resolution and Discrimination Experiment	UKSA United Kingdom Space Agency	VSAT Very Small Aperture Terminal
SSN Space Surveillance Network	TsNIIKhM Central Scientific Research Institute for Chemistry and Mechanics	UKSC United Kingdom Space Command	XGEO Beyond Geostationary Earth Orbit
SST Space Surveillance Telescope	TT&C Tracking, Telemetry, and Control	UKSpOC UK Space Operations Centre	YACMS Yet Another Mission Control System
SSU Space Strategic Update	TT&M Targeting, Tracking, and Measurement	USAF United States Air Force	YODA Yeux en Orbite pour un Démonstrateur Agile
STARS Space Threat Analysis and Response System		USSF United States Space Force	
SYDERAL Système Laser de Défense de Nouvelle Génération		USINDOPACOM United States Indo-Pacific Command	

EXECUTIVE SUMMARY



The space domain is undergoing a significant set of changes. A growing number of countries and commercial actors are getting involved in space, resulting in more innovation and benefits on Earth, but also more congestion and competition in space. From a security perspective, an increasing number of countries are looking to use space to enhance their military capabilities and national security. The growing use of, and reliance on, space for national security has also led more countries to look at developing their own counterspace capabilities that can be used to deceive, disrupt, deny, degrade, or destroy space systems.

The existence of counterspace capabilities is not new, but the circumstances surrounding them are. Today there are increased incentives for development, and potential use, of offensive counterspace capabilities. There are also greater potential consequences from their widespread use that could have global repercussions well beyond the military, as huge parts of the global economy and society are increasingly reliant on space applications.

This report compiles and assesses publicly available information on the counterspace capabilities being developed by multiple countries across five categories: co-orbital, direct-ascent, electronic warfare, directed energy, and cyber. It assesses the current and near-term future capabilities for each country, along with their potential military utility. The evidence shows significant research and development of a broad range of destructive and non-destructive counterspace capabilities in multiple countries. **However, only non-destructive capabilities are actively being used against satellites in current military operations.** The following provides a more detailed summary of each country's capabilities.

	US	RUSSIA	CHINA	INDIA	AUS.	FRANCE	GERMANY	IRAN	ISRAEL	JAPAN	N. KOREA	S. KOREA	UK
LEO Co-Orbital	■	▲	■	●	●	■	●	●	●	●	●	●	●
MEO/GEO Co-Orbital	■	■	■	●	●	■	●	●	●	●	●	●	●
LEO Direct-Ascent	▲	▲	▲	■	●	●	●	●	■	●	●	●	●
MEO/GEO Direct-Ascent	?	?	■	●	●	●	●	●	●	●	●	●	●
Directed Energy	▲	▲	■	●	●	■	●	●	●	●	●	●	●
Electronic Warfare	▲	▲	▲	■	■	■	●	▲	▲	■	▲	●	●
Space Situational Awareness	▲	▲	▲	■	■	■	■	■	■	■	■	■	■

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

1 – THE UNITED STATES

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	▲	▲	?	●
MEO/GEO Direct-Ascent	?	—	—	●
LEO Co-Orbital	▲	?	—	●
MEO/GEO Co-Orbital	▲	?	—	●
Directed Energy	▲	■	?	●
Electronic Warfare	▲	▲	▲	▲
Space Situational Awareness	▲	▲	▲	▲

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

The United States has conducted multiple tests of technologies for close approach and rendezvous in both LEO and GEO, along with tracking, targeting, and hit-to-kill (HTK) intercept technologies that could lead to a co-orbital anti-satellite (ASAT) capability. These tests and demonstrations were conducted for other non-offensive missions, such as missile defense, on-orbit inspections, and satellite servicing, and the United States does not have an acknowledged program to develop co-orbital capabilities. However, the United States possesses the technological capability to develop a co-orbital capability in a short period of time if it chooses to. If the United States does move ahead with its plan for a space-based interceptor layer of a proposed “Golden Dome for America,” these weapons would have co-orbital counterspace capabilities.

While the United States does not have an operational, acknowledged direct-ascent anti-satellite (DA-ASAT) program, it does have operational midcourse missile defense interceptors that have been demonstrated in an ASAT role against a low LEO satellite. The United States has developed dedicated DA-ASATs in the past, both conventional and nuclear-tipped, and likely possesses the ability to do so in the near future should it choose so.

The United States has three operational electronic warfare (EW) offensive counterspace systems: the Counter Communications System (CCS), which is deployed globally to provide uplink jamming capability against geostationary communications satellites; Meadowlands, an upgrade to CCS; and Remote Modular Terminal (RMT), an EW counterspace system that can be operated remotely. Through its Navigation Warfare program, the United States has the capability to jam and interfere with the civil signals of global navigation satellite services (GNSS) within a local area of operation to prevent their effective use by adversaries and has demonstrated doing so in several military exercises. The United States likely could jam military GNSS signals as well, although the effectiveness is difficult to assess based on publicly available information. The effectiveness of US measures to counter adversarial jamming and spoofing operations against military GPS signals is not known.

Over the past several decades, the United States has conducted significant research and development on the use of ground-based high-energy lasers for counterspace and other purposes. We assess that there are no technological roadblocks to the United States operationalizing them for counterspace applications. With its Satellite Laser Ranging (SLR) sites and defense research facilities, the United States possesses low-power laser systems with the capability to dazzle, and possibly blind, Earth observation (EO) imaging satellites. However, there is no indication that these potential high or low power capabilities have been operationalized.

There is no public evidence that the United States has a space-based directed energy weapons (DEW) capability. The Missile Defense Agency (MDA) is planning to conduct research into the feasibility of DEW for defending against ballistic missiles and the Space Force has expressed an interest in a directed energy architecture in general (not necessarily space-based). If developed, these systems may have a capability against other orbiting satellites and, depending on their target acquisition and tracking capabilities, may be considered de facto anti-satellite systems.

The United States currently possesses the most advanced SSA capabilities in the world, particularly for military applications. US SSA capabilities date back to the beginning of the Cold War and leverage significant infrastructure developed for missile warning and missile defense. The core of its SSA capabilities is a robust, geographically dispersed network of ground-based radars and telescopes and space-based telescopes. The United States is investing heavily in upgrading its SSA capabilities by deploying new radars and telescopes in the Southern Hemisphere, upgrading existing sensors, and signing SSA data sharing agreements with other countries and satellite operators. The United States still faces challenges in modernizing the software and computer systems used to conduct SSA analysis and is increasingly looking to leverage commercial capabilities.

The United States has had established doctrine and policy on counterspace capabilities for several decades, although not always publicly expressed. Most US presidential administrations since the 1960s have directed or authorized research and development of counterspace capabilities, and in some cases greenlit testing or operational deployment of counterspace systems. These capabilities have typically been limited in scope and designed to counter a specific military threat, rather than be used as a broad coercive or deterrent threat. The current US military doctrine includes offensive and defensive military force and is focused on suppressing adversary uses of space in an armed conflict while protecting the United States' ability to use space.

The United States recently underwent a major reorganization of its military space activities as part of a renewed focus on space as a warfighting domain. Since 2014, US policymakers have placed increased focus on space security, and have increasingly talked publicly about preparing for a potential "war in space." This rhetoric has been accompanied by a renewed focus on reorganizing national security space structures and increasing the resilience of space systems. This has culminated in the reestablishment of US Space Command (USSPACECOM) and the creation of the US Space Force (USSF), which assumed the responsibilities of US Strategic Command for space warfighting and Air Force Space Command (AFSPC) for operating, training, and equipping of space forces, respectively. To date, the missions of these new organizations are largely a continuation of previous military space missions, although some have advocated for expanding their focus to include cislunar activities and more offensive weapons. The United States has acknowledged it has also begun developing new offensive counterspace capabilities, although the United States has publicly stated it will not test destructive DA-ASAT weapons. The United States also continues to hold annual space wargames and exercises that increasingly involve close allies and commercial partners.

2 – RUSSIA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	▲	▲	?	●
MEO/GEO Direct-Ascent	?	—	—	●
LEO Co-Orbital	▲	▲	?	●
MEO/GEO Co-Orbital	▲	—	—	●
Directed Energy	▲	■	?	●
Electronic Warfare	▲	▲	▲	▲
Space Situational Awareness	▲	▲	▲	▲

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

There is strong evidence that Russia has embarked on a set of programs since 2010 to regain offensive counterspace capabilities it lost following the end of the Cold War. Since 2010, Russia has been testing technologies for RPO in both LEO and GEO that could lead to or support a co-orbital ASAT capability, and some of those efforts have links to a Cold War-era LEO co-orbital ASAT program. Additional evidence suggests Russia may have started a new co-orbital ASAT program called Burevestnik, potentially supported by a surveillance and tracking program called Nivelir. The technologies developed by these programs could also be used for non-aggressive applications, including surveilling and inspecting foreign satellites, and most of the on-orbit RPO activities done to date match these missions. However, Russia has deployed two “sub-satellites” at high velocity, which suggests at least some of their LEO RPO activities are of a weapons nature.

Russia has long had the potential for a DA-ASAT capability through its historical ballistic missile defense capabilities and had DA-ASAT development programs in the past that never fully became operational. In November 2021, after more than a decade of development and testing, Russia successfully demonstrated a DA-ASAT capability against a LEO satellite. It is unclear whether this system, the Nudol, will become operational soon, and it does not appear to have the capability to threaten targets beyond LEO.

Russia places a high priority on integrating electronic warfare (EW) into military operations and has been investing heavily in modernizing this capability. Most of the upgrades have focused on multifunction tactical systems whose counterspace capability is limited to jamming of user terminals within tactical ranges. Russia has a multitude of systems that can jam GPS receivers within a local area, potentially interfering with the guidance systems of unmanned aerial vehicles (UAVs), guided missiles, and precision-guided munitions (PGMs), but has no publicly known capability to interfere with the GPS satellites themselves using radio frequency interference. The Russian Army fields several types of mobile EW systems, some of which can jam specific satellite communications user terminals within tactical ranges. Russia can likely jam communications satellites uplinks over a wide area from fixed ground stations facilities. Russia has operational experience in the use of counterspace EW capabilities from current military campaigns, as well as using it within Russia for protecting strategic locations and VIPs. Russia may be developing high-powered space-based EW platforms to augment its existing ground-based platforms.

Russia has a strong technological knowledge base in directed energy physics and is developing a number of military applications for laser systems in a variety of environments. Russia has a mobile ground-based laser dazzler system, Peresvet, that is linked to protection of its road mobile intercontinental ballistic missile force. Russia may have revived a legacy program whose goal is to develop an aircraft-borne laser system for targeting the optical sensors of imagery reconnaissance satellites, although there is no indication that an operational capability has been achieved. Although not their intended purpose, Russian ground-based satellite laser ranging (SLR) facilities could be used to dazzle the sensors of optical imagery or ISR satellites. There is no indication that Russia is developing, or intending to develop, high-power space-based laser weapons.

Russia has sophisticated SSA capabilities that are likely second only to the United States. Russian SSA capabilities date to the Cold War and leverage significant infrastructure originally developed for missile warning and missile defense. Although some of these capabilities atrophied after the fall of the Soviet Union, Russia has engaged in several modernization efforts since the early 2000s to reinvigorate them. While the government-owned and -operated SSA capabilities are limited to the geographic boundaries of the former Soviet Union, Russia is engaging in international civil and scientific cooperative efforts that likely give it access to data from SSA sensors around the globe. Today, Russia maintains a catalog of Earth-orbiting space objects in LEO that is somewhat smaller than that of the United States but a slightly more robust catalog of HEO and GEO objects.

Russian military thinkers see modern warfare as a struggle over information dominance and net-centric operations that can often take place in domains without clear boundaries and contiguous operating areas. To meet the challenge posed by the space aspect of modern warfare, Russia is pursuing goals of incorporating EW capabilities throughout its military to both protect its own space-enabled capabilities and degrade or deny those capabilities to its adversary. In space, Russia is seeking to mitigate the superiority of US space assets by fielding a number of ground-, air-, and space-based offensive capabilities. Russia has recently reorganized its military space forces into a new organization that combines space, air defense, and missile defense capabilities. Although technical challenges remain, Russian leadership has indicated that Russia will continue to seek parity with the United States in space.

3 – CHINA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	▲	▲	▲	●
MEO/GEO Direct-Ascent	■	■	—	●
LEO Co-Orbital	▲	?	—	●
MEO/GEO Co-Orbital	▲	?	—	●
Directed Energy	▲	■	—	●
Electronic Warfare	▲	▲	▲	?
Space Situational Awareness	▲	▲	▲	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

China has conducted multiple tests of technologies for close approach and rendezvous in both LEO and GEO that could lead to a co-orbital ASAT capability. However, the public evidence indicates they have not conducted an actual destructive intercept of a target, and there is no proof that these technologies are definitively being developed for counterspace use as opposed to intelligence gathering or other purposes.

China has at least one, and possibly as many as three, programs underway to develop DA-ASAT capabilities, either as dedicated counterspace systems or as midcourse missile defense systems that could provide counterspace capabilities. China has engaged in multiple, progressive tests of these capabilities since 2005, indicating a serious and sustained organizational effort. Chinese DA-ASAT capability against LEO targets is likely mature and may be operationally fielded on mobile launchers. Chinese DA-ASAT capability against deep space targets (medium Earth orbit, or MEO, and GEO) is likely still in the experimental or development phase, and there is not sufficient evidence to conclude whether it will become an operational capability in the near future.

China is likely to have significant EW counterspace capabilities against GNSS and satellite communications, although the exact nature is difficult to determine through open sources. Chinese military doctrine places a heavy emphasis on electronic warfare as part of the broader information warfare. While there is significant evidence of Chinese scientific research and development of EW capabilities for counterspace applications and some open-source evidence of Chinese EW counterspace capabilities being deployed, there is no public evidence of their active use in military operations.

China is likely to be developing DEW for counterspace use, although public details are scarce. There is strong evidence of dedicated research and development and reports of testing at five different locations, but limited details on the operational status and maturity of any fielded capabilities.

China is developing a sophisticated network of ground-based optical telescopes and radars for detecting, tracking, and characterizing space objects. Like the United States and Russia, several of the Chinese SSA radars also serve missile warning functions. While China lacks an extensive network of SSA tracking assets outside its borders, it does have a fleet of tracking ships and is developing relationships with countries that may host future sensors. Since 2010, China has deployed several satellites capable of conducting RPO on orbit, which likely aids in its ability to characterize and collect intelligence on foreign satellites.

Although official Chinese statements on space warfare and weapons have

remained consistently aligned to the peaceful purposes of outer space, unofficially they have become more nuanced. China has recently designated space as a military domain, and military writings state that the goal of space warfare and operations is to achieve space superiority using offensive and defensive means in connection with their broader strategic focus on asymmetric cost imposition, access denial, and information dominance. In 2024, China proceeded to disband its Strategic Support Force in favor of splitting up its responsibilities among three forces and putting renewed efforts into information service. China's considerable investment in developing and testing counterspace capabilities, suggest it sees space as a domain for future conflicts, whether or not that is officially stated. That said, it is uncertain whether China would fully utilize its offensive counterspace capabilities in a future conflict or whether the goal is to use them as a deterrent against US aggression. There is no public evidence of China actively using destructive counterspace capabilities in current military operations, although it is likely China is using SSA and electronic warfare in at least some support roles.

4 – INDIA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	■	■	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	■	—	—	●
Electronic Warfare	■	■	?	?
Space Situational Awareness	■	■	?	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

India has over five decades of experience with space capabilities, but most of that has been civil in focus. It is only relatively recently that India has started organizationally making way for its military to become active users of space and creating explicit military space capabilities. India demonstrated its ASAT capability in March 2019 when it destroyed one of its satellites. While India continues to insist that it is against the weaponization of space, India may be moving toward an offensive counterspace posture. India is reportedly in the early stages of working on directed energy weapons. In 2025, India successfully showcased twice its ability to maneuver civilian space assets in orbit, marking an important step toward developing rendezvous and docking technology for space assets.

6 – AUSTRALIA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	■	—	—	●
Electronic Warfare	■	—	—	—
Space Situational Awareness	■	■	■	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

Australia is a relative newcomer in space, although it has long played a support role by hosting ground infrastructure for satellite communications and command and control. Recently, however, Australia has created the groundwork for more indigenous space capabilities, including within its military. Australia has recently started a military space organization, is building out a policy framework for its military space priorities, is putting concerted efforts and resources into building its own SSA capabilities, is examining an EW capability for its Department of Defence, and is looking into non-destructive ways in which to interfere with enemy satellites.

7 – FRANCE

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	■	—	—	●
MEO/GEO Co-Orbital	■	—	—	●
Directed Energy	■	?	—	●
Electronic Warfare	?	?	?	?
Space Situational Awareness	■	■	■	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

While France has long had a space program, as well as military satellites, it was not until recently that France had an explicit focus on offensive and defensive counterspace activities. The major change occurred in July 2019 with the release of the first French Space Defense Strategy, which elevated French military space efforts and control of French military satellites. While some French officials suggested machine guns on satellites, the actual plan calls for ground-based lasers for dazzling and satellites equipped for on-orbit inspections and also with lasers used for what has been described as self-defense, but could suggest potential for enabling counterspace capability. Subsequently, new demonstration assets are slated for deployment, including patrol-guard satellites and lasers. Since 2021, France has carried out annual military exercises, codenamed “ASTERX,” in outer space, testing the capabilities of its Space Command, as part of France’s evolving goal to be the world’s third-largest spatial power. France and the United States conducted two RPO engagements in 2025.

8 – GERMANY

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	?	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	?	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	?	—	—	●
Electronic Warfare	■	—	—	—
Space Situational Awareness	▲	▲	▲	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

Germany historically has had a civil focus to its space program. However, its military, the Bundeswehr, is working to expand its presence in orbit. The combination of a significant planned investment in space and defense systems over the next five years, a new space strategy, and growing engagement in space surveillance points to an increase in German abilities to develop the necessary capabilities to potentially carry out attacks against space systems, should it choose to do so. Germany is changing rapidly from having no offensive counterspace capabilities, to soon having several options available to it.

9 – IRAN

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	—	—	—	●
Electronic Warfare	▲	▲	▲	▲
Space Situational Awareness	■	■	?	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

Iran has a nascent space program, building and launching small satellites that have limited capability. Technologically, it is unlikely Iran has the capacity to build on-orbit or direct-ascent anti-satellite capabilities, and little military motivation for doing so at this point. Iran's military has an independent ability to launch satellites, separate from Iran's civil space program. Iran has not demonstrated any ability to build homing kinetic kill vehicles, and its ability to build nuclear devices is still constrained. Iran has demonstrated an electronic warfare capability to persistently interfere with the broadcast of commercial satellite signals and Starlink ground terminals, although its capacity to interfere with military signals is difficult to ascertain.

10 – ISRAEL

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	?	—	—	—
MEO/GEO Direct-Ascent	—	—	—	—
LEO Co-Orbital	—	—	—	—
MEO/GEO Co-Orbital	—	—	—	—
Directed Energy	■	■	—	—
Electronic Warfare	▲	▲	▲	▲
Space Situational Awareness	■	■	?	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

In 1988, Israel became the eighth country to be able to launch its own satellite into orbit. It has maintained a space program that has largely been civil in nature and co-developed a missile defense system that has been until recently strictly for endoatmospheric interception of rockets. However, in recent years Israel has moved to expand its military space program and launched a Space Directorate Unit within the Israel Defense Forces. Moreover, there is evidence it has developed counterspace capabilities. These include the recent demonstration of an exoatmospheric missile defense intercept capability and use of electronic warfare in active military conflicts.

11 – JAPAN

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	?	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	?	—	—	●
Electronic Warfare	■	—	—	—
Space Situational Awareness	■	■	■	—

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

Japan has long been a well-established space actor and its space activities have historically been non-military in nature. In 2008, Japan released a Basic Space Law that allowed for national security-related activities in space and since then, government officials have begun to publicly speak about developing various counterspace capabilities and military SSA capacity. Japan is currently undergoing a major reorganization of its military space activities and the development of enhanced SSA capabilities to support military and civil applications. While Japan does not have any acknowledged offensive counterspace capabilities, it is exploring whether to develop them. Japan recently published guidelines for space domain defense that call for “bodyguard” satellites. Japan has a latent DA-ASAT capability via its missile defense system but has never tested it in that capacity.

12 – NORTH KOREA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	—	—	—	●
Electronic Warfare	▲	▲	▲	?
Space Situational Awareness	?	?	?	—

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

North Korea has no demonstrated capability to mount kinetic attacks on space assets. North Korea does not appear highly motivated to develop kinetic counterspace capabilities, though certain capabilities in its ballistic missile program could eventually be evolved for such a purpose. North Korea has exhibited the capability to jam civilian and military GPS signals within a limited geographical area. There has been no demonstrated ability of North Korea to interfere with satellite communications, although its technical capability remains unknown.

13 – SOUTH KOREA

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	?	—	—	●
Electronic Warfare	■	—	—	—
Space Situational Awareness	■	■	■	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

Over the last several years, South Korea has increased its focus on military space capabilities. South Korea is working to enhance the space capabilities of the Republic of Korea Air Force through the establishment of the Korea Space Operations Center, cooperating with the United States on sharing SSA capabilities, and the creation of a Space Operations Squadron in charge of informing and supporting the entire military on space threats. South Korea is developing its own space launch vehicles; it also has expressed interest in developing its own reversible counterspace capabilities.

14 – THE UNITED KINGDOM

	R&D	TESTING	OPERATIONAL	USE IN CONFLICT
LEO Direct-Ascent	—	—	—	●
MEO/GEO Direct-Ascent	—	—	—	●
LEO Co-Orbital	—	—	—	●
MEO/GEO Co-Orbital	—	—	—	●
Directed Energy	—	—	—	●
Electronic Warfare	—	—	—	●
Space Situational Awareness	■	■	■	?

LEGEND: NONE ● SOME ■ SIGNIFICANT ▲ UNCERTAIN ? NO DATA —

The United Kingdom has long played a supporting role in military space activities through its participation in NATO and its bilateral relationship with the United States. Over the past few years, the United Kingdom has begun to add additional elements to increase its indigenous military space capabilities, primarily in SSA and policy, organization, and doctrine. The United Kingdom and the United States conducted an RPO. While the United Kingdom has not publicly announced any specific plans to develop offensive counterspace capabilities, its recently published Strategic Defence Review does include a focus on space control.

15 – CYBER CAPABILITIES

Multiple countries possess cyber capabilities that could be used against space systems; however, actual evidence of cyberattacks in the public domain is limited. The United States, Russia, China, France, Iran, Israel, and North Korea have all demonstrated the ability and willingness to engage in offensive cyberattacks against non-space targets. Additionally, a growing number of non-state actors are actively probing commercial satellite systems and discovering cyber vulnerabilities that are similar to those found in non-space systems. This indicates that manufacturers and developers of space systems may not yet have reached the same level of cyber hardness as other sectors. But to date, there have only been a few publicly-disclosed cyberattacks directly targeting space systems and nearly all have gone after the end user segment and not satellites themselves. The largest was a cyberattack by Russia against the user segment of Viasat's commercial satellite broadband service in Europe, which coincided with the first day Russian forces entered Ukraine in February 2022.

There is a clear trend toward lower barriers to access, and widespread vulnerabilities, coupled with reliance on relatively unsecured commercial space systems, create the potential for non-state actors to carry out some counterspace cyber operations without state assistance. However, while this threat deserves attention and will likely grow in severity over the next decade, there remains a stark difference at present between the cyberattack capabilities of leading nation-states and other actors.

2026 ADDITIONS



The following are brief summaries of the major additions for the 2026 edition of this report, broken down by country, along with a page reference to their location in the text. Individual minor changes or the impact of changes on summaries and assessments have been integrated into the text.

01 – The United States /

- Added information about the end of the X-37B mission OTV-7, the beginning of OTV-8, and updated the table tracking flights of the X-37B (01-07)
- Added Clio, thought to be part of the Nemesis series moving around the GEO belt (01-10)
- Updated the number of GSSAPs on orbit with the launch of GSSAPs 7 and 8 (01-11)
- Added information about GSSAPs conducting close approaches of China's TJS-15, TJS-16, and TJS-17 (01-13)
- Added the follow-on program to GSSAP, RG-XX (01-13)
- Added information about US/French and US/UK RPOs during 2025 (01-14)
- Updated the table of recent US RPOs (01-15)
- Added information about LDPE-3A conducting close approaches with China's SJ-23 in October 2024 (01-16)
- Added information about LDPE 2 releasing satellites in January 2023, August 2024, and June 2025 (01-16)
- Updated the status of Victus Haze, corrected the mission of Victus Sugo, and added the contract for Victus Sol (01-16)
- Created a section on Golden Dome, tracking what is known about its timeline and architecture, as well as what it may cost (01-17)
- Added information from the 2025 American Physical Society about boost phase intercept (01-19)
- Updated the number of Aegis BMD-capable ships the MDA is planning to have (01-25)

- Added details about the CCS jamming systems' customers and how its follow-on, Meadowlands, is supposed to be an improvement; also added information about the fielding of Meadowlands and how it has been approved to be sold to close US allies (01-29)
- Added the USSF announcement that it is fielding a tactical EW center (01-30)
- Updated the state of the OCX system (01-32)
- Added information about US work on a space-based chemical laser, the Zenith system, during the SDIO era (01-36)
- Added information about the Ground-based Optical Sensors (GBOSS) system (01-40)
- Updated the current state of the DARC radar program (01-41)
- Added information about the follow-on program to SILENT BARKER (01-42)
- Added JCO's reorganization (01-44)
- Discussed President Trump's December 2025 executive order, "Ensuring Space Superiority" (01-46)
- Added the USSF's capstone operations document, Space Force Doctrine Document (SFDD)-1 (01-53)
- Added the USSF's Warfighting Framework (01-53)
- Added the USSF's International Partnership Strategy (01-53)
- Added a GAO report on difficulties DoD has been having in working with partners and allies in space (01-54)
- Added the USSF's "Vector 2025" guidance (01-54)
- Added the USSF's new taxonomy for its systems (01-54)
- Discussed what is known about the USSF's "Objective Force 2025" roadmap (01-54)
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- Added information on counterspace budget requests and OMB reportedly holding back some funding relevant to military space (01-62)
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- Added information about Cosmos 2558 and Object C conducting RPOs in the summer of 2025 (02-11)
- Added information about the launch of Cosmos 2581, Cosmos 2582, and Cosmos 2583; the release of Object F; and the RPOs conducted by this group with each other throughout 2025 (02-12)
- Added information about Luch's close approach in spring 2019 to TJS-3 and its apogee kick motor (02-13)
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- Added information about Cosmos 2589, its release of Cosmos 2590, and their RPOs during the second half of 2025 (02-17)
- Updated the status of the S-500 (02-25)
- Updated incidents of GNSS interference thought to originate in Russia and added information about the resolution the ICAO passed censuring Russia for doing so (02-30)
- Added a Russian submission to the ITU that it believed Western satellites being used by the Ukrainian military to be "legitimate targets" (02-30)
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- Added information on GNSS interference occurring in the India-Pakistani border region and around various Indian airports (04-05)
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- Added information on Infinite Orbits winning a contract to create a GEO inspection and monitoring service for the French Space Command (07-07)
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- Added information about Russian launches of satellites for Iran (09-05)
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- Added details about US Cyber Command's cyberattack during the first Trump administration against the Wagner Group (15-10)
- Added research concluding that 161 cyber operations had been aimed at space between 2022 and 2025, in the context of the Russian-Ukrainian War (15-11)
- Added more details of a CIA document that says China is working to develop cyber capabilities against satellites (15-12)
- Added information on North Korean view that cyber capabilities can provide it with an asymmetric advantage (15-12)
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ACKNOWLEDGE - MENTS



Laetitia Cesari

Catherine Dill

Gilles Doucet

Kylee Dickinson

Jeffrey Edmonds

Laura Grego

Brandon Kelley

Emily Kunasek

Marissa Martin

Louison Mazeaud

Jonathan McDowell

Sean O'Connor

Pavel Podvig

Kevin Pollpeter

Robert Ronci

Tamara Tanso

Seth Walton

Josh Wolny

This publication would not have been possible without the contributions from the following individuals who contributed their time and expertise in a personal capacity in developing the original and subsequent editions. We are deeply grateful for their expertise and commitment.

Special thanks go to Brian Weeden, the report's original instigator and co-editor through the 2024 version; none of this would have happened without him.

This work is a synthesis of all these individual contributions with those from SWF staff, and as such, Secure World Foundation bears all responsibility for any errors or omissions.

We would also like to thank Kratos for assisting with some of the imagery and graphics.

FOREWORD



Space security has become an increasingly salient policy issue. Over the last decade, there has been growing concern from multiple governments about the reliance on vulnerable space capabilities for national security and the corresponding proliferation of offensive counterspace capabilities that could be used to disrupt, deny, degrade, or destroy space systems. This in turn has led to increased rhetoric from some countries about the need to prepare for future conflicts on Earth to extend into space and calls from some corners to increase the development of offensive counterspace capabilities and put in place more aggressive policies and postures.

Unfortunately, much of this debate has taken place out of sight of the public, largely due to the reluctance of most countries to talk openly about the subject. Part of this can be traced to the classified nature of the intelligence on offensive counterspace capabilities and to the unwillingness to reveal details that could compromise sources and methods. But part of it is also the political sensitivity of the topic and the discrepancies between what countries say in public and what they may be doing behind the scenes. At the same time, some media outlets and pundits have used what little information is known to make hyperbolic claims that do not add constructively to the debate.

We feel strongly that a more open and public debate on these issues is urgently needed. Space is not the sole domain of militaries and intelligence services, nor is space security and stability something that only matters to geopolitical rivals. Our global society and economy are increasingly dependent on space capabilities, and a future conflict in space could have massive, long-term negative repercussions that are felt here on Earth, as everyone on this planet is a user of space data in some form. The public should be as aware of the developing threats and risks of different policy options as would be the case for other national security issues in the air, land, and sea domains.

The purpose of the project is to provide a public assessment of counterspace capabilities being developed by countries based on unclassified information. We hope doing so will increase public knowledge of these issues, the willingness of policymakers to discuss these issues openly, and the involvement of other stakeholders in the debate.

Finally, we must note that this publication is not meant to be the conclusive answer on these issues. We have done our best to base our findings and assessments on publicly available data, and we would like to thank our expert contributors for their hard work on this issue. However, some of the topics discussed here are difficult to assess using open sources, and we acknowledge that significant gaps are likely to remain. Our limited resources also prevented us from covering all the topics we hoped to. We intend to continue to publish updated editions of this publication that address these shortcomings, and work with the broader space community to improve this assessment.

Victoria Samson and Kathleen Brett

INTRODUCTION



The space domain is undergoing a significant set of changes. A growing number of countries and commercial actors are getting involved in space, resulting in more innovation and benefits on Earth but also more congestion and competition in space. From a security perspective, an increasing number of countries are looking to use space to enhance their military capabilities and national security. Most of the space applications being worked on are not new and have been developed by the United States or the Soviet Union since the beginning of the Space Age. Space-based intelligence, surveillance, reconnaissance (ISR), positioning navigation and timing (PNT), and satellite communications (SATCOM) are staples of military space applications. What has changed is the proliferation of these capabilities beyond just superpowers.

The growing use of, and reliance on, space for national security has also led more countries to look at developing their counterspace capabilities.

Counterspace, also known as **space control**, is the set of capabilities or techniques that are used to gain space superiority. **Space superiority** is the ability to use space for one's own purposes while denying it to an adversary for a limited time and location. Accordingly, counterspace capabilities have both offensive and defensive elements, which are both supported by **space situational awareness** (information about the space environment). Defensive counterspace helps protect one's own space assets from attack, while offensive counterspace tries to prevent the adversary from using their space assets. Anti-satellite (ASAT) weapons are a subset of offensive counterspace capabilities, although the satellite itself is only one part of the system that can be attacked. Offensive capabilities can be used to deceive, disrupt, deny, degrade, or destroy any of the three elements of a space system: the satellite, the ground system, or the communication links between them.

A key driver in the proliferation of offensive counterspace capabilities is the increased use of space capabilities to support conventional warfare. For much of the Cold War, space was limited to mainly a strategic role in collecting strategic intelligence, enforcing arms control treaties, and warning of potential nuclear attacks. Although the Cold War saw significant development and testing of counterspace capabilities, the close link between space capabilities and nuclear war provided a level of deterrence against actual attacks on space systems. However, over the last three decades, many of these strategic space capabilities have found new roles by directly supporting conventional wars by

providing operational and tactical benefits to militaries. This has increased the incentives for countries to develop offensive counterspace capabilities, while also decreasing the deterrent value of the nuclear link.

While there are undeniable military benefits to these new uses of space, there are risks as well. First, the growing reliance on space for national security and the proliferation of counterspace capabilities creates an increased risk that incidents in space can spark or escalate conflict on Earth. The sudden loss or interruption of space capabilities during a period of heightened geopolitical tensions could create the assumption that it is the opening salvo of an armed attack, even if it was a natural event or an onboard failure. Second, the actual use of offensive counterspace capabilities could have long-lasting consequences for humanity, whether through the loss of critical space capabilities that underpin the global economy and societies or through the creation of long-lived space debris that hinders future space activities.

To help address this issue, Secure World Foundation began a project in the summer of 2017 to develop an open-source assessment of global counterspace capabilities. We convened a group of international experts to work with our staff to compile publicly available information on the development of counterspace capabilities by several countries. We decided to examine five distinct categories of offensive counterspace capabilities:

Co-Orbital: weapons that are placed into orbit and then maneuver to approach the target to attack it by various means, including destructive and non-destructive;

Direct-Ascent: systems that use ground-, air-, or sea-launched missiles with interceptors that are used to kinetically destroy satellites through force of impact, but are not placed into orbit themselves;

Electronic Warfare: weapons that use radio frequency energy to interfere with or jam the communications to or from satellites;

Directed Energy: weapons that use focused energy, such as laser, particle, or microwave beams to interfere with or destroy space systems; and

Cyber: systems that use software and network techniques to compromise, control, interfere with, or destroy computer systems.

In the 2020 edition, we added space situational awareness (SSA) as a separate category for each of the countries included in the report. SSA is defined as knowledge about the space environment and human space activities and generally includes detection, tracking and characterization of space objects, and space weather monitoring and prediction. While SSA is not uniquely used for counterspace, it is a critical enabler for both offensive and defensive counterspace operations. In some countries, the national security version of SSA is known as Space Domain Awareness (SDA), with an added emphasis on detecting and characterizing threats.

For each of these categories, we assessed what the current and near-term capabilities might be for the countries examined in this report, based on the publicly available information. We also assessed the potential military utility for each capability, which includes both the advantages and disadvantages of the capabilities. Finally, when possible, we examined each country's policy, doctrine, and budget to support the offensive counterspace capabilities being developed. Taken together, this analysis is intended to provide a more holistic picture of

what each country is working on and how these capabilities may be used.

This edition has been updated to include events through February 2026.

All catalogued space objects mentioned in this report are described by three separate identifiers. The first identifier is the public name of the space object as determined by official reports or documents. The second identifier is the international designator, a unique code established by the Committee on Space Research (COSPAR) of the International Council for Science, consisting of the year of launch, a three-digit incrementing launch number of that year, and up to a three-letter code representing the sequential identifier of a piece in a launch. The third identifier is the unique number assigned to the object by the US military in its public satellite catalog, often referred to as the satellite number or satno, which increments by one for each new object catalogued. In this text, the first mention of a space object will include all three identifiers in the format <name> (international designator, satno). Further mentions will include only the public name if it is known or the catalog number if the public name is not known.

The countries we chose to examine in this report are the ones most active in developing their own indigenous offensive counterspace capabilities and for which there is public evidence of these efforts. However, they should not be taken as an exhaustive list of countries doing so. Some of the capabilities, such as cyber or DEW, are difficult to observe while in development and could be much more widely proliferated than indicated herein this report. It is likely, however, that the types of counterspace capabilities being developed by other countries are similar to those discussed in this report.

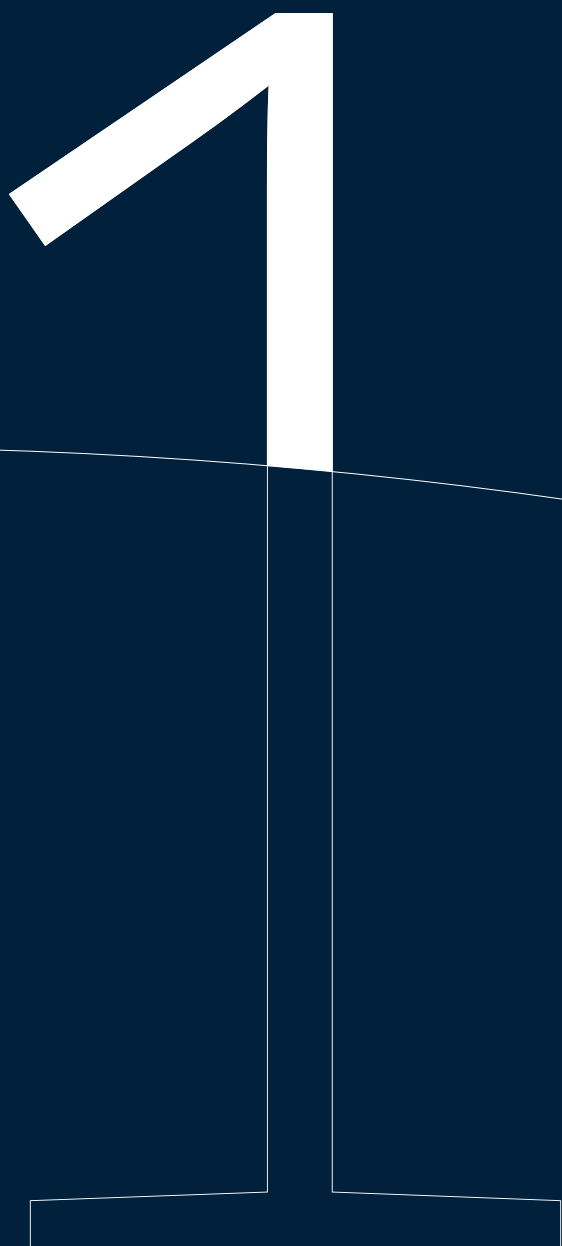
Many of the details contained in this report will not be new to the government experts who have been analyzing these same trends. In fact, we hope that much of our work replicates theirs. However, since much of the government work on these issues is classified or otherwise not divulged to the public, the assessment presented in this report is likely to be new to those who do not have active security clearances. We hope that it provides useful context to the sound bites and headlines being generated over military and political leaders' concerns about counterspace and space superiority.

Finally, while we have strived to make this report as unbiased and accurate as possible, like all analytical products, it should be read with a degree of skepticism. A significant degree of judgment was used in determining which sources of information to include in this report, and how to weigh their impact on the overall assessment. Many of the sources themselves are flawed in that they originate from media reports that similarly are the product of individual judgment about what to report, or not to report. Wherever possible, we tried to include the lowest level of reference for the information presented here so that the reader can bring their own judgment to bear.

In 2022, we did a major restructuring to better highlight the scope of different countries' counterspace activities. The report is now divided into three main sections. Section 1 includes countries that have conducted destructive ASAT tests in space, in chronological order by year of their first test, and ends with an assessment of the space debris created by these tests. Section 2 includes countries that have significant counterspace R&D programs but have not yet done a destructive test. Section 3 focuses on cyber capabilities, given that they are exceedingly difficult to assess on a per-country level based on open-source data. Finally, the report includes two Appendices: one with tables of historical ASAT testing in space, and a second with satellite imagery of major launch, testing, and other facilities discussed in the report.



Countries That Have Conducted Destructive ASAT Tests



38.9072°N

01

THE UNITED STATES

77.0369°W

The United States currently has the most advanced military space capabilities in the world although the relative gap with China is narrowing. During the Cold War, the United States pioneered many of the national security space applications that are in use today and remains the technology leader in nearly all categories. The US military also has the most operational experience of any military in the world in integrating space capabilities into military operations, having done so in every conflict since the 1991 Persian Gulf War against Iraq.

During the Cold War, the United States, like the Soviet Union, had multiple counterspace programs, ranging from nuclear-tipped missiles to conventional DA-ASATs launched from fighter jets. Most of these programs were to counter specific Soviet military space capabilities, such as the ability to use satellites to target US Navy ships with anti-ship missiles. After the fall of the Soviet Union, the United States briefly considered pushing ahead and developing new counterspace systems to solidify its space superiority. However, these efforts never fully materialized due to a range of factors, including domestic budgetary and political pressure, deliberate self-restraint, and the focus on counterterrorism and counterinsurgency campaigns following the 9/11 terrorist attacks.

Today, the United States fields three acknowledged counterspace systems that use electronic warfare capabilities to interfere with satellite signals, but it also has multiple other operational systems that could be used in counterspace roles. The United States has acknowledged it is developing new offensive counterspace capabilities to deny an adversary their own space capabilities in the event of a future conflict. The impetus for this is renewed Russian and Chinese space and counterspace developments and the recent conclusion that the United States is engaged in great power competition with Russia and China. The United States undertook a major reorganization of its military space capabilities by creating a separate military service, the US Space Force, and combatant command, US Space Command, dedicated to space.

The following sections summarize US counterspace development across co-orbital, direct-ascent, electronic warfare, directed energy, and space situational awareness categories, along with a summary of US policy and doctrine on counterspace.

1.1 – US CO-ORBITAL ASAT

Assessment /

The United States has conducted multiple tests of technologies for close approach and rendezvous in both LEO and GEO, along with tracking, targeting, and hit-to-kill (HTK) intercept technologies that could lead to a co-orbital ASAT capability. These tests and demonstrations were conducted for other non-offensive missions, such as missile defense, on-orbit inspections, and satellite servicing, and the United States does not have an acknowledged program to develop offensive co-orbital capabilities. However, the United States possesses the technological capability to develop a co-orbital capability in a short period of time if it chooses to. Additionally, if the United States does move ahead with its plan for a space-based interceptor layer of a proposed “Golden Dome for America,” these weapons would have co-orbital counterspace capabilities.

- 1 To see contemporaneous US government thinking about SDI, see: "SDI and Strategic Modernization," *Foreign Relations of the United States, 1981–1988, Volume XLIV, Part 1, National Security Policy, 1985–1988*, Office of the Historian, US Department of State, accessed March 8, 2026, <https://history.state.gov/historicaldocuments/frus1981-88v44p1/ch1>.
- 2 Paul Stares, "The Militarization of Space: US Policy, 1945–1984," *Cornell University Press*, August 1, 1985, pp. 112.
- 3 Stares, "The Militarization of Space: US Policy, 1945–1984," *ibid.*, p. 112–113.
- 4 Stares, "The Militarization of Space: US Policy, 1945–1984," *ibid.*, p. 115.
- 5 John Dassoulas and Michael D. Griffin, "The Creation of the Delta 180 Program and Its Follow-ons," *Johns Hopkins APL Technical Digest*, vol. 11, Numbers 1 and 2 (1990): p.86, <https://www.jhuapl.edu/Content/techdigest/pdf/V11-N1-2/V11-01-Dassoulas.pdf>.
- 6 "VSE (Delta-180, DM-43)," *Gunter's Space Page*, accessed March 22, 2018, http://space.skyrock-et.de/doc_sdat/vse.htm.

Specifics /

Although the United States never had an operational co-orbital ASAT program during the Cold War, it has had proposals for such a program and did test and develop many of the underlying technologies. Most notably, several of the technologies for space-based ballistic missile intercepts developed as part of the Strategic Defense Initiative (SDI) during the 1980s, could have been used to intercept satellites as well.¹

Project SAINT

Project SAINT (also known as the Satellite Inspector Program) was a USAF effort to develop a system that could be used initially as a satellite inspector but could be turned into a co-orbital ASAT weapon. The concept began because of a set of studies done from 1956 through 1959 on ways to defend against hostile satellites.² Following those studies, the USAF developed initial ideas for three different concepts: one that was uncrewed and ground-launched, one that was uncrewed and air-launched, and a third that was crewed. In 1960, the USAF pressed forward with a "satellite inspector" version of the program in response to concerns about an unidentified space object that was detected in December 1959, which later turned out to be a piece of debris from the US Discoverer V satellite (1959-005A, 18).³

The inspector concept called for the SAINT vehicle to be launched into orbit on an Atlas booster, after which it would match orbits with the target and use onboard television cameras and radars to inspect the target from as close as 50 feet. However, the USAF also hoped that a later version of the SAINT vehicle would include a kill mechanism, such as high-explosive rockets. The USAF planned for an initial set of four intercept tests beginning in 1963 and for SAINT to be fully operational by the summer of 1967.⁴ However, lack of budget support and political concerns led to the program's cancellation in 1962, before any on-orbit tests were conducted.

Delta 180

Although not explicitly designed as a co-orbital ASAT weapon, the United States did conduct a successful co-orbital intercept during the Delta 180 experiment as part of the SDI. The goal of the Delta 180 experiment was to better understand tracking, guidance, and control for a space intercept of an accelerating target.⁵ The experiment involved modifying the second stage of a Delta 2 rocket (D2) to carry a sophisticated tracking system that included laser ranging, ultraviolet, visible, and infrared sensors. The payload consisted of a McDonnell Douglas PAS (Payload Assist System) platform combined with the warhead and seeker from a Phoenix air-to-air missile and D2 rocket motors. The Delta 180 rocket was launched from the Cape Canaveral Air Force Station (CCAFS) on September 5, 1986, and two objects (Delta 1 R/B, 1986-069B, 16938; USA 19, 1986-069A, 16937), presumably the D2 and PAS, respectively, were placed into a 220 km circular orbit. The PAS maneuvered to a separation distance of 200 km, and 90 minutes after launch, the D2 observed the launch of an Aries rocket from White Sands Missile Range. At 205 minutes after launch, the D2 and PAS both ignited their engines on an intercept course, colliding at a combined speed of nearly 3 km/s.⁶ Sixteen pieces of orbital debris from the collision were catalogued with apogees as high as 2,300 km. Due to the low altitude of the intercept, most of the pieces reentered the atmosphere within two months. The final piece of debris reentered on April 4, 1987, more than seven months after the test.

Recent US LEO RPO Activities

Since the end of the Cold War, the USAF, National Aeronautics and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA), and other US government agencies have all conducted tests and demonstrations of close approach and rendezvous technologies in LEO. On January 29, 2003, the USAF launched the XSS-10 (2003-005B, 27664) as a secondary payload on a D2 rocket carrying a US military GPS satellite. After the GPS satellite was deployed and the Delta upper stage (203-005C, 27665) conducted its passivation burns, the XSS-10 was released. It then conducted a pre-planned series of RPO maneuvers near the Delta upper stage, eventually closing to within 50 m.⁷ XSS-11 (2005-011A, 28636) was launched on April 11, 2005, and according to the official fact sheet, proceeded to “successfully demonstrate rendezvous and proximity operations with the expended rocket body [that placed it in orbit].”⁸ The fact sheet also stated that over the following 12 to 18 months, the spacecraft “conduct[ed] rendezvous and proximity maneuvers with several US owned, dead or inactive resident space objects near its orbit.” However, it is impossible to verify whether these activities occurred and whether XSS-11 visited any non-US space objects because the US military did not publish any positional information for the XSS-11 while in orbit.⁹

- 7 Thomas M. Davis and David Melanson, “XSS-10 Micro-Satellite Flight Demonstration,” Paper No. GT-SSEC.D.3: p.7, https://smartech.gatech.edu/bitstream/handle/1853/8036/SSEC_SD3_doc.pdf;jsessionid=906BB-52FE69F848048883B704DB20F07.smart2?sequence=2.
- 8 “XSS-11 Micro Satellite,” Fact Sheet: Air Force Research Laboratory, Space Vehicles Directorate, current as of September 2011, accessed March 22, 2018, p.1, <http://www.kirtland.af.mil/Portals/52/documents/AFD-111103-035.pdf?ver=2016-06-28-110256-797>.
- 9 An engineer who worked on the program wrote about his experience with it, discussing the RPOs it undertook; see Jack Anthony, “Jack’s Astro Corner XSS-11 - Daring Greatly in Rendezvous & Proximity Operations (RPO) (Part 3 of 3) by Jack Anthony, *Integrity Flash Issue* 127, August 18, 2025, <https://isruniversity.com/2025/08/18/issue-127/>.
- 10 “XSS-11 Micro Satellite,” *ibid*, p.2.
- 11 “Overview of the DART Mishap Investigation Results,” NASA, accessed March 22, 2018, http://www.nasa.gov/pdf/148072main_DART_mishap_overview.pdf.

FIGURE 1-1 – MINOTAUR UPPER STAGE



The image was taken by XSS-11 from a distance of approximately 500 m. Image credit: AFRL.¹⁰

On April 15, 2005, NASA launched the DART satellite (2005-014A, 28642) to conduct an autonomous rendezvous experiment with a US Navy communications satellite, the MUBLCOM satellite (1999-026B, 25736). DART ended up “bumping” into MUBLCOM during the test, and although both satellites were apparently unharmed, the public version of NASA’s mishap report lacks details as to why the collision happened.¹¹

DARPA also conducted a demonstration of close approach and rendezvous technology in the context of satellite servicing with its Orbital Express mission. Orbital Express consisted of two spacecraft, the ASTRO servicing vehicle (2007-006A, 30772) and the NEXTSat client vehicle (2006-006C, 30774). On March 8, 2007, the two spacecraft were launched from CCAFS on an Atlas V rocket and placed into a roughly 500 km circular orbit. After checkout, the ASTRO demonstrated the ability to autonomously transfer fluid to NEXTSat and use a robotic arm to swap out components. The two spacecraft then

- 12 "Orbital Express – Mission Updates," *Boeing, Defense, Space & Security PhantomWorks*, accessed March 22, 2018, https://web.archive.org/web/20121017163534/http://www.boeing.com/bds/phantom_works/orbital/updates.html.
- 13 Stephen Clark, "In-space Satellite Servicing Tests Come to an End," *Spaceflight Now*, July 4, 2007, <http://spaceflightnow.com/news/n070704orbitalexpress/>.
- 14 "Orbital Express: Testing On-Orbit Servicing," *Defense Industry Daily*, April 19, 2007, <https://www.defenseindustrydaily.com/orbital-express-is-that-a-new-battery-or-are-you-just-glad-to-see-me-03220/>.
- 15 Stephen Clark, "Air Force spaceplane is an odd bird with a twisted past," *Spaceflight Now*, April 2, 2010, <https://www.spaceflightnow.com/atlas/av012/100402x37update/>.
- 16 Vanessa Young, "New unmanned spacecraft set to launch," *Air Force News Service*, April 16, 2010, <https://www.af.mil/News/Article-Display/Article/116970/new-unmanned-spacecraft-set-to-launch/>.
- 17 Stephen Clark, "Atlas rocket delivers Air Force spaceplane to orbit," *Spaceflight Now*, April 22, 2010, <https://www.spaceflightnow.com/atlas/av012/100422launch/>.
- 18 "X-37B Orbital Test Vehicle lands at Vandenberg AFB," *Air Force News Service*, December 10, 2010, <https://www.af.mil/News/Article-Display/Article/114795/x-37b-orbital-test-vehicle-lands-at-vandenberg-afb/>.
- 19 Amaani Lyle, "Air Force launches second unmanned spacecraft," *Secretary of the Air Force Public Affairs*, March 5, 2011, <https://www.patrick.spaceforce.mil/News/Article-Display/Article/330116/air-force-launches-second-unmanned-spacecraft/>.

separated and spent the next few months demonstrating multiple rendezvous and capture scenarios, including the first-ever use of a robotic arm to autonomously capture another space object.¹² The two spacecraft were deactivated in July 2007.¹³

FIGURE 1-2 — ORBITAL EXPRESS MISSION PLAN

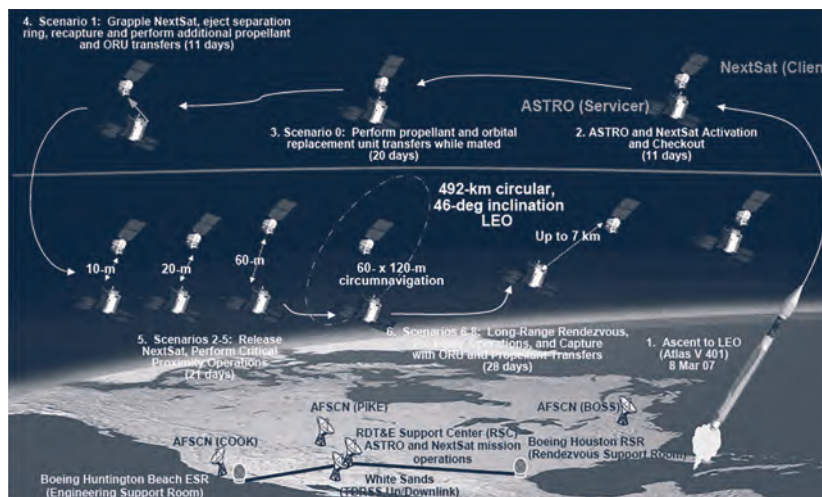


Image credit: Boeing.¹⁴

X-37B Robotic Spaceplane

The X-37B is a reusable robotic spacecraft that serves as a technology demonstrator and experimental vehicle. It is launched into orbit on an SLV, can stay in orbit for an extended period of time, and glides to a runway landing.¹⁵ The original X-37A was developed by NASA and derived from Space Shuttle concepts before being transferred to DARPA in 2004. In 2006, the USAF took over the program and developed a new version, the X-37B, and produced two spacecraft known as Orbital Test Vehicles (OTVs) that have since flown seven missions, likely for testing new reusable space launch vehicle technologies (such as guidance and thermal protection) and on-orbit testing of new sensor technologies and satellite hardware for risk reduction.

The first flight of the X-37B was in April 2010. OTV-1 (2010-015A, 36514) was launched on a United Launch Alliance-built Atlas V Evolved Expendable Launch Vehicle. The program was described to be a "flexible space test platform to conduct various experiments" and that it will "allow satellite sensors, subsystems, components and associated technology to be efficiently transported to and from the space environment."¹⁶ A Boeing spokesperson said, "This first flight will demonstrate the readiness of the X-37B to begin serving the Air Force as it continues to investigate ways to make space access more routine, affordable and responsive."¹⁷ It landed at Vandenberg Air Force Base, California, in December 2010 after 224 days in orbit; Lt. Col. Troy Giese, the X-37B program manager, stated, "We are very pleased that the program completed all the on-orbit objectives for the first mission."¹⁸ The specifics were not given.

The second flight of the X-37B, OTV-2 (2011-010A, 37375), began in March 2011 with a launch via the Atlas V rocket from Cape Canaveral Air Force Station, Florida. This was the second vehicle of the X-37B program. Program officials again did not say anything specific about the mission but did anticipate that it would be able to stay on orbit for 270 days, given analysis of OTV-1's performance parameters.¹⁹ They also indicated that they would be looking at "the performance of its advanced thermal protection systems and

tiles, solar power systems and environmental modeling,” as well as possibly landing in a more challenging environment with higher winds.²⁰ Around the 270-day mark of its flight, Air Force officials announced that they were extending its mission to allow for “additional experimentation opportunities;” it eventually landed at Vandenberg Air Force Base, California, in June 2012, after 469 days in orbit.²¹

The third flight of the X-37B, OTV-3 (2012-071A, 39025), was the first to reuse a flight vehicle; in this case, it was the vehicle used in OTV-1. It was originally intended to be launched in October 2012, but due to a flight anomaly with a different version of the Atlas 5’s RL-10 engine on Oct. 4, 2012, it was decided to push back the launch until the anomaly investigation and a crossover assessment of the X-37B launch could be completed.²² It ended up being launched in December 2012 via an Atlas 5 from Cape Canaveral Air Force Base, Florida, with one of the missions given as intending to “incorporate the lessons learned during the refurbishment process on OTV-1;” it spent 675 days in orbit before landing in October 2014, again at Vandenberg Air Force Base, California.²³

In May 2015, OTV-4 (2015-025A, 40651) was launched via an Atlas 5 launch rocket from Cape Canaveral Air Force Base, Florida; program officials would not confirm at the time of launch which vehicle was being used for the mission.²⁴ They did state that OTV-4 would be carrying a Hall thruster (ion engine) in order to experiment with the technology for its eventual use in the Advanced Extremely High Frequency (AEHF) military satellite program; it was intended to see how the thruster performed and its effect on OTV-4.²⁵ Additionally, NASA officials stated that OTV-4 would be carrying Materials Exposure and Technology Innovation in Space (METIS), a program intended to test almost 100 different types of materials to the space environment for over 200 days; this was a follow-on to a similar experiment on the ISS known as Materials on International Space Station Experiment (MISSE).²⁶ OTV-4 ended up landing at NASA’s Space Shuttle Landing Site at the Kennedy Space Center, Florida, in May 2017, after 718 days in space; this was the first time the vehicle had landed at that site.²⁷

In September 2017, OTV-5 (2017-052A, 42932) was launched from the Kennedy Space Center, Florida, via (for the first time) SpaceX’s Falcon 9 reusable launch vehicle to a higher inclination orbit; it was announced that the mission would be carrying “small satellite rideshare” and an “Advanced Structurally Embedded Thermal Spreader payload to test experimental electronics and oscillating heat pipe technologies in the long duration space environment.”²⁸ On October 27, 2019, the OTV-5 flight of the X-37B completed an, at that time, record-breaking 780-day stay in orbit with a landing at NASA’s Kennedy Space Center Shuttle Landing Facility. In a press release, the director of the Rapid Capabilities Office stated that as part of its mission it had provided a ride for small satellites.²⁹ Although a similar reference was made during the launch of OTV-5 in September 2017, it was perceived at that time to be small satellite ride shares that would be attached to the upper stage of the Falcon 9 booster that placed it into orbit, as has been done on previous launches. However, no such deployment was announced nor catalogued by the US military after the launch of OTV-5, leading to the conclusion that the deployment must have occurred from the X-37B itself later in the mission. On February 11, 2020, the US military catalogued three new satellites associated with OTV-5: USA 295 (45169, 2017-052C), USA 296 (45170, 2017-052D), and USA 297 (45171, 2017-052E). However, no orbital information was provided for those three satellites. On February 12, the catalog was updated to reflect that they were no longer in orbit. An analysis done by Dr. Marco Langbroek suggests the three cubesats had to be deployed before August 2018 if they were of 3U size.³⁰

- 20 Lyle, “Air Force launches second unmanned spacecraft,” *ibid*.
- 21 Stephen Clark, “Military space shuttle receives mission extension,” *Spaceflight Now*, November 29, 2011, <https://www.spaceflightnow.com/news/n111/29otv2/>; “X-37B Orbital Test Vehicle lands at Vandenberg,” *30th Space Wing Public Affairs*, June 16, 2012, <https://www.vandenberg.spaceforce.mil/News/Article-Display/Article/338649/x-37b-orbital-test-vehicle-lands-at-vandenberg/>.
- 22 Amy McCullough, “X-37B Launch Delayed,” *Air Force Magazine*, October 25, 2012, <https://web.archive.org/web/20140220190719/http://www.airforcemag.com/DRArchive/Pages/2012/October%202012/October%2025%202012/X-37BLaunchDelayed.aspx>.
- 23 Eric Badger, “Air Force launches 3rd X-37B Orbital Test Vehicle,” *Air Force News Service*, December 11, 2012, <https://www.af.mil/News/Article-Display/Article/109994/air-force-launches-3rd-x-37b-orbital-test-vehicle/>; Stephen Clark, “US military’s X-37B space plane lands in California,” *Spaceflight Now*, October 17, 2014, <https://spaceflightnow.com/atlas/av034/141017landing/>.
- 24 Justin Ray, “X-37B embarks on fourth voyage in orbit,” *Spaceflight Now*, May 20, 2015, <https://spaceflightnow.com/2015/05/20/recap-story-x-37b-embarks-on-fourth-voyage-in-space/>.
- 25 David Szondy, “Hall ion thrusters to fly on X-37B spaceplane,” *New Atlas*, April 29, 2015, <https://newatlas.com/us-air-force-x-37b-hall-thruster/37200/>.
- 26 Justin Ray, “NASA gives more information on its experiment aboard the X-37B,” *Spaceflight Now*, May 6, 2015, <https://spaceflightnow.com/2015/05/06/nasa-gives-more-information-on-its-experiment-aboard-the-x-37b/>.
- 27 Jeff Foust, “X-37B lands after record-setting mission,” *SpaceNews*, May 7, 2017, <https://spacenews.com/x-37b-lands-after-record-setting-mission/>.
- 28 “Air Force preparing to launch fifth Orbital Test Vehicle mission,” *Air Force News Service*, August 31, 2017, <https://www.af.mil/News/Article-Display/Article/1296566/air-force-preparing-to-launch-fifth-orbital-test-vehicle-mission/>; “45th SW launches 5th OTV mission,” *Air Force News Service*, September 7, 2017, <https://www.af.mil/News/Article/1301794/45th-sw-launches-5th-otv-mission/>.
- 29 Secretary of the Air Force Public Affairs, “X-37B Breaks Record, Lands After 780 Days In Orbit,” *United States Air Force*, October 27, 2019, <https://www.af.mil/News/Article-Display/Article/1999734/x-37b-breaks-record-lands-after-780-days-in-orbit/>.
- 30 Marco Langbroek, “Launching Cubesats From the X-37B OTV 5: Lifetime Modelling With GMAT,” *SatTrackCam Leiden (blog)*, February 21, 2020, <https://sattrackcam.blog-spot.com/2020/02/launching-cubesats-from-x-37b-otv-5.html>.

- 31 Stephen Clark, "Upgraded X-37B spaceplane rockets into orbit aboard Atlas 5 launcher," *Spaceflightnow.com*, May 17, 2020, <https://spaceflightnow.com/2020/05/17/upgraded-x-37b-spaceplane-rockets-into-orbit-aboard-atlas-5-launcher/>; "X-37B orbital test vehicle concludes sixth successful mission," *Space Force News*, November 12, 2022, <https://www.spaceforce.mil/News/Article/3217077/x-37b-orbital-test-vehicle-concludes-sixth-successful-mission/>.
- 32 Jonathan McDowell, "The X-37 spaceplane OTV-6 has released a subsatellite, USA 300 (catalog 45610, 2020-029B). No orbital data have been released," *Twitter*, May 30, 2020, <https://twitter.com/planet4589/status/1266781929078231041>.
- 33 Joseph Trevithick, "X-37B's Power Beaming Payload A Reminder Of Potential Orbital Microwave Anti-Satellite Weapons," *The War Zone*, May 19, 2020, <https://www.thedrive.com/the-war-zone/33531/x-37bs-power-beaming-payload-a-reminder-of-potential-orbital-microwave-anti-satellite-weapons>.
- 34 Thomas Newdick, "Details About X-37B Payload Adapter Revealed After Record-Setting Mission," *The War Zone*, November 14, 2022, <https://www.thedrive.com/the-war-zone/details-about-x-37b-payload-adapter-revealed-after-record-setting-mission>.
- 35 Joseph Trevithick, "Look At An X-37B In Space With An Extended Payload Module," *The War Zone*, December 29, 2023, <https://www.twz.com/this-appears-to-be-our-first-look-at-an-x-37b-in-space>.
- 36 Dmitry Stefanovich, "Sometimes VPK still delivers. What looked like a pack of traditional space-related narratives and accusations RE: destabilizing US space activities by Kozin unexpectedly included a very, very specific detail about recent stuff done by the X-37B (of course)," *Twitter*, December 8, 2021, <https://twitter.com/KomissarWhipla/status/1468593293235793924?s=20>; Vladimir Kozin, "Cold Star War: The US has Questions for Moscow about Space, Russia has even more Questions for the US," *VKP-News*, November 29, 2021, <https://vpk-news.ru/articles/64859>.
- 37 Stefano D'Urso and David Cenciotti, "Reflecting On The X-37B's Latest Record-Breaking Mission," *The Aviationist*, December 24, 2022, <https://theaviationist.com/2022/12/24/reflecting-on-the-x-37bs-latest-record-breaking-mission/>.
- 38 Newdick, "Details About X-37B Payload Adapter Revealed After Record-Setting Mission," *ibid*.
- 39 Mike Wall, "SpaceX Falcon Heavy rocket launches mysterious X-37B space plane for US Space Force after delays," *Space.com*, December 28, 2023, <https://www.space.com/spacex-falcon-heavy-x-37b-space-plane-launch-success>.
- 40 "Department of the Air Force scheduled to launch seventh X-37B mission," *Air Force News Service*, November 8, 2023, <https://www.spaceforce.mil/News/Article-Display/Article/3583347/department-of-the-air-force-scheduled-to-launch-seventh-x-37b-mission/>.
- 41 "X-37B begins novel space maneuver," *Secretary of the Air Force Public Affairs*, October 10, 2024, <https://www.spaceforce.mil/News/Article-Display/Article/3932137/x-37b-begins-novel-space-maneuver/>.
- 42 Jonathan McDowell, "Congrats to Tomi Simola for locating the secret X-37B spaceplane. OTV 7 is in a 323 x 38838 km x 59.1 deg orbit. Could be testing out a new HEO IR sensor for future early warning satellites - just a wild speculation on my part here," *Twitter*, February 9, 2024, <https://twitter.com/planet4589/status/1755974823119872007?s=20>.

The next launch of the X-37B was OTV-6 (2020-029A, 45606) in May 2020, carrying for the first time a new service module at its end that would give it more room for payloads and experiments; one of which was a satellite, FalconSAT 8, built by students at the USAF Academy, and which was deployed in October 2021.³¹ OTV-6 released another subsatellite at the end of May 2020, which was catalogued by the US military as USA 300 (2020-029B, 45610), indicating it was another separate payload.³² OTV-6 also tested an on-orbit power beaming system, the US Naval Research Laboratory (NRL)'s Photovoltaic Radio-frequency Antenna Module (PRAM), that collected solar power and transformed it into a microwave beam. This was the first test of such capabilities in space and could eventually lead to large-scale space-based solar power, but could also provide offensive DEW counterspace capabilities.³³ OTV-6 also carried NASA payloads that did not separate, including Materials Exposure and Technology Innovation in Space (METIS-2), which tested candidate radiation shielding materials, printed electronic materials, and thermal control coatings; METIS-1 had been on OTV-5.³⁴ Boeing and SpaceX later released a video showing the X-37B and its payload module separating from the launch rocket.³⁵ Russian reports claimed that the X-37B released a small object in October 2021, which spent a day keeping about 200 meters away from the object, and then moved away from it.³⁶ The US military's public satellite catalog lists an additional object associated with the launch as USA 299 DEB (2020-029D, 54246) but has not provided orbital data for any objects associated with OTV-6 before it returned to Earth.

OTV-6 landed in November 2022 after spending 908 days in orbit, which was a new record for the X-37B.³⁷ The service module separated from the plane prior to landing and is thought to have burned up in the Earth's atmosphere during reentry; Secretary of Air Force Frank Kendall stated, "The deliberate manner in which we conduct on-orbit operations to include the service module disposal speaks to the United States' commitment to safe and responsible space practices, particularly as the issue of growing orbital debris threatens to impact global space operations."³⁸

The next X-37B mission was OTV-7 (USA 349, 2023-210A, 58666), which was launched in December 2023 after being delayed twice, first due to weather, and then second because of ground equipment issues.³⁹ USSF officials said prior to the launch that tests of the X-37B would include "operating the reusable spaceplane in new orbital regimes, experimenting with future space domain awareness technologies, and investigating the radiation effects on materials provided by NASA."⁴⁰ A later USAF Public Affairs press release clarified that it has, "conducted radiation effect experiments and has been testing Space Domain Awareness technologies in a Highly Elliptical Orbit."⁴¹ It was spotted by an amateur astronomer in February 2024 in a HEO of 323 x 38,838 km x 59.1 deg inclination,⁴² which is significantly higher than earlier test flights (which stayed well within LEO) and also distinct from other well-known HEO missions, such as the Soviet/Russian Molniya satellites.

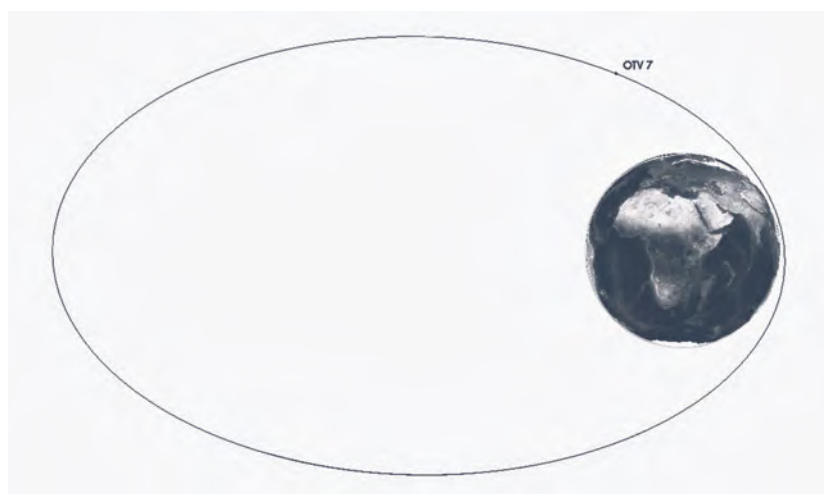
FIGURE 1-3 – X-37B OTV 7 HIGHLY ELLIPTICAL ORBIT

Image credit: Marco Langbroek.⁴³

The USSF announced in October 2024 that OTV-7 would undertake aerobraking maneuvers, a series of passes through the Earth's atmosphere to lower its orbit in a manner that uses less fuel, in order for it to get to a low enough orbit that it could safely discard its service module components "in accordance with recognized standards for space debris mitigation."⁴⁴ Chief of Space Operations Chance Saltzman said that part of the reason why the United States announced that it intended to do the aerobraking maneuvers was that, "We wanted to let everybody know that we were going to do it... We want other nations to observe it. We want to share the data."⁴⁵ In order to do the aerobraking maneuvers, the vehicle had to undergo modifications, including the development of a new collision avoidance system.⁴⁶ This is a new capability for the program. It is unclear how long the procedure took, and after its completion, OTV-7 was anticipated to go back to its planned experiments and testing, but it is not clear if it went back to HEO or stayed in LEO.⁴⁷ From the mission's launch to February 21, 2025, the USSF reported it had identified 1.7 million "collision avoidance opportunities;" it is not clear what that means.⁴⁸ On February 21, 2025, the USSF released a picture of Earth taken from OTV-7 (and some of the vehicle itself); internet sleuths were able to identify the date of the picture (January 30, 2024) and altitude of the vehicle at its apogee (38,318 km).⁴⁹ USSF officials noted that they are able to evaluate how well the US Space Surveillance Network's radars and telescopes track the vehicle, as well as monitor how other countries' sensors locate and track OTV-7. On March 7, 2025, the OTV-7 landed at Vandenberg Space Force Base, ending the seventh mission of the X-37B after 434 days in orbit.

The most recent flight of the X-37B, OTV-8 (2025-183A, 65271), started on August 21, 2025, with a launch on a Falcon 9 from Kennedy Space Center Launch Complex 39A.⁵⁰ The USSF press release about it did not talk specifically about the OTV-8's mission, but rather said of the whole program, "The X-37B is a dynamic and responsive spacecraft responsible for conducting a range of tests and experiments that expedite the development of critical next-generation technologies and operational concepts for reusable space capabilities."⁵¹ Its builder, Boeing, said that OTV-8 "is hosting several technology demonstrations from government partners on this mission, include laser communications and a quantum inertial sensor designed to support navigation when GPS is unavailable;" these partners include Air Force Research Laboratory and Defense Innovation Unit.⁵² As of February 2026, OTV-8 is still in orbit.

43 Marco Langbroek, "Imaging the X-37B robotic spaceplane mission OTV-7," *SatTrackCam Leiden (b)log*, February 13, 2024, <https://sattrackcam.blogspot.com/2024/02/imaging-x-37b-robotic-spaceplane.html>.

44 "X-37B begins novel space maneuver," *ibid*.

45 Vivienne Machi, "How The X-37B Is Shaping The Future Of The US Space Force," *Aviation Week Network*, February 21, 2025, <https://aviation-week.com/space/budget-policy-regulation/how-x-37b-shaping-future-us-space-force>.

46 Machi, "How The X-37B Is Shaping The Future Of The US Space Force," *ibid*.

47 Sandra Erwin, "X-37B to jettison payload module in orbital shift, Space Force announces," *SpaceNews*, October 10, 2024, <https://space-news.com/u-s-military-spaceplane-to-perform-orbital-maneuvers/>.

48 Erwin, "X-37B to jettison payload module in orbital shift, Space Force announces," *ibid*.

49 Marco Langbroek, "Close enough, the released X-37B OTV-7 image seems to have been taken on January 30th 2024 based on the photo meta-data below and attached cloud pattern match," *Twitter*, February 21, 2025, <https://x.com/DutchSpace/status/1893015064816259540>; Grycan Alain, "Meteosat MGS and Heavensat confirm January 30, 2024 around 2:30 p.m. UTC. Altitude 38318 km near apogee," *Twitter*, February 21, 2025, <https://x.com/AlainGrycan/status/1893054100008292863>.

50 Secretary of the Air Force Public Affairs, "US Space Force launches eighth X-37B mission," *Air Force News Service*, August 22, 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4283172/us-space-force-launches-eighth-x-37b-mission/>.

51 "US Space Force launches eighth X-37B mission," *ibid*.

52 "Boeing-Built X-37B Spaceplane Launches, Beginning Eighth Mission," Boeing press release, August 22, 2025, <https://boeing.mediaroom.com/2025-08-22-Boeing-Built-X-37B-Spaceplane-Launches,-Beginning-Eighth-Mission>.

53 Secretary of the Air Force Public Affairs, "X-37B Orbital Test Vehicle concludes seventh successful mission," United States Space Force, March 13, 2025, <https://www.spaceforce.mil/News/ArticleDisplay/Article/4112259/x-37b-orbital-test-vehicle-concludes-seventh-successful-mission/>.

54 @USSpaceForce, "An X-37B onboard camera, used to ensure the health and safety of the vehicle, captures an image of Earth while conducting experiments in HEO in 2024," *Twitter*, February 21, 2025, <https://x.com/SpaceForceDoD/status/1892960033513554202>.

Table 1-1 sums up all OTV flights to date.⁵³

TABLE 1-1 – X-37B FLIGHT HISTORY

LAUNCH DATE	LAUNCH LOCATION	LANDING DATE	LANDING LOCATION	TIME ON ORBIT	VEHICLE
Apr. 22, 2010	Cape Canaveral, FL	Dec. 3, 2010	Vandenberg Air Force Base, CA	224 days	OTV-1
Mar. 5, 2011	Cape Canaveral, FL	Jun. 16, 2012	Vandenberg Air Force Base, CA	469 days	OTV-2
Dec. 11, 2012	Cape Canaveral, FL	Oct. 17, 2014	Vandenberg Air Force Base, CA	675 days	OTV-3
May 20, 2015	Cape Canaveral, FL	May 7, 2017	Kennedy Space Center, FL	718 days	OTV-4
Sep. 7, 2017	Cape Canaveral, FL	Oct. 27, 2019	Kennedy Space Center, FL	780 days	OTV-5
May 17, 2020	Cape Canaveral, FL	Nov. 12, 2022	Kennedy Space Center, FL	908 days	OTV-6
Dec. 28, 2023	Kennedy Space Center, FL	Mar. 7, 2025	Vandenberg Space Force Base, CA	434 days	OTV-7
Aug. 21, 2025	Kennedy Space Center, FL	–	–	–	OTV-8

FIGURE 1-4 – X-37B OTV-7 IN ORBIT



Image credit: USSF⁵⁴

The mission of the X-37B has long been a source of mystery and speculation. While the US government has acknowledged the existence of the X-37B program and announced launches and landings, it has been secretive about the mission of the X-37B and its location and activities while on orbit. Officially, the USSF has stated that the X-37B is a platform for testing new technologies and operational concepts.⁵⁵ However, the secrecy has led to a large amount of speculation, particularly by Russia and China, that the X-37B is some sort of orbital bomber or secret weapons testing platform. Not helping calm concerns about its mission was the release of the USSF's first official painting in October 2023, which showed a military space plane described only as a "futuristic intercept vehicle" getting ready to engage with an enemy satellite; the USSF stated that they had the artist "rely on historic space planes and his own imagination" for the painting.⁵⁶ Complicating things further is that the USSF's Space Delta 9 is now responsible for overseeing the X-37B's operations once it is in orbit. Space Delta 9 "conducts protect and defend operations from space and provides response options to deter and defeat adversary threats in space."⁵⁷

Analyzing the known facts about the size, shape, and orbit of the X-37B provides a more useful answer. The spaceplane resembles the now-retired space shuttle orbiter in overall shape but is much smaller, completely robotic, and as initially designed, has a payload bay that is roughly the size of a pickup truck bed.⁵⁸ The ring-shaped service module added for OTV-6 does increase what it can carry. However, it still has a limited ability to host weapons, and its limited gliding capability and maneuverability makes it not militarily useful as an orbital bomber.⁵⁹ Based on tracking data from hobbyists, the X-37B historically has orbited between 300 and 400 km and at inclinations between 38 and 54 degrees with a ground track that repeats every few days. This strongly indicates a likely remote sensing mission, perhaps by flight testing new payloads. Given that the OTV-7 mission was at a much higher altitude of nearly 39,000 km, it is possible it was testing a new type of sensor or payload, but it is unclear what kind or why. While it likely has substantive maneuvering capability, to date, the X-37B has not approached nor rendezvoused with any other space objects.

The secret deployment of multiple small satellites raises additional questions about the mission of the X-37B. It suggests that the X-37B may have a mission to serve as a covert satellite deployment platform. The secrecy surrounding both the X-37B and the deployment may indicate they are part of a covert intelligence program, but it may also indicate the testing of offensive technologies or capabilities. The failure to catalog the deployed satellites—something that is done even for classified US military and intelligence satellites—calls into question the trustworthiness of the public SSA data provided by the US military. However, similar behavior in terms of secret deployments has also been seen by the Chinese Reusable Experimental Spacecraft (see Chinese Co-Orbital ASAT, Section 3.1).

Recent US GEO RPO Activities

The United States has also conducted multiple close approach and proximity operations in GEO. The earliest known example is a satellite reportedly called Prowler. Based on publicly available data, satellite observer Ted Molczan concluded that Prowler was secretly launched from a Space Shuttle mission in 1990,⁶⁰ and matched the description given in a 2004 NBC news article about a classified US government satellite program that had run afoul of Congress.⁶¹ The satellite had reportedly maneuvered close to multiple Russian geosynchronous orbit (GSO) satellites to collect intelligence on their characteristics and capabilities, and utilized stealth technologies to remain undetected by Russian optical space surveillance systems. To this day, the United

- 55 "X-37B Orbital Test Vehicle," *United States Air Force*, September 1, 2018, <https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104539/x-37b-orbital-test-vehicle/>.
- 56 Brett Tingley, "US Space Force's 1st official painting shows military space plane intercepting adversary satellite," *Space.com*, October 24, 2023, <https://www.space.com/space-force-painting-plane-intercepting-satellite>.
- 57 Joseph Trevithick, "Space Force Has A Unit Dedicated To Orbital Warfare That Now Operates The X-37B Spaceplane," *TheDrive.com*, Oct. 30, 2020, <https://www.thedrive.com/the-war-zone/37361/space-force-has-a-unit-dedicated-to-orbital-warfare-that-now-operates-the-x-37b-spaceplane>.
- 58 Tyler Rogoway, "This Is Our First Look At The Secretive X-37B Spaceplane With Its Cargo Bay Doors Open," *TheDrive.com*, Sept. 15, 2020, <https://www.thedrive.com/the-war-zone/36440/this-is-our-first-look-at-the-secretive-x-37b-spaceplane-with-its-cargo-bay-doors-open>.
- 59 Brian Weeden, "X-37B Orbital Test Vehicle Fact Sheet," *Secure World Foundation*, June 1, 2017, https://swfound.org/media/206982/swf_x-37b_otv_fact_sheet.pdf.
- 60 Ted Molczan, "Unknown GEO Object 2000-653A/90007 Identified as Prowler," January 21, 2011, p. 12, http://satobs.org/seesat_ref/STS_38/Unknown_GEO_Object_2000-653A_-_90007_Identified_as_Prowler.pdf.
- 61 Robert Windrem, "What Is America's Top-Secret Spy Program? Experts Think Democrats Objected to Satellite Weapon," *NBC News*, December 9, 2004, http://www.nbcnews.com/id/6687654/ns/us_news-security/t/what-america-top-secret-spy-program/.

- 62 Justin Ray, "Experimental Military Microsatellites Reach Orbit," *Spaceflight Now*, June 22, 2006, <https://www.space.com/2529-experimental-military-microsatellites-reach-orbit.html>.
- 63 Ryan Caron, "Mysterious Microsatellites in GEO: is MiTeX a Possible Anti-Satellite Capability Demonstration?" *TheSpaceReview.com*, July 31, 2006, <http://www.thespacereview.com/article/670/1>.
- 64 Brian Weeden, "The Ongoing Saga of DSP Flight 23," *TheSpaceReview.com*, January 19, 2009, p.1, <http://www.thespacereview.com/article/1290/1>.
- 65 Marco Langbroek, "A NEMESIS in the Sky: PAN, MENTOR 4, and Close Encounters of the SIGINT Kind," *TheSpaceReview.com*, October 31, 2016, <https://www.thespacereview.com/article/3095/1>.
- 66 Marco Langbroek, "PAN (NEMESIS 1) is on the Move Again," *SatTrackCam Leiden Blog*, September 14, 2021, <https://sattrackcam.blogspot.com/2021/09/pan-nemesis-1-is-on-move-again.html>.
- 67 Marco Langbroek, "Recovering USA 310, PAN and Trumpet 2," *SatTrackCam Leiden Blog*, September 10, 2023, <https://sattrackcam.blogspot.com/2023/09/recovering-usa-310-pan-and-trumpet-2.html>.
- 68 Marco Langbroek, "PAN is on the move again," *SatTrackCam Leiden Blog*, September 16, 2023 <https://sattrackcam.blogspot.com/2023/09/pan-is-on-move-again.html>.
- 69 Marco Langbroek, "Dark moves at Geosynchronous altitude: Mentor 6 and Luch (Olymp) 2 have repositioned," *SatTrackCam Leiden (b)log*, April 23, 2024, <https://sattrackcam.blogspot.com/2024/04/dark-moves-at-geosynchronous-altitude.html>.
- 70 Marco Langbroek, "A NEMESIS in the sky," *The Space Review*, October 21, 2016, <https://www.thespacereview.com/article/3095/1>.
- 71 Langbroek, "A NEMESIS in the sky," *ibid*; Gunter D. Krebs, "Nemesis 1, 2 (PAN, CLIO / P360)," *Gunter's Space Page*, accessed March 8, 2026, https://space.skyrocket.de/doc_sdat/nemesis-1.htm.
- 72 Langbroek, "A NEMESIS in the sky," *ibid*.
- 73 Langbroek, "A NEMESIS in the sky," *ibid*.
- 74 Langbroek, "A NEMESIS in the sky," *ibid*.
- 75 Langbroek, "A NEMESIS in the sky," *ibid*.
- 76 Amy Butler, "USAF Reveals Sats to Offer Unprecedented Space Intel," *Aviation Week & Space Technology*, March 3, 2004, <http://aviationweek.com/awin/usaf-reveals-sats-offer-unprecedented-space-intel>.
- 77 "Geosynchronous Space Situational Awareness Program," *USAF*, March 22, 2017, <http://www.afspc.af.mil/About-Us/Fact-Sheets/Article/730802/geosynchronous-space-situational-awareness-program-gssap/>.

States has never officially acknowledged the existence of Prowler and lists it as an extra rocket body from the Shuttle launch in its public satellite catalog.

While Prowler is thought to have been decommissioned in around 1998, it was followed by programs designed for similar missions. In 2006, the USAF launched two small satellites into GSO, officially designated as Micro-satellite Technology Experiment (USA 187, 2006-024A, 29240; USA 188, 2004-024B, 29241), with the official mission to identify, integrate, test, and evaluate small satellite technologies to support and enhance future US space missions.⁶² Observers speculated that the MiTeX satellites would be conducting RPO in GSO.⁶³ In 2009, news reports revealed that they had been used to conduct "flybys" of the US early-warning satellite DSP 23 (USA 197, 2007-054A, 32287), which had mysteriously failed on-orbit shortly after launch.⁶⁴ Observations from hobbyists noted that the two MiTeX satellites maneuvered from their parking slots in GSO to drift towards the location of DSP 23, passing it around December 23, 2009, and January 1, 2010.

A classified satellite publicly known only as PAN (USA 207, 2009-047A, 35815), part of a series called Nemesis, was launched on September 8, 2009, into GEO, where it was observed relocating every six months or so, until late 2013; its nine moves over four years placed it near several other satellites.⁶⁵ Then it stayed in a stable position until roughly February 2021, when it appears to have started moving again.⁶⁶ Amateur observers were able to observe it again starting in August 2023, station-keeping at 39.7 degrees east, so it is assumed to still be active.⁶⁷ In September 2023, PAN was spotted drifting westward.⁶⁸ As of April 2024, it was still drifting westward at an average rate of about 0.03 degrees longitude daily.⁶⁹ Very little is known about the mission of PAN, although most public observers believe it has a signals intelligence mission. Leaked files in 2016 stated its mission was "Foreign Satellite (FORNSAT) collection from space – targeting commercial satellite uplinks not normally accessible via conventional means"⁷⁰, and could be conducting similar activities to the Russian Luch/Olymp-K satellite (see Russian Co-Orbital ASAT, Chapter 2.1). Another satellite thought to be in the Nemesis series is Clio (USA 257, 2014-055A, 40208).⁷¹ Not much is known about this satellite other than it was launched in September 2014 and has maneuvered between orbital slots "multiple times."

Another US intelligence satellite that has moved around the GEO belt is the Mentor 4, or USA 202 (2009-001A, 33490).⁷² Launched on January 18, 2009, to a near-geosynchronous orbit at the longitude of 100 degrees east, it drifted westward around 0.8 degrees per day for several weeks, and eventually stabilized in a geosynchronous orbit at 44 degrees east longitude in May 2009.⁷³ That placement put it right next to commercial satellite Thuraya 2 (2003-026A, 27825), where it appeared to match up with the latter's orbital inclination.⁷⁴ An analysis written in 2016 noted that Mentor 4 was conducting very closely synchronized co-orbital movements with Thuraya 2.⁷⁵

In recent years, the USAF appears to have applied the lessons it learned with Prowler and MiTeX to an operational program known as the Geosynchronous Space Situational Awareness Program (GSSAP), which may have the internal codename of Hornet. GSSAP consists of multiple pairs of small satellites deployed in near-GEO orbits, with altitudes slightly above or below the GSO belt, which allow them to drift east or west relative to other GSO satellites and provide close inspections of objects in the GEO region.⁷⁶ The official USAF fact sheet states that the GSSAP satellites can conduct RPO of "resident space objects of interest."⁷⁷ The first pair of GSSAP satellites (USA 253, 2014-043A; USA 254, 2014-043B) was launched on July 28, 2014, and the second pair (USA 270, 2016-052A; USA 271, 2016-052B) on August 19, 2016, both times on a

Delta 4 rocket from CCAFS. A third pair (USA 324, 2022-006A, 51280; USA 325, 2022-006B, 51281), was launched in January 2022.⁷⁸ The US Space Systems Command confirmed in August 2023 that one of the satellites from the pair launched in 2014, GSSAP Space Vehicle (SV) 2, had reached its end of life and been placed in a graveyard orbit.⁷⁹ Two more launches of new GSSAP satellites were planned to occur in 2024 and 2027; the 2024 launch did not happen.⁸⁰ GSSAPs 7 (USA 582, 2026-029A, 67759) and 8 (USA 583, 2026-029B, 67760) were launched via a United Launch Alliance Vulcan Centaur in February 2026.⁸¹ Very limited public information is known about the on-orbit activities of the seven remaining GSSAP satellites, as the USSF does not disclose information on their orbits; they are thought to operate in pairs, with one satellite staying below the GEO belt, and one operating above it.⁸² The GSSAP satellites are operated by the 1st Space Operations Squadron of the USSF's Space Delta 9, which has a mission to conduct orbital warfare.⁸³

On September 18, 2015, General John E. Hyten, then Commander of AFSPC, remarked at a public forum that the two GSSAP satellites had been, "pressed into early service" to provide information to an unnamed customer.⁸⁴ According to General Hyten, the two satellites provided what he deemed "eye-watering" pictures of one or more objects in GSO.

FIGURE 1-5 – GSSAP SATELLITES



Artist's depiction. Image credit: US Air Force.⁸⁵

Although the US military did not initially provide any public data on the locations or maneuvers of the GSSAP satellites, other sources of tracking data show they are very active in GEO. Data collected by the ISON space surveillance network, managed by the Russian Academy of Sciences, indicates that the GSSAP satellites have conducted hundreds of maneuvers since 2014 and have conducted close approaches or proximity operations of more than a dozen operational satellites in GEO, as summarized in Table 1-2. The GSSAP satellites have done close approaches of several US military satellites, several Russian and Chinese military satellites, and commercial satellites built by China and operated by other countries. According to Russian sources, some of these close approaches involved the GSSAP satellite making many small phasing maneuvers during a short period of time or conducting its close approach while both satellites passed through the Earth's shadow and could not be tracked by ground-based optical telescopes. These incidents made it very difficult to estimate the current and future position of the GSSAP satellite and the other

78 "GSSAP 1, 2, 3, 4, 5, 6," *Gunter's Space Page*, accessed March 22, 2018, http://space.skyrocket.de/doc_sdat/gssap-1.htm; Theresa Hitchens, "Space Force to loft 2 new 'neighborhood watch' sats, as leader frets launch funds," *Breaking Defense*, January 21, 2022, <https://breakingdefense.com/2022/01/space-force-to-loft-2-new-neighborhood-watch-sats-as-leader-frets-launch-funds/>.

79 Sandra Erwin, "US deactivates GSSAP surveillance satellite, two new ones in the works," *SpaceNews*, August 15, 2023, <https://spacenews.com/u-s-deorbits-gssap-surveillance-satellite-two-new-ones-in-the-works/>.

80 Hillary Gibson, "Mission Complete: GSSAP SV2 transfers to SSC," *Space Operations Command*, August 2, 2023, <https://www.spaceforce.mil/News/Article-Display/Article/3486658/mission-complete-gssap-sv2-transfers-to-ssc/>.

81 "Space Systems Command, Mission Partners Prepares USSF-87 for National Space Security Launch on ULA's Vulcan Centaur," SSC Public Affairs, February 10, 2026, <https://www.ssc.spaceforce.mil/Newsroom/Article/4403552/space-systems-command-mission-partners-prepares-ussf-87-for-national-space-security-launch-on-ula-s-vulcan-centaur>; Gunter D. Krebs, "GSSAP 1, ..., 10 (Hornet 1, ..., 10)," *Gunter's Space Page*, accessed March 7, 2026, https://space.skyrocket.de/doc_sdat/gssap-1.htm.

82 Mariia Kiseleva, "USSF-8 / Atlas V 511," *EverydayAstronaut*, January 13, 2022, <https://everydayastronaut.com/ussf-8-atlas-v-511/>.

83 Joseph Trevithick, "Space Force Has A Unit Dedicated To Orbital Warfare That Now Operates The X-37B Spaceplane," *The War Zone*, October 30, 2020, <https://www.thedrive.com/the-war-zone/37361/space-force-has-a-unit-dedicated-to-orbital-warfare-that-now-operates-the-x-37b-spaceplane>.

84 Mike Gruss, "Space Surveillance Sats Pressed Into Early Service," *SpaceNews*, September 18, 2015, <http://spacenews.com/space-surveillance-sats-pressed-into-early-service/>.

85 "Geosynchronous Space Situational Awareness Program," USAF, March 22, 2017, <https://www.afspc.af.mil/About-Us/Fact-Sheets/Display/Article/730802/geosynchronous-space-situational-awareness-program/>.

- 86 Stephen Chen, "Study says US spy satellites approaching China's high-value space assets a 'threat to security'," *South China Morning Post*, May 5, 2023, <https://www.scmp.com/news/china/science/article/3219350/too-often-too-close-study-says-us-spy-satellites-approaching-chinas-high-value-space-assets-threat>; Andrew Jones, "Chinese study finds GSSAP close approaches a threat to its GEO assets," *SpaceNews*, August 31, 2023, <https://spacenews.com/chinese-study-finds-gssap-close-approaches-a-threat-to-its-geo-assets/>.
- 87 Based on data provided by Vladimir Agapov, derived from tracking data collected by the ISON Space Surveillance Network; and from Andrew Jones, "Chinese study finds GSSAP close approaches a threat to its GEO assets," *SpaceNews*, August 31, 2023, <https://spacenews.com/chinese-study-finds-gssap-close-approaches-a-threat-to-its-geo-assets/>.
- 88 Colin Clark, "US, China, Russia Test New Space War Tactics: Sats Buzzing, Spoofing, Spying," *Breaking Defense*, October 28, 2021, <https://breakingdefense.com/2021/10/us-china-russia-test-new-space-war-tactics-sats-buzzing-spoofing-spying/>.
- 89 Debra Werner, "An In-Orbit Game of Cat and Mouse: Close approaches prompt calls for communications and norms," *SpaceNews*, June 16, 2022, <https://spacenews.com/an-in-orbit-game-of-cat-and-mouse-close-approaches-prompt-calls-for-communications-and-norms/>.
- 90 SpaceNewsInc, "USA 270/Shiyan12 encounter," *YouTube*, accessed February 22, 2023, <https://www.youtube.com/watch?v=H0ZlgmdjXjw>.

object, creating difficulty in determining safe approaches and ascertaining the intent of the approach, which could lead to misperceptions and mistakes. Russian sources also claim GSSAP made more than 14 one- and two-impulse maneuvers during their proximity operations of WGS 4 (2012-003A, 38070), a US military communications satellite, which raised concerns about whether it was testing co-orbital technologies. The US military began releasing public positional information for the four GSSAP satellites active at the end of 2019, although some of the data are weeks or months old. A Chinese paper released in 2023 indicated that they had tracked GSSAP satellites conducting at least 14 uncoordinated close approaches with six Chinese satellites (Tianlian 2-01, BD-2 G8, SJ-20, TJS-2, TJS-3, and TJS-5) in 2020 and 2021.⁸⁶

TABLE 1-2 – SATELLITES APPROACHED BY GSSAP THROUGH JANUARY 2022⁸⁷

DATE	SATELLITE APPROACHED	COUNTRY OF OWNERSHIP	APPROACH DISTANCE
Sept. 13, 2016	TJS-1	China	15 km
Jul. 13, 2017	Express AM-8	Russia	10 km
Sept. 14, 2017	Luch	Russia	10 km
Sept. 21, 2017	Paksat 1R	Pakistan	12 km
Sept. 29, 2017	Nigcomsat 1R	Nigeria	11 km
Oct. 5, 2017	Blagovest (Cosmos 2520)	Russia	14 km
Nov. 17, 2017	Raduga-1M 3	Russia	12 km
May 14, 2018	Raduga-1M 2	Russia	13 km
Feb. 26, 2020	Tianlian 2-01	China	88 km
Feb. 28, 2020	BD-2 G8	China	110 km
Apr. 8, 2020	SJ-13	China	360 km
Aug. 23, 2020	SJ-20/Chinasat 6A	China	24 km
Nov. 1, 2020	SJ-20	China	12 km
Nov. 23, 2020	SJ-13	China	102 km
Nov. 30, 2020	TJS-2	China	53 km
Jan. 1, 2021	TJS-3 AKM	China	469 km
Mar. 19, 2021	TJS-2	China	28 km
Apr. 16, 2021	TJS-3	China	1141 km
May 3, 2021	SJ-20	China	1032 km
May 4, 2021	SJ-20	China	10 km
May 6, 2021	TJS-3	China	104 km
Jan. 2022	SY-12 01, SY-12 02	China	73 km

In a video released by the commercial SSA company COMSPOC, it can be seen that USA 271 approached China's SJ-20 satellite in August 2020, getting within 20 km of it.⁸⁸ In late January 2022, USA 270 maneuvered to approach a pair of Chinese satellites, SY-12 01 (2021-129A, 50321) and SY-12 02 (2021-129B, 50322), that had recently been launched into GEO (see Chinese Co-Orbital ASAT, Section 3.1). According to tracking data collected by ExoAnalytic Solutions, SY-12 01 and SY-12 02 made significant maneuvers to split up and begin rotating around the GEO belt in opposite directions, with SY-12 02 apparently also getting an imaging opportunity on USA 270.⁸⁹ A video animation released by COMSPOC Corporation also shows the encounter.⁹⁰

USA 271 (GSSAP 4) maneuvered along the GEO belt in April 2025 to conduct a close approach to the recently launched TJS-15, estimated to have been 33 km, according to COMSPOC.⁹¹ Later that same month, COMSPOC announced that USA 324 (GSSAP 5) had done its own close approaches to two other recently launched Chinese satellites, getting within 17 km of TJS-16 and 12 km of TJS-17.⁹²

In April 2025, the Space Force formalized an acquisition plan that will allow the follow-on to GSSAP to be provided and operated by commercial actors.⁹³ 150 companies attended an industry day for this new constellation.⁹⁴ As well, it will be unclassified and able to participate in the United States' Foreign Military Sales (FMS) program, which means allies will have the opportunity to purchase the follow-ups.⁹⁵ A draft request for proposals for the new constellation, called RG-XX, was released in October 2025, with the formal request for proposals released in January 2026.⁹⁶ The Space Force will be using an indefinite delivery, indefinite quantity contract in order to have more flexibility in awarding contracts, as it is unclear how many RG-XX satellites it will need.⁹⁷ One of the requirements for the constellation is that they must be refuelable so that they can be more maneuverable than GSSAPs.⁹⁸

The launch of the first two GSSAP satellites included a satellite from another RPO program, the Automated Navigation and Guidance Experiment for Local Space (ANGELS) Program.⁹⁹ The goal of ANGELS was to provide a clearer picture of the local area around important US national security satellites in GSO. The ANGELS (USA 255, 2014-043C, 40101) satellite stayed attached to the Delta 4 upper stage (2014-043D, 40102) while it placed the first GSSAP pair into GSO and conducted a disposal maneuver to place it several hundred km above GSO. At that point, ANGELS detached from the upper stage and conducted a series of RPO maneuvers to close within a few kilometers.¹⁰⁰ Russian tracking sources indicate that during one close approach conducted on June 9, 2016, the Delta upper stage altered its orbit, suggesting it might not have been entirely inert. The USAF originally did not disclose orbital information for either ANGELS or the Delta 4 upper stage but began to do so in February 2020. ANGELS was decommissioned in November 2017 and remains in a GEO graveyard orbit.¹⁰¹

On April 14, 2018, the United States conducted another military launch that placed multiple small satellites in GEO, including at least one that has conducted rendezvous and proximity operations.¹⁰² The primary payload on the launch was the USAF's Continuous Broadcast Augmenting SATCOM (CBAS) military communications relay satellite, catalogued at USA 283 (2018-036A, 43339). The launch also included the Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Augmented Geosynchronous Laboratory Experiment satellite, known by the triple-nested acronym EAGLE but officially catalogued as USA 284 (2018-036B, 43340). The ESPA ring is commonly used for deploying small satellites as secondary payloads, and the EAGLE concept converts the ESPA ring from part of the launch vehicle into an independent maneuverable satellite, allowing for more flexible deployment of multiple small satellites.¹⁰³

On this first launch, the EAGLE separated from the upper stage in the GEO region and subsequently deployed at least three small satellites. One of these small satellites, Mycroft (USA 287, 2018-036G, 43465), separated from EAGLE in early May 2018 and conducted a series of close approaches to EAGLE. The name Mycroft refers to the older and smarter brother of the fictional detective Sherlock Holmes, and the USAF describes it as demonstrating "improved space situational awareness for space vehicles."¹⁰⁴ The US military has not provided any information on the other two payloads. In January 2020, the US military began providing public orbital information for CBAS, the Centaur upper stage,

91 @COMSPOC_OPS, "Update: TJS-15 (SSN.63157) and USA 271 (SSN.41745)," *Twitter*, April 8, 2025, https://x.com/COMSPOC_OPS/status/1909700911045525953.

92 @COMSPOC_OPS, "Over the weekend, USA 324, maneuvered into the 152 °E neighborhood," *Twitter*, April 29, 2025, https://x.com/COMSPOC_OPS/status/1917299841039831248.

93 Sandra Erwin, "Space Force embraces commercial tech in major overhaul of surveillance satellite program," *SpaceNews*, April 29, 2025, <https://spacenews.com/space-force-embraces-commercial-tech-in-major-overhaul-of-surveillance-satellite-program/>.

94 Lauren C. Williams, "Space Force goes commercial for space domain awareness," *Defense One*, September 2, 2025, <https://www.defenseone.com/business/2025/09/space-force-goes-commercial-space-domain-awareness/407814/>.

95 Erwin, "Space Force embraces commercial," *ibid*.

96 "Andromeda Draft RFP," Notice ID FA881926RB001, Department of the Air Force, Office FA8819 Space Programs Dir SMC SP, October 21, 2025, <https://sam.gov/opp/a6bfcbb40da14969914332ceddce40be/view>; "Andromeda IDIQ," Notice ID FA881926RB001, Department of the Air Force, Office FA8819 Space Programs Dir SMC SP, January 13, 2026, <https://sam.gov/opp/952cfc3850ed493da7dd-35aea6e212e7/view>.

97 Theresa Hitchens, "Space Force envisions rolling awards for new RG-XX neighborhood watch satellites," *Breaking Defense*, January 26, 2026, <https://breakingdefense.com/2026/01/space-force-envisions-rolling-awards-for-new-rg-xx-neighborhood-watch-satellites/>.

98 Hitchens, "Space Force envisions," *ibid*.

99 Stephen Clark, "Air Force General Reveals New Space Surveillance Program," *SpaceFlight Now*, February 25, 2014, <http://spaceflightnow.com/news/n1402/25gssap/>.

100 "Fact Sheet: Automated Navigation and Guidance Experiment for Local Space," *Air Force Research Laboratory*, current as of July 2014, accessed March 22, 2018, p.1, <http://www.kirtland.af.mil/Portals/52/documents/AFD-131204-039.pdf?ver=2016-06-28-105617-297>.

101 Arielle Vasquez, "3rd SES Bids Farewell to ANGELS Satellite," *50th Space Wing Public Affairs*, November 21, 2017, <http://www.patrick.af.mil/News/Article-Display/Article/1378964/3rd-ses-bids-farewell-to-angels-satellite/>.

102 Stephen Clark, "Multi-satellite payload hoisted into high altitude orbit by Atlas 5 rocket," *SpaceflightNow.com*, April 15, 2018, <https://spaceflightnow.com/2018/04/15/multi-satellite-stack-hoisted-into-high-altitude-orbit-by-atlas-5-rocket/>.

103 Air Force Research Laboratory, "ESPA Augmented Geosynchronous Laboratory Experiment (EAGLE)," *ABW Public Affairs*, April 2018, <https://www.kirtland.af.mil/Portals/52/documents/EAGLE-factsheet.pdf>.

104 88th Air Base Wing Public Affairs, "Successful launch for AFRL Eagle spacecraft experiment on AFSPC-11 mission," *Schriever Air Force Base*, April 18, 2018, <https://www.schriever.af.mil/News/Article-Display/Article/1496633/successful-launch-for-afri-eagle-spacecraft-experiment-on-afspc-11-mission/>.

- 105 Data compiled from the public satellite catalog maintained by the US military at <https://space-track.org>.
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and the other two unnamed payloads, but not EAGLE or Mycroft.¹⁰⁵

In October 2019, the USAF announced that Mycroft was being sent to inspect another US satellite in the GEO region, S5 (2019-009D, 44065).¹⁰⁶ S5 was an experimental satellite launched into GEO on February 22, 2019, to test out new space situational awareness concepts, but stopped communicating with ground controllers in March 2019.¹⁰⁷ The USAF stated that Mycroft would conduct a series of RPO maneuvers with S5 over a period of weeks to try and determine the status of the latter's solar arrays and antennas. Amateur observers noted that Mycroft was communicating using a largely "suppressed" carrier signal, making it more difficult to detect.¹⁰⁸

France and the United States held their first bilateral RPO engagement in April 2025, which involved a US and a French satellite approaching each other near a "strategic competitor spacecraft;" it is unclear which country that spacecraft belonged to or which US and French satellites conducted the RPO.¹⁰⁹ In September 2025, a USSF official said that France and the United States would be engaging in a second RPO mission.¹¹⁰ This ended up happening as part of Operation Olympic Defender in November 2025.¹¹¹ While both countries acknowledged the maneuvers, they did not provide specifics. However, US commercial SSA company COMSPOC monitored the RPOs and identified the participating satellites as USA 324 (2022-006A, 51280, part of the United States' GSSAP program) and France's SYRACUSE 3A (2005-041B, 28885); there were three sets of maneuvers observed (November 11-14, November 22-23, and November 28-29), and, according to a COMSPOC spokesperson, "In all these movements, SYRACUSE 3A seems to lead and USA 324 seems to follow as the maneuvers performed by USA 324 is lagged by a day."¹¹² The closest the two satellites got to each other was just a little over 25 km.¹¹³

In September 2025, US Space Command and UK Space Command announced the conduction of their first jointly coordinated RPO maneuver, occurring between September 4-12, 2025.¹¹⁴ During this RPO maneuver, UK Space Command stated that a satellite, USA 271 (2016-052B, 41745) "maneuvered near the UK (satellite) SKYNET 5A (2007-007B, 30794) communications satellite, a complex and meticulously planned operation."¹¹⁵ Going into more detail, the US commercial SSA company COMSPOC reported that it was one of the US GSSAP satellites, USA 271, which had been drifting westward but stopped near SKYNET-5A at 95.3°E from September 5-11, 2025.¹¹⁶ USA 271 had been drifting since July 2025 at a rate of -1.5° per day, until an in-track maneuver was detected on September 4, 2025, with additional maneuvers that followed, until USA 271 was within 0.05° of the British satellite and, at its closest point, was 13 km away.¹¹⁷ According to Major General Paul Tedman, commander of UK Space Command, "This operation was a first of its kind for U.K. Space Command."¹¹⁸ See 14.1 United Kingdom Co-Orbital ASAT for a diagram and images of the RPO.

TABLE 1-3 — RECENT US RPOs

DATE(S)	SYSTEM(S)	ORBITAL PARAMETERS	NOTES
Jan. 2003	XSS-10, Delta R/B	800 x 800 km; 39.6°	XSS-10 did a series of maneuvers to bring it within 50 meters of the Delta upper stage that placed it in orbit.
Apr. 2005 – Oct. 2006	XSS-11, multiple objects	LEO	XSS-11 did a series of maneuvers to bring it close to the Minotaur upper stage that placed it in orbit. It then performed additional close approaches to other US space objects in nearby LEO orbits over the next 12-18 months.

DATE(S)	SYSTEM(S)	ORBITAL PARAMETERS	NOTES
Apr. 2005	DART, MUBLCOM	LEO	DART did a series of autonomous maneuvers to bring it close to the MUBLCOM satellite and ended up bumping into it.
Mar. – Jul. 2007	ASTRO, NEXTSat	LEO	ASTRO and NEXTSat were launched together and performed a series of separations, close approaches, and dockings with each other.
Dec. 23, 2008 and Jan. 1, 2009	DSP-23, MiTeX (USA 187, USA 188)	GEO	Inspection and close rendezvous with a failed US satellite. Possibly other demonstrations and tests in geosynchronous orbit.
2009 – 2013	Yahsat 1B, others unknown, PAN (USA-207)	GEO	Part of NRO's Nemesis satellites (geostationary COMINT). Presumed to have completed SIGINT (signals intelligence) with other satellites. Unique for roaming various times to different orbits and satellites.
Jul. 2014 – present	GSSAP, multiple objects	GEO	Multiple pairs of GSSAP satellites have been performing RPO with various other objects in the GEO region.
Jul. 2014 – Nov. 2017	ANGELS, Delta 4 R/B	GSO	ANGELS separated from the Delta 4 upper stage that placed the first GSSAP pair into orbit and then performed a series of RPO in the GSO disposal region.
Sep. 2014 – present	Clio	GEO	Clio has approached other orbital slots "multiple" times.
May 2018	Mycroft, EAGLE	GEO	EAGLE separated from the Delta V upper stage, and Mycroft subsequently separated from EAGLE. Mycroft conducted RPO of EAGLE in the GEO region.
Oct. 2019	Mycroft, S5	GEO	Mycroft maneuvered to rendezvous with S5 after the latter ceased communications.
Aug. 2020	SJ-20, USA 271	GEO	USA 271 approached China's SJ-20, shadowing the spacecraft. The Chinese spacecraft detected the US satellite and rapidly moved away.
Jan. 2022	Shiyan-12(01) and Shiyan-12(02), USA 270	GEO	USA 270 approached China's Shiyan-12(01) and (02) satellites. As USA 270 approached, the Shiyan-12 satellites maneuvered away to drift orbits. The closest approach was around 73 kilometers.
Oct. – Nov. 2024	SJ-23	GEO	In October 2024, LDPE 3A maneuvered to approach SJ-23, possibly to 30 km by Nov. 4 or Nov. 5, after which it maneuvered to synchronize itself with SJ-23 and drift along with it 0.68 degrees west each day.
Apr. 2025	USA 271, TJS-15	GEO	USA 271 maneuvered to conduct a close approach to the recently-launched TJS-15, and is estimated to have gotten within 33 km of it.
Apr. 2025	USA 324, TJS-16, TJS-17	GEO	USA 324 maneuvered to conduct close approaches to two other recently launched Chinese satellites, getting within 17 km of TJS-16 and 12 km of TJS-17.
Apr. 2025	US satellite, French satellite	?	This was France and the United States' first bilateral RPO engagement, which involved a US and a French satellite approaching each other near a "strategic competitor spacecraft;" it is unclear which country that spacecraft belonged to or which US and French satellites conducted the RPO.
Sep. 2025	USA 271, SKYNET 5A	GEO	This was the United Kingdom and the United States' first bilateral RPO engagement. USA 271 satellite had been drifting since July 2025 at a rate of -1.5° per day, until an in-track maneuver was detected on September 4, 2025. Additional maneuvers followed, until USA 271 was within 0.05° of SKYNET-5A and, at its closest point, was 13 km away. USA 271 and SKYNET 5A's RPO lasted roughly from Sept. 5-11, 2025.
Nov. 2025	USA 324, SYRACUSE 3A	GEO	There were three sets of maneuvers observed (November 11-14, November 22-23, and November 28-29), and, according to a COMSPOC spokesperson, "In all these movements, SYRACUSE 3A seems to lead and USA 324 seems to follow as the maneuvers performed by USA 324 is lagged by a day." The closest the two satellites got to each other was just a little over 25 km.

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In April 2023, USSF Space Systems Command (SSC) launched small satellite known as Tetra-1 (USA 340, 2022-144E, 55138) into an orbit at around 38,000 kilometers altitude, which is well above the active GEO belt.¹¹⁹ The Tetra-1 small satellite is intended to practice maneuvering and other activities needed to survive an altitude that is often used as a graveyard orbit for satellites at GEO.¹²⁰ SSC used Tetra-1 in a series of training maneuvers with Space Delta 11 as part of an exercise referred to as "Scarlet Star."¹²¹ It is unknown if Tetra will be doing any RPO or conducting any SSA activities.

An unnamed space-based SSA program with three novel sensor payloads developed by the Space Rapid Capabilities Office (SpRCO) was launched in January 2023 by the USSF; according to SpRCO, the payloads "fly around GEO and collect data about potential threats on-orbit."¹²² The payloads are likely attached to the Long Duration EELV Secondary Payload Adapter (LDPE) 3A (USA 342, 2023-008A, 552643), which also hosts two other technology demonstration payloads for the USSF.¹²³ It is thought to carry a wide-area sensor with four cameras to collect SSA.¹²⁴ In October 2024, LDPE 3A started maneuvering close to China's SJ-23; it may have gotten to within 30 km of it sometime between November 4 and 5, after which point it maneuvered so it could synchronize itself with SJ-23 and drift along with it 0.68 degrees west each day.¹²⁵ Some payloads on the LDPE 3A have been collecting information about China's space situational awareness capabilities and, according to Kelly Hammett of the Space Rapid Capabilities Office, "are sensors that can tell whether you're being observed, tracked, targeted."¹²⁶

Another bus in that same series, LDPE 2 (2022-144A, 54219) was detected releasing satellites in January 2023 (USA 341, 2022-144F, 55139), April 2023 (USA 344, 2022-144J, 56307), August 2024 (USA 399, 2022-144K, 60741), and June 2025 (USA 546, 2022-144L, 64289).¹²⁷ According to its manufacturer, the platform's "six payload ports are capable of accommodating any combination of up to six hosted and 12 separable (fly-away) payloads (maximum one hosted or two separables per port)."¹²⁸

The Space Force is striving to provide capabilities under its tactically responsive space (TacRS) program. Some of the program to date has focused on launching satellites very quickly on demand, which is not in and of itself a counterspace capability. However, upcoming versions of TacRS are intended to provide RPO capabilities, which could also provide on-orbit counterspace capabilities. Victus Haze was intended to launch in fall 2025; during the exercise, Rocket Lab will launch a pre-manufactured payload 24 hours after it receives the notification to do so, which will then conduct RPO activities with True Anomaly's Jackal Autonomous Orbital Vehicle spacecraft [catalogued as TANSTAAFL-2 (2024-247B, 62378)] which was launched in December 2024.¹²⁹ Victus Haze's launch got delayed to some point in 2026 due to Firefly's 2025 rocket anomalies.¹³⁰ In October 2024, Impulse Space won a \$34.5 million contract as part of the TacRS program to create two two orbital maneuver vehicles, Victus Surgo and Victus Salo; Victus Surgo is supposed to move a payload from LEO to GEO, while Victus Salo would carry what has been only described as a "government-provided payload."¹³¹ Also part of this series is Victus Sol, awarded to Firefly in February 2025, which is intended to put an operational capability in orbit, but the specifics have been kept classified.¹³²

Golden Dome for America¹³³

On January 27, 2025, President Donald Trump released an Executive Order (EO) called "An Iron Dome for America." The EO sets out the mission of "deploying and maintaining a next-generation missile defense shield." Relevant to this threat assessment, it calls for the Secretary of Defense to submit within 60 days an architecture, capabilities requirements, and implementation plan for the "Development and deployment of proliferated space-based interceptors capable of boost-phase intercept." Four days later, the Missile Defense Agency (MDA) released a Request for Information (RFI) for industry to submit by February 28, 2025, details on capabilities that could be demonstrated or delivered by four milestone dates: on or before December 31, 2026; December 31, 2028; December 31, 2030; and "beyond" December 31, 2030.¹³⁴ In support of this EO, Senators Dan Sullivan (R-Alaska) and Kevin Cramer (R-North Dakota) introduced on February 6, 2025, legislation called the *Increasing Response Options and Deterrence of Missile Engagements (IRON DOME) Act*, which included "\$900 million to research and develop space-based missile defense."¹³⁵ While the EO calls for space-based interceptors (SBIs) for boost phase intercept of ballistic missiles, Golden Dome is included here because it could provide an on-orbit strike capability against other satellites. It was reported that Secretary of Defense Pete Hegseth released an undated "strategic guidance" for how to create the missile shield called for in the EO, and part of the plan calls for creating kinetic and non-kinetic SBIs.¹³⁶ By the end of February 2025, the program had been renamed "Golden Dome for America;" it is unclear why the program was renamed.¹³⁷

President Trump stated in May 2025 that his vision of Golden Dome was that it would be "fully operational before the end of my term," and that it could intercept missiles "even if they are launched from space."¹³⁸ He said that Space Force's Gen. Michael Guetlein would be Golden Dome's program manager and that the system would cost \$175 billion.¹³⁹ Guetlein was officially confirmed by the Senate in July 2025.¹⁴⁰ In discussing this confirmation, he said that he had been given 60 days to come up with the initial architecture that would integrate existing systems (e.g., Ground-based Midcourse Defense system, Terminal High Altitude Area Defense system, Aegis Ballistic Missile Defense system, the Patriot area missile defense system, and existing missile detection and tracking sensors).¹⁴¹ In regards to SBIs, Guetlein said that from a technology viewpoint, "[W]e have proven every element of the physics that we can to make it work. What we have not proven is, first, can I do it economically, and then second, can I do it at scale?"¹⁴² In September 2025, Guetlein gave briefings at the Pentagon and in Congress about the initial architecture of Golden Dome, but details were not made public.¹⁴³ The Golden Dome implementation plan was completed and briefed as required by November 2025, but again details have not been released.¹⁴⁴

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It is unclear what the actual architecture will be of Golden Dome, as open-source discussion of specifics is very vague. Reuters reported in August 2025, based on a US government slide given at an industry day event on Golden Dome, that it is intended to have four layers (three ground-based, one satellite-based) and 11 short-range ballistic missile defense batteries scattered across the United States.¹⁴⁵ The space-based layer is to include sensors and interceptors, while a third GMD field was portrayed in a map to be in the Midwest.¹⁴⁶ The space-based layer slide also leaves open the possibility of using directed energy for intercepts in the future. A test of the whole system is reported to be scheduled by MDA for the 4th quarter of 2028; its name, Flight Test Integrated (FTI)-X, would indicate that it would include multiple layers of the system integrated together.¹⁴⁷ Canada has not been officially invited to participate in it yet but it was reported in August 2025 that the Canadian government had removed all restrictions on Canada's air and missile defenses, giving it the option to join Golden Dome.¹⁴⁸

The Pentagon released requests for proposals for space-based interceptors that can do boost phase intercepts and midcourse intercepts, respectively in September 2025 and December 2025.¹⁴⁹ The first set of awards for boost phase intercept were given in November 2025; however, the Pentagon did not release the names of the companies who had won them, with a spokesperson saying, "The names of the contractors are currently not releasable as they are protected by enhanced security measures."¹⁵⁰ There are reportedly plans for SBIs to conduct endo- and exo-atmospheric intercepts.¹⁵¹ The midcourse SBI contracts were supposed to have been released in February 2026 but as of February 2026, they have not been released.¹⁵²

The amount that Golden Dome will cost is unclear, as is the expenditures on it to date. The reconciliation bill passed in July 2025 gave Golden Dome \$23 billion to start; however, in January 2026, House and Senate appropriators noted in the FY 26 defense appropriations bill that "due to insufficient budgetary information, the House and Senate Defense Appropriations Subcommittees were unable to effectively assess resources available to specific program elements and to conduct oversight of planned programs and projects for fiscal year 2026 Golden Dome efforts in consideration of the final agreement," even given that they "support the operational objectives of Golden Dome for national security."¹⁵³ The bill requires the Pentagon to submit a detailed spending plan to Congress within 60 days for anticipated expenditures from FY 25 to FY 27; additionally, a budget justification book is required for Golden Dome starting in FY 28.¹⁵⁴ The Pentagon's FY 2026 Mandatory Funding Allocation Plan, released in February 2026, says for "Development, procurement, and integration of space-based and boost phase interceptor capabilities," there is \$9 million in FY 25 and just under \$5.6 billion in FY 26.¹⁵⁵ Todd Harrison did an analysis in September 2025 of what Golden Dome could cost, depending on which architecture the United States decides to go with.¹⁵⁶ The smallest amount was for a limited tactical defense that had no space-based interceptor layer; it would cost an estimated \$252 billion over 20 years.¹⁵⁷ The largest amount was for a "robust all-threat defense" that matches what the White House has said it would like Golden Dome to do; it would cost an estimated \$3.6 trillion over 20 years.¹⁵⁸

Potential Military Utility /

The most likely military utility of the capabilities demonstrated by the DART, XSS-10, XSS-11, Orbital Express, Prowler, MiTeX, PAN, Clio, Mentor 4, GSSAP, ANGELS, Mycroft, and LDPE 2 and 3A satellites is for on-orbit SSA and close-up inspections. What little is known of their operational pattern is consistent with relatively slow and methodical approaches to rendezvous with other space objects in similar orbits. The satellites they are known to have approached were in similar orbits and, based on the publicly available data, they did not make large changes to rendezvous with satellites in significantly different orbits. This behavior is similar to several international RPO missions to test and demonstrate satellite inspection and servicing capabilities, in particular the Chinese SJ-12, SJ-15, SJ-17, and TJS-3 satellites (see Chinese Co-Orbital ASAT, Section 3.1) and the Russian Cosmos 2499, Luch, and Cosmos 2521 satellites (see Russian Co-Orbital ASAT, Section 2.1).

The Delta 180 mission did include explicit testing of offensive capabilities, particularly the ability to physically collide with another satellite to damage or destroy it. However, the deliberate maneuvering to create a conjunction with the target satellite would be detectable with already existing processes to detect accidental close approaches. Warning time of such a close approach would likely be at least hours for LEO or days for GEO, unless the attacking satellite was already in a very similar orbit.

Boost-phase missile defense targets a ballistic missile just after launch when it is still moving relatively slowly, is easily tracked by radar, and has not yet deployed decoys or countermeasures that complicate interception. However, the boost phase is very short, no more than 250 seconds for liquid-fuel ICBMs (solid-fuel ICBMs have a shorter boost phase), necessitating the interceptors to be positioned nearby. Given that interceptors in space are constantly orbiting Earth, thousands would be needed. A 2025 American Physical Society study found that, even under ideal conditions, 1,600 interceptors would be needed just to target a single ICBM from North Korea.¹⁵⁹ The operating, maintenance, and repair cost of such a system, beyond developing and testing one, would be prohibitive, running from hundreds of billions of dollars to over a trillion dollars.¹⁶⁰

1.2 – US DIRECT-ASCENT ASAT

Assessment /

While the United States does not have an operational, acknowledged DA-ASAT system, it does have operational midcourse missile defense interceptors that have been demonstrated in an DA-ASAT role against a low LEO satellite. The United States has developed dedicated DA-ASAT systems in the past, both conventional and nuclear-tipped, and likely possesses the ability to do so in the near future.

Specifics /

During the Cold War, the US military had multiple efforts to develop DA-ASAT capabilities. Some of those efforts remained on the drawing board and several were tested in space, but no efforts reached operational status.

Bold Orion and High Virgo

US DA-ASAT capabilities began as final tests of already existing anti-ballistic missile (ABM) weapons. Because midcourse missile defense systems are intended to destroy nuclear warheads that travel through outer space at speeds and altitudes comparable to those of satellites, such midcourse ABM

159 "Strategic Ballistic Missile Defense: Challenges to Defending the United States," A Report by the American Physical Society Panel on Public Affairs, February 2025, <https://www.aps.org/publications/reports/strategic-ballistic-missile-defense>.

160 Kevin Holden Platt, "Space Missiles Might Shield US From Doomsday Russian Nuclear Strike," *Forbes*, February 18, 2025, <https://www.forbes.com/sites/kevinholdenplatt/2025/02/18/space-missiles-might-shield-us-from-doomsday-russian-nuclear-strike/>.

- 161 Andreas Parsch, "WS-199," *Directory of US Military Rockets and Missiles*, updated November 1, 2005, <http://www.designation-systems.net/dusrm/app4/ws-199.html>.
- 162 Gunter D. Krebs, "Pilot (NOTS-EV-1, NOTSNIK)," *Gunter's Space Page*, accessed February 21, 2022, https://space.skyrocket.de/doc_lau/nots1.htm.
- 163 John Pike, "HiHo / Hi-Hoe / NOTS-EV-2 Caleb," *GlobalSecurity.org*, accessed February 24, 2021, <https://www.globalsecurity.org/space/systems/hiho.htm>.
- 164 Gunter D. Krebs, "Caleb (NOTS-EV-2)," *Gunter's Space Page*, accessed February 20, 2022, https://space.skyrocket.de/doc_lau/caleb.htm.
- 165 Jeff Scott, "NOTSNIK, Project Pilot & Project Caleb," *Aerospaceweb.org*, April 23, 2006, <http://www.aerospaceweb.org/question/spacecraft/q0271.shtml>. Accessed February 20, 2022.

systems have inherent ASAT capabilities. In the late 1950s and early 60s, the United States tested many air-launched ballistic missiles (ALBM) as part of efforts to defend against Soviet ICBMs. At the end of the testing period, the final ALBM tests of the Bold Orion and High Virgo were used to validate the feasibility of destroying a satellite with ballistic missile technology.¹⁶¹ These tests led to the development of the first DA-ASAT program built from the Nike Zeus anti-ballistic missile.

NOTSNIK, HiHo, and Satellite Interceptor Program (SIP)

During the 1960s, the US Navy was also researching possible ASAT capabilities. Early efforts focused on matching a Navy Sparrow anti-aircraft missile with a Polaris submarine-launched ballistic missile (SLBM) but these efforts did not proceed beyond ground experiments. In 1958, the Navy started working on a program (known as Project Pilot or, more commonly, NOTSNIK) that would give the United States an air-launched SLV capability; after 10 launch failures, NOTSNIK was halted, with efforts focusing on an improved launch vehicle, the Caleb rocket, also known as NOTS-EV-2.¹⁶² In 1962, the Navy began work on Project HiHo, which involved a Caleb rocket fired from a Phantom 4D fighter bomber aircraft.¹⁶³ Although the primary focus was on developing an air-launched SLV, a secondary objective was to develop ASAT capabilities. Three test launches in space were conducted from 1961 to 1962; the first two failed but the third reached an apogee of 1,600 km. In the end, the Navy decided not to pursue an operational version.¹⁶⁴ Subsequently, the Navy investigated using the NOTS-EV-2 launch vehicle but adapted for ground-launch as part of a program known as the Satellite Interceptor Program (SIP). There were two launches (held in October 1961 and May 1962) that apparently were successful tests, but little else is known about them.¹⁶⁵

FIGURE 1-6 – SATELLITE INTERCEPTOR PROGRAM GROUND TEST



Image credit: Aerospaceweb.org

Nike Zeus

The Nike Zeus ASAT Program was developed out of anti-ballistic missile testing of the US Army's Nike Zeus system and later came to be known as Program 505. Beginning in 1957, the US Army argued that the Nike Zeus ABM system could have an ASAT capability added to it to help defend against ICBMs and space threats.¹⁶⁶ In 1962, the proposal was approved and Project Mudflap, later named Nike Zeus, began development. Nike Zeus consisted of a modified three-stage solid fuel Nike rocket tipped with a one-megaton nuclear warhead. It was believed that detonating the warhead in close proximity to a target satellite would disable it, either through the resultant fireball or an EMP. In May 1963, a modified Zeus B missile successfully intercepted an Agena D rocket stage in orbit, marking a key success of the program's new capability and extension to Kwajalein Atoll.¹⁶⁷ Testing continued throughout the early 1960s but eventually gave way to Program 437, which demonstrated greater performance. Program 437 would extend through the remainder of the decade.

Program 437

Similar to Nike Zeus/Program 505, Program 437 was developed from ABM technology but replaced the Nike Zeus with a Thor missile allowing for longer range capabilities.¹⁶⁸ Program 437 could target satellites orbiting as high as 1,300 kilometers with a 1.4 megaton W49 nuclear warhead with a likely kill radius of 8 kilometers.¹⁶⁹ The missiles and warheads were stored at Vandenberg AFB in California, while the Thors were operated out of Johnston Island,¹⁷⁰ so they required a two-week notification to load the missiles and warheads on their launch vehicle.¹⁷¹ On August 6, 1963, President John F. Kennedy directed that Program 437 be given the highest national priority category for further research and development.¹⁷² It was tested multiple times against rocket bodies and other space debris to assure the missile could pass within the kill radius without destroying the object and creating unnecessary debris. It remained operational on Johnston Island until the early 1970s and was formally terminated in 1975.¹⁷³

FIGURE 1-7 – PROJECT 437¹⁷⁴



Image credit: USAF

¹⁶⁶ Paul Stares, *The Militarization of Space: US Policy, 1945-1984*, Cornell University Press, August 1, 1985, p. 117.

¹⁶⁷ Brian Weeden, "Through a Glass, Darkly Chinese, American, and Russian Anti-satellite Testing in Space," *The Space Review*, March 17, 2014, https://swfound.org/media/167224/through_a_glass_darkly_march2014.pdf.

¹⁶⁸ Curtis Peebles, "High Frontier: The US Air Force and the Military Space Program," *Air Force History and Museums Program*, 1997, https://www.google.com/books/edition/_/cMq-dYypcPc8C?hl=en&gbpv=1&pg=PP1.

¹⁶⁹ Paul Stares, "The Militarization of Space: US Policy, 1945-1984," Cornell University Press, August 1, 1985, https://www.google.com/books/edition/The_Militarization_of_Space/2asgAAAAAAJ?hl=en&gbpv=0.

¹⁷⁰ A fascinating history of life on Johnston Island and work on Project 437 can be found here: Dwayne Day, "The middle of No and Where: Johnston Island and the US Air Force's nuclear anti-satellite weapon," *The Space Review*, February 26, 2024, <https://thespacereview.com/article/4748/1>.

¹⁷¹ Mark Wade, "Program 437," *Astronautix.com*, accessed February 19, 2021, <http://www.astronautix.com/p/program437.html>.

¹⁷² McGeorge Bundy, "Assignment of the Highest National Priority to Program 437," *The White House, National Security Action Memorandum No. 258*, August 6, 1963, <https://fas.org/irp/offdocs/nsam-jfk/nsam258.jpg>.

¹⁷³ Andreas Parsch, "Vought ASM-135 ASAT," *Directory of US Military Rockets and Missiles*, updated December 29, 2004, <http://www.designation-systems.net/dusrm/m-135.html>.

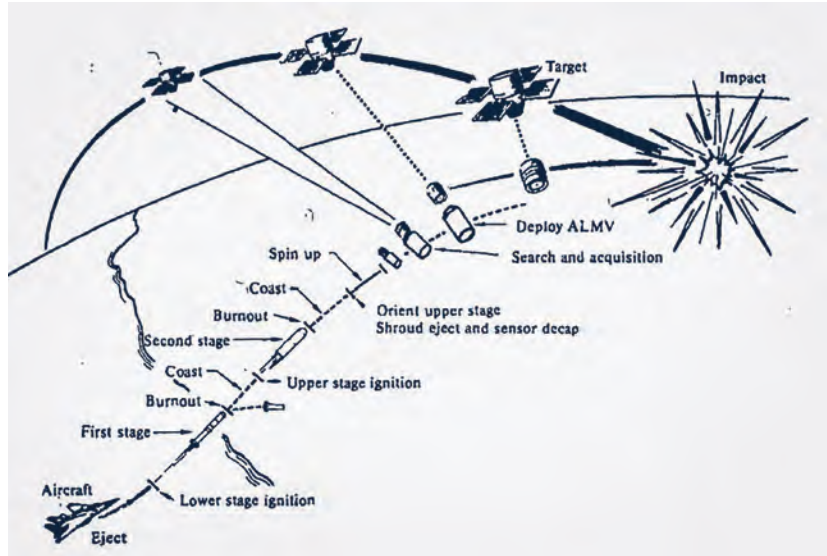
¹⁷⁴ Dwayne Day, "The middle of No and Where: Johnston Island and the US Air Force's nuclear anti-satellite weapon," *The Space Review*, February 26, 2024, <https://thespacereview.com/article/4748/1>.

- 175 Day, "The middle of No and Where: Johnston Island and the US Air Force's nuclear anti-satellite weapon," *ibid.*
- 176 Day, "The middle of No and Where: Johnston Island and the US Air Force's nuclear anti-satellite weapon," *ibid.*
- 177 The four other tests include: a successful missile test without the MHV on January 21, 1984; a failed missile test directing MHV at a star on November 13, 1984; and two successful flight tests directing MHV at a star on August 22, 1986 and September 29, 1986. Gregory Karambelas and Sven Grahn, "The F-15 ASAT Story," <http://www.svengrahn.pp.se/histind/ASAT/F15ASAT.html>; Raymond Puffer, "The Death of a Satellite," *Air Force Flight Test Center History Office*, archived from web in 2003, https://web.archive.org/web/20031218130538/http://www.edwards.af.mil/moments/docs_html/85-09-13.html.
- 178 "Vought ASM-135A Anti-Satellite Missile," *National Museum of the US Air Force*, March 14, 2016, <http://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198034/asm-135-asat/>.
- 179 "Soviet Satellite Defense Against the US Miniature Vehicle Antisatellite Weapon (U): An Intelligence Assessment," Office of Scientific and Weapons Research, *Central Intelligence Agency*, SW83-10062, September 1983, <https://www.archives.gov/files/declassification/iscap/pdf/2012-151-doc01-03.pdf>.
- 180 Parsch, "Vought ASM-13 ASAT," *ibid.*
- 181 "ASAT Overview," *Vought Heritage Website*, archived from web in 2007, <https://web.archive.org/web/20070131173354/http://www.vought.com/heritage/products/html/asat.html>; "Altair 3," *Encyclopedia Astronautica*, archived from web in 2008, <https://web.archive.org/web/20080202163409/http://www.astronautix.com/stages/altair3.htm>.
- 182 "Soviet Satellite Defense Against the US Miniature Vehicle Antisatellite Weapon (U): An Intelligence Assessment," Office of Scientific and Weapons Research, *Central Intelligence Agency*, SW83-10062, September 1983, <https://www.archives.gov/files/declassification/iscap/pdf/2012-151-doc01-03.pdf>.
- 183 Parsch, "Vought ASM-13 ASAT," *ibid.*

ASM-135 Air-Launched DA-ASAT

ASM-135 was an air-launched missile developed in response to the Soviet Union's successful demonstration of a co-orbital ASAT capability and intended to fulfill the DA-ASAT role without requiring the use of nuclear weapons.¹⁷⁵ The missile, produced in 1984, was designed to be launched from a modified F-15A in a supersonic zoom climb and intercept targets in LEO.¹⁷⁶ Five flight tests occurred,¹⁷⁷ the most famous of which was an intercept test on September 13, 1985, in which the Solwind P78-1 satellite (1979-017A, 11278) was destroyed at an altitude of 555 km, marking the only time that a US missile destroyed a satellite prior to 2008.¹⁷⁸

FIGURE 1-8 – ASM-135 FLIGHT PROFILE¹⁷⁹



Credit: US Department of Defense.

The ASM-135 had an estimated operational range of 648 km, flight ceiling of 563 km, and speed of over 24,000 km/h.¹⁸⁰ The missile incorporated an infrared homing seeker guidance system, and three rocket stages: a modified Boeing AGM-69 SRAM with a Lockheed LPC-415 solid-propellant two-pulse rocket engine, an LTV Aerospace Altair 3 using a Thiokol FW-4S solid-propellant rocket engine and equipped with hydrazine-fueled thrusters for finer maneuvering to target, and an LTV-produced interceptor named the Miniature Homing Vehicle (MHV) equipped with 63 small rocket motors for fine trajectory adjustments and attitude control.¹⁸¹ A declassified CIA document from 1983 about the system (calling it then the Air-Launched Miniature Vehicle program, or ALMV) noted how various Soviet satellite systems would fare against the system. Included in the group was the crewed Salyut Soviet space station.¹⁸² This was likely due to some of the Salyuts actually being secret Soviet Almaz military space stations (see Russian Co-orbital ASAT, Section 2.2).

The USAF had planned to deploy an operational force of 112 ASM-135 missiles, to be deployed aboard 20 modified F-15s.¹⁸³ Fifteen ASM-135 missiles were ultimately produced, five of which were used in flight tests, and a number of airframes were modified to support its use. In 1988, due to a mix of budgetary, technical, and political concerns, the Reagan administration mothballed the program, though the expertise and technical capability likely remain intact.

TABLE 1-4 – HISTORY OF US DA-ASAT TESTING

DATE	ASAT SYSTEM	SITE	TARGET	APOGEE	NOTES
Sept. 22, 1959	High Virgo (TX-20)	Unknown	None	12 km	Unknown results due to loss of telemetry
Oct. 13, 1959	Bold Orion	Unknown	Explorer VI	200 km	Success (passed within kill radius)
Oct. 1, 1961	SIP (NOTS-EV-2)	San Nicolas Island	None	Unknown	Successful rocket test
Oct. 5, 1961	HiHo (NOTS-EV-1)	F4D-I	None	Unknown	Rocket failure
Mar. 26, 1962	HiHo (NOTS-EV-1)	F4D-I	None	Unknown	Rocket failure
May 5, 1962	SIP (NOTS-EV-2)	F4-C	None	Unknown	Successful rocket test
Aug. 26, 1962	HiHo (NOTS-EV-1)	F4-C	None	1,600 km	Successful rocket test
Dec. 17, 1962	Program 505 (Nike Zeus)	WSMR	None	160 km	Success (reached designated point in space)
Feb. 15, 1963	Program 505 (Nike Zeus)	Kwajalein	None	241 km	Successful intercept of designated point in space
Mar. 21, 1963	Program 505 (Nike Zeus)	Kwajalein	None	–	Unsuccessful attempt to intercept simulated satellite target
Apr. 19, 1963	Program 505 (Nike Zeus)	Kwajalein	None	–	Unsuccessful attempt to intercept simulated satellite target
May 24, 1963	Program 505 (Nike Zeus)	Kwajalein	Agena D	Unknown	Successful close intercept
Jan. 4, 1964	Program 505 (Nike Zeus)	Kwajalein	None	146 km	Successful intercept of a simulated satellite target
Feb. 14, 1964	Program 437 (Thor)	Johnston Atoll	Transit 2A Rocket Body	1000 km	Success (passed within kill radius)
Mar. 1, 1964	Program 437 (Thor)	Johnston Atoll	Unknown	674 km	Success (primary missile scrubbed, backup missile passed within kill radius)
Apr. 21, 1964	Program 437 (Thor)	Johnston Atoll	Unknown	778 km	Success (passed within kill radius)
May 28, 1964	Program 437 (Thor)	Johnston Atoll	Unknown	932 km	Failed (missed intercept point)
Nov. 16, 1964	Program 437 (Thor)	Johnston Atoll	Unknown	1,148 km	Successful Combat Test Launch (passed within kill radius)
Mar. 1965	Program 505 (Nike Zeus)	Kwajalein	None	–	–
Apr. 5, 1965	Program 437 (Thor)	Johnston Atoll	Transit 2A Rocket Body	826 km	Successful Combat Test Launch (passed within kill radius)
Jun. - Jul., 1965	Program 505 (Nike Zeus)	Kwajalein	None	Unknown	Four test intercepts, of which three were successful
Jan. 13, 1966	Program 505 (Nike Zeus)	Kwajalein	None	Unknown	Successful intercept with simulated target
Mar. 30, 1967	Program 437 (Thor)	Johnston Atoll	Unknown piece of space debris	484 km	Successful Combat Evaluation Launch (passed within kill radius)
May 15, 1968	Program 437 (Thor)	Johnston Atoll	Unknown	823 km	Successful Combat Evaluation Launch (passed within kill radius)

184 "Navy Missile Hits Dying Spy Satellite, Says Pentagon," *CNN*, February 21, 2008, <http://www.cnn.com/2008/TECH/space/02/20/satellite.shootdown/>; "History of ASAT Tests in Space," *Secure World Foundation*, last updated February 5, 2025, https://docs.google.com/spreadsheets/d/1e5GtZEzd06x-k41i2_ei3c8jRZDjvP4Xwz3BV5UHwi48/edit?gid=1623728214#gid=1623728214.

185 For an excellent compilation of government documents and contemporary news stories about Operation Burnt Frost, see "USA-193: Selected Documents," compiled by P.J. Blount; P.J. Blount and Joanne Irene Gabrynowicz, editors; *Special Topics in Aerospace Law Series, No. 1; A Supplement to the Journal of Space Law*, at the The National Center for Remote Sensing, Air, and Space Law of the University of Mississippi School of Law, 2009, <https://airandspacelaw.olemiss.edu/pdfs/usa193-selected-documents.pdf>.

186 Kelley M. Saylor, Coordinator, CRS In Focus IF10541, *Defense Primer: Ballistic Missile Defense*, Congressional Research Service, updated January 30, 2024, <https://sgp.fas.org/crs/natsec/IF10541.pdf>. Originally authored by Stephen M. McCall, former Analyst in Military Space, Missile Defense, and Defense Innovation.

187 "Defense Primer: US Ballistic Missile Defense," *Congressional Research Service*, December 30, 2024, <https://crsreports.congress.gov/product/pdf/IF/IF10541>.

188 Laura Grego, George N. Lewis, David Wright, "Shielded from Oversight: The Disastrous US Approach to Strategic Missile Defense; Appendix 6: The Ground-Based Interceptor and Kill Vehicle," *Union of Concerned Scientists*, July 2016, <https://www.ucsusa.org/sites/default/files/attach/2016/07/Shielded-from-Oversight-appendix-6.pdf>.

DATE	ASAT SYSTEM	SITE	TARGET	APOGEE	NOTES
Nov. 21, 1968	Program 437 (Thor)	Johnston Atoll	Unknown	1,158 km	Successful Combat Evaluation Launch (passed within kill radius)
Mar. 28, 1970	Program 437 (Thor)	Johnston Atoll	Unknown satellite	1,074 km	Success (passed within kill radius)
Jan. 21, 1984	ASM-135	Aircraft	None	1,000 km	ASM-135 missile fired from F-15 fighter, successful missile test
Nov. 13, 1984	ASM-135	Aircraft	Star	1,000 km	Failed test
Sept. 13, 1985	ASM-135	Aircraft	Solwind	555 km	Successful test, debris created
Aug. 22, 1986	ASM-135	Aircraft	Star	1,000 km	Successful test in tracking
Sept. 5, 1986	Delta 180 Payload Adapter System	Air Force Eastern Test Range	Delta 2/B	326 km?	Successful intercept of thrusting object in 220-km circular orbit, debris created
Sept. 29, 1986	ASM-135	Aircraft	Star	1,000 km	Successful test in tracking
Feb. 20, 2008	SM-3	USS Lake Erie	USA 193	2,700 km	Successful test

Midcourse Missile Defense Systems as Anti-Satellite Weapons

Because midcourse missile defense systems are intended to destroy long-range ballistic missile warheads, which travel at speeds and altitudes comparable to those of satellites, such defense systems also have inherent ASAT capabilities. In many ways, attacking satellites is an easier task than defending against ballistic missiles. Satellites travel in repeated, predictable orbits, and observations of the satellite can be used to predict its future position. While the launch of a ballistic missile may occur with little or no advanced notice, an anti-satellite attack could be planned in advance to occur under the most convenient conditions, and the attacker may be able to try multiple times if the first try fails.

The United States currently has two operational midcourse missile defense systems that have latent DA-ASAT capabilities: the ground-based interceptors (GBIs), part of the Ground-based Midcourse System (GMD), and the ship-based Standard Missile 3 (SM-3) interceptors, part of the Aegis system. Of the two, only the SM-3 has been demonstrated in a DA-ASAT role. In 2008, the US Operation Burnt Frost used an SM-3 Block IA interceptor fired from an Aegis Cruiser to destroy an ailing US reconnaissance satellite, USA-193 (2006-057A, 29651), at an altitude of 240 km. This test created 175 pieces of trackable debris which took about 20 months to de-orbit entirely.¹⁸⁴ Three SM-3 missiles had a "one-time software modification" to enable them to intercept the satellites, but it is impossible for an adversary to verify whether any additional SM-3 interceptors have been modified for ASAT capability.¹⁸⁵

The GBIs have the most potential capability in a DA-ASAT role. Forty-four GBIs are currently deployed at bases in Fort Greely, Alaska (see Imagery Appendix, pg. 17-01), and Vandenberg Air Force Base, California,¹⁸⁶ with Congress having mandated that a third site on the East Coast of the United States be built by 2030.¹⁸⁷ The planned burnout speed of the GBIs is reported to be 7 to 8 km/s.¹⁸⁸ A missile with this burnout speed could lift the exoatmospheric kill vehicle (EKV) to a height of roughly 6,000 km. This puts it in reach of all satellites in LEO, and possibly some satellites in highly elliptical orbits with perigees that dip down into these altitudes. The GBI could not reach satellites in much higher MEO or GEO.

The EKV will be guided toward the predicted position of the satellite by ground-based radar data. From there, the sensors on the EKV use light in two infrared bands, designed to detect light emitted by room-temperature ICBM-launched warheads or sunlight reflected off them in their journey through the vacuum of space. Their ability to hone in on any given satellite depends on the satellite's particular properties, including its operating temperature, its surface properties, and whether it is in sunlight. Note that while satellites in LEO may enter and exit the Earth's shadow repeatedly during a day, an attacker has the advantage of being able to choose the most advantageous time to attack.

The current SM-3 Block IA and IB interceptors are less capable as DA-ASATs than the current GBIs; they can only reach the relatively few satellites in orbits with perigees at or below 600 km altitude.¹⁸⁹ However, the SM-3 Block IIA interceptors, currently under joint development with Japan, are intended to defend larger areas against more capable threats. The SM-3 Block IIA made its first flight test intercept in February 2017 and received approval to enter into full-rate production in October 2024.¹⁹⁰ Even using a conservative estimate of the burnout speed for such a missile (4.5 km/s), it would be able to reach the vast majority of LEO satellites as shown in Table 1-5. Interceptors with burnout speeds at the high range of estimates for the SM-3 IIA (5.5 km/s) would be able to reach any satellite in LEO.

TABLE 1-5 — MAXIMUM ALTITUDE REACHABLE BY SM-3 VARIANTS¹⁹¹

SM-3 VARIANT	BURNOUT VELOCITY (KM/S)	MAXIMUM REACHABLE ALTITUDE (KM)
Block IA	3.0	600
Block IIA (lower range)	4.5	1,450
Block IIB (upper range)	5.5	2,350

The SM-3 interceptors are meant to be flexible and address emerging ballistic missile threats from the Middle East and East Asia over the coming decade. They exist not only on US Navy ships that can be redeployed around the world, but also are intended to be deployed at land-based "Aegis Ashore" sites. The initial land-based Aegis Ashore site in Romania is in operation.¹⁹² It was delayed for years due to construction issues but was finally accepted by the US Navy in December 2023. The US Navy then almost immediately started working on upgrades in preparation for transferring it over to NATO's command and control, which occurred in November 2024.¹⁹³ At one point, Japan was planning on joining the Aegis Ashore program, but canceled construction in June 2020.¹⁹⁴ MDA expects to have 63 ballistic missile defense (BMD)-capable Aegis ships by the end of FY 26 and any of their hundreds of interceptors could be ASAT-capable.¹⁹⁵

Potential Military Utility /

The SM-3 and GBI interceptors represent a potentially large and flexible DA-ASAT capability that could be used against adversary military satellites in LEO in a future conflict. Of particular interest is China's rapid development of space-based reconnaissance capabilities to target anti-ship ballistic missiles against US ships.¹⁹⁶ These Chinese satellites pose a similar threat to one posed by Soviet satellites during the Cold War, against which the United States decided to develop a DA-ASAT capability.¹⁹⁷

As the United States continues to build out its Aegis, GMD, and Aegis Ashore missile defense architecture, it could theoretically hold at risk a significant portion of either China's or Russia's LEO satellites, particularly if the number of Block II interceptors is increased or it is considered in concert with GMD.

189 Laura Grego, "The Anti-Satellite Capability of the Phased Adaptive Approach Missile Defense System," *Federation of American Scientists*, Winter 2011, p. 3, <https://fas.org/pubs/pir/2011winter/2011Winter-Anti-Satellite.pdf>.

190 "US, Japan Successfully Conduct First SM-3 Block IIA Intercept Test," *Commander, US 7th Fleet*, February 6, 2017, <https://www.c7f.navy.mil/Media/News/Display/article/1079063/us-japan-successfully-conduct-first-sm-3-block-ii-intercept-test>; "RTX's Raytheon SM-3@ Block IIA achieves full-rate production approval," *RTX*, October 15, 2024, <https://www.rtx.com/news/news-center/2024/10/15/rtxs-raytheon-sm-3-block-ii-achieves-full-rate-production-approval>.

191 "US, Japan Successfully Conduct First SM-3 Block IIA Intercept Test," *ibid*; "RTX's Raytheon SM-3@ Block IIA achieves full-rate production approval," *ibid*.

192 Sam LaGrone, "Aegis Ashore Site in Romania Declared Operational," *USNI News*, May 12, 2016, <https://news.usni.org/2016/05/12/aegis-ashore-site-in-romania-declared-operational>.

193 Jen Judson, "Aegis Ashore Poland enters maintenance period ahead of NATO acceptance," *Defense News*, January 22, 2024, <https://www.defensenews.com/naval/2024/01/22/aegis-ashore-poland-enters-maintenance-period-ahead-of-nato-acceptance/>; John Vandiver, "European missile defense nears integration of US Aegis Ashore system in Poland," *Stars and Stripes*, December 21, 2023, <https://www.stripes.com/branches/navy/2023-12-21/navy-poland-missile-defense-12427699.html>; "NATO Assumes Command of Aegis Ashore Site in Poland," *Allied Air Command Public Affairs Office*, Nov. 19, 2024, <https://ac.nato.int/archive/2024/nato-assumes-command-of-aegis-ashore-site-in-poland>.

194 Michael Unbehauen & Christian Decker, "Japan Cancels Aegis Ashore: Reasons, Consequences, and International Implications," *Journal of Indo-Pacific Affairs*, Air University Press, September 25, 2020, <https://www.airuniversity.af.edu/JIPA/Display/Article/2361398/japan-cancels-aegis-ashore-reasons-consequences-and-international-implications/>.

195 Ronald O'Rourke, "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress," *Congressional Research Service Report RL33745*, January 20, 2026, https://www.congress.gov/crs-product/RL33745#_Toc219801161.

196 S. Chandrashekar and Soma Perumal, "China's Constellation of Yaogan Satellites and the Anti-Ship Ballistic Missile: October 2015 Update," *National Institute of Advanced Studies*, October 2015, p. 10, <http://iissp.in/wp-content/uploads/2015/10/Chinese-Yaogan-Satellite-Constellation-and-ASBM-Oct-2015-Update.pdf>.

197 Robert L. Smith, "Final Report of the Ad Hoc NSC Space Panel—Part II: US Anti-Satellite Capabilities," *National Security Council*, November 3, 1976: p. 1.

- 198 DoD Dictionary of Military and Associated Terms, United States Department of Defense: Defense Technical Information Center, February 2018, p. 78, <https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/dictionary.pdf>.
- 199 DoD Dictionary of Military and Associated Terms, *ibid*, p. 76.

The Aegis ships could be positioned optimally to stage a “sweep” attack on a set of satellites nearly at once, rather than a sequential set of attacks as satellites moved into the range of fixed interceptor sites. This positioning flexibility also means that the SM-3 missiles would not have to expend much of their thrust going cross-range and could retain the ability to reach the highest LEO satellites. The more powerful GMD interceptors also could use some of their fuel to reach out laterally over thousands of kilometers, allowing them to hit satellites in orbits that do not pass directly over the GMD missile fields in Alaska and California.

1.3 – US ELECTRONIC WARFARE

Assessment /

The United States has three operational EW counterspace system: the Counter Communications System (CCS), which can be deployed globally to provide uplink jamming capability against geostationary communications satellites; Meadowlands, an updated version of the CCS system; and Remote Modular Terminal (RMT), an EW counterspace system that can be operated remotely.

Through its Navigation Warfare program, the United States has the capability to jam and interfere with the civil signals of global navigation satellite services (GNSS) within a local area of operation to prevent their effective use by adversaries and has demonstrated doing so in several military exercises. The United States likely could jam military GNSS signals as well, although the effectiveness is difficult to assess based on publicly available information. The effectiveness of US measures to counter adversarial jamming and spoofing operations against military GPS signals is not known.

Specifics /

The following paragraphs provide a general overview of different types of EW capabilities as related to counterspace applications that are relevant to all the country-specific EW sections in this report.

Electronic warfare is defined as “military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy.”¹⁹⁸ In the context of this report, the scope of EW is narrowed to refer specifically to intentional interference with an adversary’s radio frequency (RF) transmissions to or from a satellite. This intentional interference is often referred to as “jamming.”¹⁹⁹

In the case of satellite signals, jamming is often characterized as being either uplink or downlink, as shown in Figure 1-9. Uplink, or orbital, jamming occurs when an interference signal targets the satellite directly. Most communication satellites serve as a relay node that rebroadcast signals directed at it, or uplinked, from the ground. The uplink interference signal can originate anywhere within the satellite receive antenna beam and overwhelms the intended signal such that the signal retransmitted by the satellite and received by the users on the ground consists of indecipherable noise. The impact may be widespread since all users within the satellite’s service area (known as the footprint) are affected. Downlink, or terrestrial, jamming targets the ground user of satellite services, by broadcasting an RF signal that overwhelms the intended satellite signal for users in a specific area. In downlink jamming, the satellite itself suffers no interference, nor would users outside the range of the jammer.

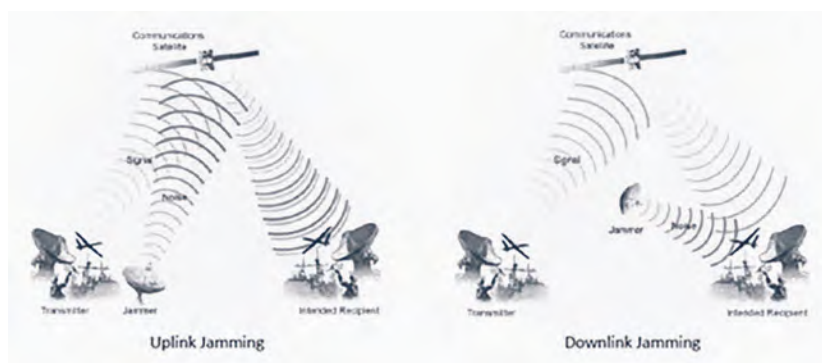
FIGURE 1-9 – UPLINK VS. DOWNLINK JAMMING

Image credit: Infosec Institute.²⁰⁰

A second type of EW attack is known as spoofing, which is altering the content of a signal or broadcasting a false signal in order to confuse or manipulate the end user. For example, an attacker might broadcast the same signal as a real one but at higher power in an attempt to get end users to use the spoofed signal instead of the real one, thereby allowing the attacker to use that spoofed signal to send their own information. In some cases, it is possible for an attacker to intercept and manipulate the real signal, enabling them to inject or alter the information that it carries.

Modern militaries regard EW capabilities and vulnerabilities as highly sensitive information and hence little public information is generally available. Development and testing of equipment and techniques can be conducted within secure defense facilities, leaving little or no external evidence of the activities.

The three principal areas of concern for counterspace are the jamming or spoofing of:

1. GNSS signals,
2. Satellite communications, and
3. Synthetic aperture radar (SAR) imaging.

The following sections indicate US-specific developments of these capabilities.

Counter Communications System (CCS)

The Counter Communications System (CCS) program was initiated in 2003 as part of a broader counterspace capability development program. A February 2020 budget planning document describes the CCS mission as: "CCS provides expeditionary, deployable, reversible offensive space control (OCS) effects applicable across the full spectrum of conflict. It prevents adversary Satellite Communications (SATCOM) in Area of Responsibility (AOR) including Command & Control (C2), Early Warning and Propaganda, and hosts Rapid Reaction Capabilities in response to Urgent Needs."²⁰¹

Successive annual budget planning documents have continued to provide a generic description of the CCS. In the most recently available document (June 2025), the description has evolved somewhat offering more insight into the role of the CCS. It states that the "program provides expeditionary, deployable, reversible offensive space control (OSC) effects applicable across the full spectrum of conflict. It prevents adversary satellite communications (SATCOM) in the Area of Responsibility (AOR) including Command and Control (C2), Early Warning, and Propaganda; and hosts Rapid Reaction Capabilities in response to Urgent Operational Needs."²⁰²

200 Pierluigi Paganini, "Hacking Satellites: Look Up To the Sky," *Infosec Institute*, September 18, 2013, <https://resources.infosecinstitute.com/hacking-satellite-look-up-to-the-sky/#gref>.

201 "RDT&E Budget Item Justification Sheet (R-2 Exhibit), PE Number: 0604421F, PE Title: Counterspace Systems," *Air Force*, February 2020, <https://www.saffm.hq.af.mil/Portals/84/documents/FY21/RDTE/FY21%20Space%20Force%20Research%20Development%20Test%20and%20Evaluation.pdf?ver=2020-02-11-083608-887>.

202 Air Force, Justification Book Volume 1 of 1, Research, Development, Test & Evaluation, *Space Force Vol 1*, FY 2026, PE 12064215F, June 2025, <https://www.saffm.hq.af.mil/Portals/84/documents/FY26/FY26%20Space%20Force%20Research%20and%20Development%20Test%20and%20Evaluation.pdf?ver=zaaWCAil-Ua6XVMOCxpo4w%3d%3d>.

- 203 "Counter Communications System," L3Harris, <https://www.l3harris.com/all-capabilities/counter-communications-system>.
- 204 "76th Space Control Squadron Fact Sheet," Peterson AFB, August 16, 2012, <https://www.peterson.spaceforce.mil/About/Fact-Sheets/Display/Article/326218/76th-space-control-squadron/>.
- 205 Jacob Hancock, "Space Control Squadron Redesignated Electronic Warfare Squadron," *National Guard*, January 30, 2023, <https://www.nationalguard.mil/News/Article/3281489/space-control-squadron-redesignated-electronic-warfare-squadron/>.
- 206 Jeffrey Lewis, "Counter Satellite Communications System Deployed," *ArmsControlWonk.com*, October 2, 2004, <https://www.armscontrolwonk.com/archive/200025/counter-satellite-communications-system-deployed/>.
- 207 George I. Seffers, "Harris to Upgrade Counter Communication Systems," *Signal*, November 13, 2002, <https://www.afcea.org/content/harris-upgrade-counter-communication-systems>.
- 208 Sandra Erwin, "US Space Force Gets Upgraded Satellite Communications Jammers for 'Offensive' Operations," *SpaceNews*, February 4, 2020, <https://spacenews.com/u-s-space-force-gets-upgraded-satellite-communications-jammers-for-offensive-operations/>.
- 209 "Counter Communications System Block 10.2 achieves IOC, ready for the warfighter," *Space and Missile Systems Public Affairs*, March 13, 2020, <https://www.spaceforce.mil/News/Article/2113447/counter-communications-system-block-102-achieves-ioc-ready-for-the-warfighter/>.

There is no public information on any technical characteristics of the CCS, such as frequency ranges, power levels, and waveforms. However, it is reasonable to conclude that CCS can likely jam most of the major commercial frequencies (particularly C and Ku bands) and the most common military frequencies (X-band), with a possible capability in the increasingly popular Ka band. Also, the CCS is likely targeted mainly at geostationary communications satellites (COMSATS), given that they are currently the primary source of satellite communications.

FIGURE 1-10 – SPACE FORCE GUARDIAN IN FRONT OF A PAIR OF COUNTER COMMUNICATIONS SYSTEM ANTENNAS



Image credit: L3Harris.²⁰³

The CCS is operated and maintained by the 4th Electromagnetic Warfare Squadron (formerly the 4th Space Control Squadron), attached to Space Delta 3 of the US Space Force located at Peterson SFB, Colorado. The CCS units can be deployed globally to conduct mobile and transportable space superiority operations in support of global and theater campaigns.²⁰⁴ The CCS is also operated by the 114th Electromagnetic Warfare Squadron (of the Air National Guard), which supports the Space Force.²⁰⁵

The first two CCS units were reportedly delivered in 2004.²⁰⁶ The initial systems are known as Block 10 systems. In 2012, Harris Corp, Space and Intelligence Systems, was contracted to upgrade the five existing CCS Block 10 systems to the Block 10.1 configuration.²⁰⁷ In 2014, Harris again was awarded a contract to upgrade the Block 10.1 systems to the Block 10.2 configuration and deliver a total of 16 Block 10.2 systems to the 4th Space Control Squadron as well as Air National Guard units.²⁰⁸ In March 2020, CCS Block 10.2 was announced to have reached initial operating capability and was deemed to be the USSF's first offensive weapon.²⁰⁹

In March 2017, Harris was awarded a contract to provide Block 10.2 upgrades for 13 existing antennas across the CCS.²¹⁰ In October 2021, L3Harris was awarded a \$120.7 million-contract to provide upgraded units to Space Force bases in the United States and classified overseas locations, with L3Harris required to produce 16 units by 2025.²¹¹ According to L3Harris, there are currently 16 transportable units operated by US Space Force and Air National Guard units.²¹² An SSC slide from 2024 has this listed as CCS' major customers: "Ops units - 4 EWS (active duty), 216 CA ANG, 114 FL ANG, 138 CO ANG, 293 HI ANG Training units - 3 CTS (active duty) and 233 CO ANG Stakeholders - HQ SpOC, EW MAT, Del 3 Deployed COCOMs - EUCOM, CENTCOM, AFRICOM."²¹³

In April 2020, the USAF announced Meadowlands as a further block upgrade to CCS 10.2. It is intended to be lighter than the CCS system, jam a broader spectrum of frequencies (including multifrequency in S-band and X-band), be easily transportable, and use open architecture software to allow for easier updates; as well, the USSF says that it will have a comparatively reduced footprint while also "allowing one operator to control 300 percent more simultaneous missions from a geographically remote operating location."²¹⁴ It is intended to provide more distance between the operator and the antenna (10 km) and, because of its smaller size, requires 50% less aircraft support for transportation.²¹⁵ It is being built by L3Harris, who was supposed to deliver four systems by April 2023.²¹⁶ However, the system was delayed due to technical issues.²¹⁷ System-level verification reporting was completed in September 2024, which L3Harris acknowledged "took longer than anticipated," but stated that Meadowlands "is on track for delivery early next year."²¹⁸ The USSF accepted the first two Meadowlands systems in early April 2025 and spent about a month conducting integrated testing, with fielding approval then being granted in May 2025.²¹⁹ The first system was delivered to Space Delta 3 in December 2025.²²⁰ The USSF is planning for a total of 32 weapons. Also, in December 2025, it was reported that Meadowlands had been made eligible to be sold to allies through the United States' Foreign Military Sales (FMS) program, with L3Harris having finished an "international initial baseline review" for the program that determined it could be useful for foreign customers while also ensuring sensitive US technology would not fall into the wrong hands.²²¹

- 210 "US Air Force Modifies Counter Communication System Contract," *Signal*, March 13, 2017, <https://www.afcea.org/content/Blog-us-air-force-modifies-counter-communication-system-contract>.
- 211 Sandra Erwin, "L3 Harris wins \$120 million contract to upgrade Space Force electronic jammers," *SpaceNews*, October 22, 2021, <https://spacenews.com/l3-harris-wins-120-million-contract-to-upgrade-space-force-electronic-jammers/>.
- 212 "Counter Communications System," *L3Harris*, Copyright 2023, accessed February 15, 2024, <https://www.l3harris.com/all-capabilities/counter-communications-system>.
- 213 Natasha Peebles, "Counter Communications System (CCS) Development Capabilities Overview," SSC, June 2024, https://afcea-la.org/wp-content/uploads/Peebles-Briefing_Jun-2024.pdf.
- 214 Anthony Capaccio, "US Builds Ground-Based Arsenal to Jam Russia, China Satellites," *Bloomberg Quint*, April 17, 2020, <https://www.bloombergquint.com/politics/u-s-space-force-is-arming-to-jam-russian-and-chinese-satellites>; "Field approval for USSF Space Electromagnetic Warfare system upgrade expands warfighting capabilities," Space Operations Command Public Affairs, May 21, 2025, <https://www.ssc.spaceforce.mil/Newsroom/Article-Display/Article/4196523/field-approval-for-ussf-space-electromagnetic-warfare-system-upgrade-expands-wa>; Theresa Hitchens, "Space Force takes ownership of first Meadowlands satellite jammer," *Breaking Defense*, April 10, 2025, <https://breakingdefense.com/2025/04/space-force-takes-ownership-of-first-meadowlands-satellite-jammer/>.
- 215 Peebles, "Counter Communications System (CCS)," *ibid*.
- 216 Frank Wolfe, "Space Force Developing Non-Kinetic Counterspace Systems," *Defense Daily*, November 9, 2020, <https://www.defensedaily.com/space-force-developing-non-kinetic-counterspace-systems/space/>.
- 217 Anthony Capaccio, "Portable US Weapon to Jam Chinese, Russian Satellites Is Running Two Years Late," *Bloomberg*, June 29, 2023, <https://www.bloomberg.com/news/articles/2023-06-29/portable-us-weapon-to-jam-chinese-russian-satellites-is-running-two-years-late?srnd=premium-asia>.
- 218 Anthony Capaccio, "US Satellite Jammer Is Set for Delivery as Flaws Are Fixed," *Bloomberg*, October 24, 2024, <https://www.bloomberg.com/news/articles/2024-10-24/space-jammer-to-aim-at-russian-chinese-satellites-is-readied-as-flaws-are-fixed>.
- 219 "Field approval for USSF Space Electromagnetic Warfare system upgrade expands warfighting capabilities," *ibid*.
- 220 Capaccio, "Portable US Weapon to Jam," *ibid*; "L3Harris Delivers First Meadowlands Production Unit to US Space Force," *L3Harris*, December 11, 2025, <https://www.l3harris.com/newsroom/editorial/2025/12/l3harris-delivers-first-meadowlands-production-unit-us-space-force>.
- 221 Sandra Erwin, "L3Harris satellite-jamming system approved for export to close US allies," *SpaceNews*, December 10, 2025, <https://spacenews.com/l3harris-satellite-jamming-system-approved-for-export-to-close-u-s-allies/>.

- 222 Air Force, Justification Book Volume 1, Procurement, Space Force RD&E Budget Item Justification: FY 2025, "CTRSPC / Counterspace Systems," 1 Space Force, Program Element: PE 1206421F, March 2024, <https://www.saffm.hq.af.mil/Portals/84/documents/FY25/FY25%20Space%20Force%20Procurement.pdf>
- 223 Theresa Hitchens, "Satellite jamming 'normal' by militaries during conflict, not peacetime: State Dept. official," *Breaking Defense*, March 21, 2022, <https://breakingdefense.com/2022/03/satellite-jamming-normal-by-militaries-during-conflict-not-peacetime-state-dept-official/>
- 224 Space and Missile Systems Center Public Affairs, "Counter Communications System Block 10.2 achieves IOC," *United States Space Force*, March 13, 2020, <https://www.spaceforce.mil/News/Article/2113447/counter-communications-system-block-102-achieves-ioc-ready-for-the-warfighter/>
- 225 "Space Training and Readiness Command (STARCOM) and Space Systems Command (SSC) award ASTRO-E to Six Companies, Fast-Tracking Full-Spectrum Testing Capabilities," *Space Systems Command*, May 22, 2024, <https://www.spaceforce.mil/LinkClick.aspx?fileticket=tzgFZ-rpJ9Vo%3D&portalid=3>
- 226 "Space Training and Readiness Command (STARCOM) and Space Systems Command (SSC) award ASTRO-E to Six Companies, Fast-Tracking Full-Spectrum Testing Capabilities," *ibid.*
- 227 "STARCOM tests RMT system for Space Rapid Capabilities Office," *Space Training and Readiness Command*, April 18, 2024, <https://www.starcom.spaceforce.mil/News/Article-Display/Article/3747374/starcom-tests-rmt-system-for-space-rapid-capabilities-office/>
- 228 Natasha Peeples, "Counter Communications System (CCS) Development Capabilities Overview," SSC, June 2024, https://afcea-la.org/wp-content/uploads/Peeples-Briefing_Jun-2024.pdf
- 229 Courtney Albon, "New US Space Force jammers aim to disrupt China's SATCOM signals," *DefenseNews*, December 19, 2024, <https://www.defensenews.com/space/2024/12/19/new-us-space-force-jammers-aim-to-disrupt-chinas-satcom-signals/>
- 230 Albon, "New US Space Force jammers aim to disrupt China's SATCOM signals," *ibid.*
- 231 Allyson Park, "Space Force To Field Electromagnetic Warfare Operations Center In Next Few Months," *National Defense Magazine*, September 24, 2025, <https://www.nationaldefensemagazine.org/articles/2025/9/24/space-force-to-field-electromagnetic-warfare-operations-center-in-next-few-months>
- 232 Courtney Albon, "Space Force refining range needs through 'Black Skies' training," *DefenseNews*, September 22, 2022, <https://www.defensenews.com/space/2022/09/22/space-force-refining-range-needs-through-black-skies-training/>

The CCS continues to be well funded with activities including upgrades to existing systems as well as procurement of new units. Although it appears to be shifting to maintenance mode as the planned budget drops significantly after FY2024: \$52.7 million was requested for procurement in FY2024, but FY2025-2028 anticipates \$10 million total. Having said that, the budget documents indicate that through FY2028, \$232 million will have been spent on the program.²²² In March 2022, when discussing Russia's attack on Ukraine, Eric Desautels, the acting deputy assistant secretary for emerging security challenges and defense policy in the Department of State's Bureau of Arms Control, Verification and Compliance, stated that "the United States has our own communications jammer known as the CCS system," and that, "We think that jamming is probably a normal part of conflict;" however, he did not say if the CCS had been sent to the region.²²³ A USSF press release in March 2020 noted that CCS was used by USAF active-duty units and Air National Guard units in California, Colorado, and Florida.²²⁴ However, it is clear from the funding allocations that the CCS is a high-priority program and likely offers the US military a very effective SATCOM jamming capability. The CCS system continues to be evolved, presumably with increasing sophistication and capability.

In February 2024, six companies were awarded what the USSF called "Advanced Space Technology for Range Operations-Electromagnetic Range (ASTRO-E)" contracts, where they were given six months to come up with concepts for EW training ranges that incorporate space combat scenarios.²²⁵ The companies are NouSystems, ExoAnalytic Solutions, TMC Design, HII Mission Technologies Corp, Parsons Government Services Inc, and Lockheed Martin.²²⁶ The amount of the contracts was not given.

The USSF's Space Training and Readiness Command (STARCOM) announced in April 2024 that it had conducted a test of a new system built by the Space Rapid Capabilities Office (RCO) called the Remote Modular Terminal (RMT), described by a USSF official as a capability that, "will unlock the scale to provide counterspace electronic warfare capability to all of the new Space Force components globally."²²⁷ Block 0 will have Ku band antennae, while Block 1 is supposed to cover multiple bands.²²⁸ It is intended to be operated remotely and consist of a large number of "small form-factor units." In December 2024, Space Operations Command authorized the initial fielding of 11 units; the program office has funding for 160 units and anticipates that as many as 200 eventually might be required.²²⁹ Space RCO head Kelly Hammett said their goal for the system is "to block reception going either from, say, sensors that are looking at our joint forces and reporting up to a satellite and back to a battle management node, or vice versa," and to "be able to disrupt their comms and their kill chains and their targeting links." It is not known where the initial units will be fielded.

In September 2025, the Space Force announced it was going to be opening a tactical EW center to allow it to "globally command and control at a tactical level, the surveillance, tracking and targeting of [the] electromagnetic spectrum," according to Lt. Gen. David Miller, commander of Space Operations Command.²³¹

Black Skies

The Space Force undertook the first iteration of an EW training event called "Black Skies" in September 2022.²³² This event was intended to allow Space Force personnel to practice jamming satellites, focusing on a commercial satellite target leased by the Space Force for this purpose. The second one was held in March 2023, with the third happening in September 2023. The third iteration, Black Skies 23-3, had the Combined Space Operations Center

(CSpOC) coordinating live fire exercises (where operators sent signals from ground to space), as well as closed loop operations (where there was no impact to space assets); including other units, there were over 170 people participating.²³³ This is part of a larger testing series planned by the Space Force. “Red Skies” was held in December 2023 and strove to make training scenarios more realistic through incorporating space weapons simulations and allowing the participation of more operators.²³⁴ A “Blue Skies” training exercise that will focus on cyber operators was planned for the end of 2024 but has not been held as of February 2026.²³⁵ Major General Shawn Bratton, the head of Space Training and Readiness Command, has said that they are considering a fleet of “live” on-orbit satellites that the Space Force could practice on.²³⁶ The USSF has a live ground-based EW range, the Space Test and Training Range, at Schriever Space Force Base in Colorado.²³⁷

NAVWAR

The United States DoD relies heavily on PNT capabilities, which are primarily provided by GPS satellites. Over the last two decades, the US military has put significant effort into incorporating GPS capabilities into a wide array of weapons systems and operational practices. Along with the enormous potential of enhancing military operations, satellite navigation systems also introduce a potential vulnerability since their precise navigation signals are also prone to interference by an adversary. In the mid-1990s, the US military launched a formal effort called Navigation Warfare (NAVWAR) as part of the compromise to turn off Selective Availability for GPS. Over time, NAVWAR became a broader effort to develop a strategy for how the US military could conduct both defensive and offensive operations to protect US use of PNT capabilities while also interdicting or preventing adversary use of PNT capabilities.²³⁸

The Joint Navigation Warfare Center (JNWC) was established by the Deputy Secretary of Defense Memorandum on November 17, 2004, and assigned to USSTRATCOM/JFCC SPACE in 2007. JNWC is a staff element that directly supports warfighters as the Joint Subject Matter Expert to integrate/coordinate NAVWAR across the full range of military operations for all domains, every phase of war, and the seven joint warfighting functions. The JNWC’s mission is “[t]o enable Positioning, Navigation, and Timing (PNT) Superiority by providing operational NAVWAR support and by creating and maintaining NAVWAR knowledge for the Department of Defense, Interagency Partners, and the Coalition.”²³⁹ Most of the US NAVWAR capabilities and activities are classified, and hence there is little publicly available information. However, the US DoD likely devotes significant resources to this domain, since space-based PNT (specifically GPS) is crucial to most military operations.

The NAVWAR defensive measures seek to prevent adversarial electronic countermeasures from interfering with the operational use of GPS in two fundamental ways. The US military developed a new military signal, called M-code, which is much more secure than the older P(Y) military GPS signal. M-code operates at a higher power and a waveform that increases its resistance to jamming, and improved encryption protocols to protect against spoofing.

New generations of GPS satellites, starting with the first GPS Block IIR-M satellite (NAVSTAR 57, 2005-038A, 28874) launched on September 26, 2005, are able to broadcast M-code. There are currently 24 M-code capable GPS satellites, including the first of the new GPS Block IIIA satellites launched on December 23, 2018.²⁴⁰ Deployment of the ground control system (known as OCX) and new end user receivers to fully implement and utilize M-code have run into significant delays and challenges. The Director of Operational Test

233 Unshin Lee Harpley, “Space Force Conducts Its Biggest Electronic Warfare Exercise Ever,” *Air & Space Forces Magazine*, October 6, 2023, <https://www.airandspaceforces.com/space-force-biggest-electronic-warfare-exercise-ever/>.

234 Greg Hadley, “Red Skies: Space Force Launches New Orbital Warfare Exercise,” *Air & Space Forces Magazine*, January 8, 2024, <https://www.airandspaceforces.com/red-skies-space-force-new-orbital-warfare-exercise/>.

235 Courtney Mabeus-Brown, “Inaugural Red Skies exercise boosts orbital warfare readiness,” *Air Force Times*, March 7, 2024, <https://www.airforcetimes.com/news/your-air-force/2024/03/07/inaugural-red-skies-exercise-boosts-orbital-warfare-readiness>.

236 Courtney Albon, “Space Force refining range needs through ‘Black Skies’ training,” *DefenseNews*, September 22, 2022, <https://www.defensenews.com/space/2022/09/22/space-force-refining-range-needs-through-black-skies-training/>.

237 Courtney Albon, “Space Force envisions digital future for testing and training,” *C4ISRNet.com*, June 15, 2022, <https://www.c4isrnet.com/battlefield-tech/space/2022/06/15/space-force-envisions-digital-future-for-testing-and-training/>.

238 *Joint Publication 3-13.1, Electronic Warfare*, February 8, 2012, prepared under the direction of the Chairman of the Joint Chiefs of Staff (CJCS), <https://info.publicintelligence.net/JCS-EW.pdf>.

239 “Joint Navigation Warfare Center (JNWC) Fact Sheet,” *US Strategic Command*, October 17, 2016, <http://www.stratcom.mil/Media/Factsheets/Factsheet-View/Article/976408/joint-navigation-warfare-center-jnwc/>.

240 Doug Messier, “Final Steps Underway To Operationalize Ultra-Secure, Jam-Resistant GPS M-Code Signal,” *Parabolic Arc*, March 30, 2020, <http://www.parabolicarc.com/2020/03/30/final-steps-underway-to-operationalize-ultra-secure-jam-resistant-gps-m-code-signal/>; Theresa Hitchens, “GPS III Launch Will Provide Global M-Code,” *Breaking Defense*, June 14, 2021, <https://breakingdefense.com/2021/06/gps-iii-launch-will-provide-global-m-code/>.

- 241 "Global Positioning System: Updated Schedule Assessment Could Help Decision Makers Address Likely Delays Related to New Ground Control System," *Government Accountability Office*, GAO-19-250, May 21, 2019, <https://www.gao.gov/assets/700/699234.pdf>; Theresa Hitchens, "Ground system for jam-resistant GPS delayed again to July 2025 at earliest, Pentagon tester says," *Breaking Defense*, February 2, 2024, <https://breakingdefense.com/2024/02/ground-system-for-jam-resistant-gps-delayed-again-to-july-2025-at-earliest-pentagon-tester-says/>.
- 242 "GPS MODERNIZATION Delays Continue in Delivering More Secure Capability for the Warfighter," *Government Accountability Office*, September 2024, <https://www.gao.gov/assets/gao-24-106841.pdf>.
- 244 Sally Cole, "Securing military GPS from spoofing and jamming vulnerabilities," *Military Embedded Systems*, November 30, 2015, <http://mil-embedded.com/articles/securing-military-gps-spoofing-jamming-vulnerabilities/>.
- 245 Michael Jones, "New Military Code About to Board 700+ Platforms," *GPS World*, April 9, 2019, <https://www.gpsworld.com/new-military-code-about-to-board-700-platforms/>.
- 246 Daniel Cebul, "DoD Jams GPS in western states for joint exercise," *C4ISR Net*, January 26, 2018, <https://www.c4isrnet.com/special-reports/pnt/2018/01/26/dod-jams-gps-in-western-states-for-joint-exercise/>.
- 247 Minnie Chan, "'Unforgettable humiliation' led to development of GPS equivalent," *South China Morning Post*, November 13, 2009, <https://www.scmp.com/article/698161/unforgettable-humiliation-led-development-gps-equivalent>.
- 248 Tyler Rogoway, "USAF is jamming GPS in the Western US for largest ever Red Flag air war exercise," *The Drive*, January 25, 2018, <http://thedrive.com/the-war-zone/17987/usaf-is-jamming-gps-in-the-western-u-s-for-largest-ever-red-flag-air-war-exercise>.
- 249 David Cenciotti, "Basically, Carrier Strike Group 4 is jamming GPS across the US Southeast coast," *The Aviationist*, February 8, 2019, <https://theaviationist.com/2019/02/08/basically-carrier-strike-group-4-is-jamming-gps-across-u-s-southeast-coast/>.
- 250 Tracy Cozzens, "US Navy to Conduct GPS Interference Tests Off Savannah," *GPS World*, August 30, 2019, <https://www.gpsworld.com/u-s-navy-to-conduct-gps-interference-tests-off-savannah/>.
- 251 Tom Demmerly, "US Navy Now Jamming GPS Over Six States and 125,000 Square Miles," *The Aviationist*, January 23, 2020, <https://theaviationist.com/2020/01/23/u-s-navy-now-jamming-gps-over-six-states-and-125000-square-miles/>.
- 252 Chris Shieff, "Signal Jam: US GPS Interference Testing This Month," *OpsGroup*, March 14, 2022, <https://ops.group/blog/signal-jam-us-gps-interference-testing-this-month/>.
- 253 Geneva Quinn, Nicholas George, Kalyn Jones, Orlando Padilla, Sean Abrahamson, "NAVFEST: 20 Years of Cost-Effective GPS NAVWAR Testing," *Inside GNSS*, September 16, 2024, <https://insidengss.com/navfest-20-years-of-cost-effective-gps-navwar-testing/>; Jesse Khalil, "VectorNav participates in USAF PNT test," *GPS World*, June 7, 2024, <https://www.gpsworld.com/vectornav-participates-in-usaf-pnt-test/>.

& Evaluation reported in January 2024 that the delay extended the delivery of OCX until July 2025 and pointed out, "These delays increase risk that US and allied warfighters will be unable to conduct successful operations in future contested environments due to the lack of access to modernized GPS position, navigation, and timing (PNT) information."²⁴¹ In September 2024, the Government Accountability Office reported that the OCX would not reach operational acceptance until December 2025.²⁴² The Space Force received in July 2025 the first two command and control (C2) software blocks of OCX, which is now in its government-led testing phase; the operational acceptance date is unclear.²⁴³ Six USSF sites are receiving new software-defined receivers that will allow for M-code to be enabled to meet the goal of protecting from spoofing and jamming. The effectiveness of these measures against a sophisticated adversary is not known,²⁴⁴ and it will take a significant period of time to roll out upgrades or new receivers to the 700+ deployed weapon systems that utilize GPS.²⁴⁵

There is no confirmed public information on the US military's technical capabilities for offensively jamming or spoofing adversary PNT capabilities. Nevertheless, the United States likely has very effective capabilities for jamming and spoofing of GNSS receivers, including GPS, GLONASS, and BeiDou. This assessment is based on the consistent high priority placed on the NAVWAR effort, the success of US EW systems in other domains of warfare, and the technical sophistication of the US industry in this field. The most likely way this would be accomplished is by using downlink jamming to interfere with or spoof GNSS signals in a specific geographic area.²⁴⁶ It is rumored that the United States interfered with GPS in the East China Sea region in order to disrupt a Chinese missile drill held during a time of heightened relations in 1996.²⁴⁷

The US military is also known to exercise the ability to jam GNSS or operate while adversary jamming is taking place. In January 2018, the USAF announced it would be jamming the civil GPS signals across the Nevada Test and Training Range as part of its annual Red Flag exercise.²⁴⁸ In August 2018 and February 2019, a US Navy Carrier Strike Group also exercised wide-scale jamming of GPS across the southeastern coast of the United States.²⁴⁹ Wide-scale jamming was exercised along the southeastern coast of the United States on August 30, 2019, September 5, 2019,²⁵⁰ and January 16-24, 2020.²⁵¹ And additional GPS jamming was carried out as part of tests over South Carolina, California, and Alaska in March 2022.²⁵² Starting in 2004, the 746th Test Squadron at Holloman AFB, New Mexico, has held an annual "GPS interference event" called NAVFEST at White Sands Missile Range, New Mexico, where DoD and commercial entities can test how well their equipment operates in a GPS jamming environment; this past year's test was the 20th iteration of it and was held May 6-17, 2024.²⁵³

Potential Military Utility /

The Counter Communications System is likely very effective in denying potential adversaries of geostationary satellite communications capabilities, and the new upgrades (Meadowlands and RMT) even more so. With COMSATS being used for an increasingly large and diverse set of critical military communications purposes (e.g., command and control, relay of intelligence and operational data, control of UAVs) the employment of CCS in theater would likely be very effective at hampering an opponent's operations, making Meadowlands and RMT potentially very useful in military conflicts. The specific impact would depend on the circumstances of the situation.

NAWWAR, both defensive and offensive components, is essential to military operations due to the dependency on navigation services. The ability to employ precision navigation services while simultaneously denying the same to an adversary would confer a tremendous advantage in a time of conflict.

However, conducting operationally useful, dependable, and reliable jamming or spoofing of highly used military space capabilities, such as GNSS, is more difficult than most commentators suggest. Military GNSS signals are much more resilient to jamming than civil GNSS signals, and a wide variety of tactics, techniques, and procedures exist to mitigate attacks.²⁵⁴ It is much more likely that an EW counterspace weapon would degrade military space capabilities rather than completely deny them.

254 Brandon Davenport and Rich Ganske, "Recalculating Route: A Realistic Risk Assessment for GPS," *War on the Rocks*, March 11, 2019, <https://warontherocks.com/2019/03/recalculating-route-a-realistic-risk-assessment-for-gps/>.

1.4 – US DIRECTED ENERGY WEAPONS

Assessment /

Over the past several decades, the United States has conducted significant research and development on the use of ground-based high-energy lasers for counterspace and other purposes. We assess that there are no technological roadblocks to the United States operationalizing them for counterspace applications. With its Satellite Laser Ranging (SLR) sites and defense research facilities, the United States possesses low-power laser systems with the capability to dazzle, and possibly blind, imaging satellites. However, there is no indication that these potential high- or low-power capabilities have been operationalized.

There is no public evidence that the United States has a space-based DEW capability. MDA is planning to conduct research into the feasibility of DEW for defending against ballistic missiles and the Space Force has expressed an interest in a directed energy architecture in general (not necessarily space-based). If developed, these systems may have a capability against other orbiting satellites and, depending on their target acquisition and tracking capabilities, may be considered de facto anti-satellite systems.

Specifics /

Directed Energy Weapons (DEW) refers to a class of potential weapons technologies that harness concentrated beams of electromagnetic waves or subatomic particles. The three main types of DEWs are lasers, particle beams, and radio frequency energy. Of these, laser systems are the most developed and most prominent of the DEW counterspace threats.

The following paragraphs provide a general overview of different types of DEW capabilities as related to counterspace applications that apply to all the country-specific DEW sections in this report.

Laser Systems

Laser systems for counterspace applications could be either ground-based or space-based. Ground-based systems require much higher power and have few restrictions on size, type, and consumption of chemicals or electrical power. Space-based systems, on the other hand, could be effective at lower power but are severely restricted in size and power availability. For example, ground-based chemical lasers can generate high power but would be difficult to implement in space due to their size and the disturbance torques that may be generated by exhaust. Solid-state and fiber lasers would be more appropriate for space basing but require large inputs of electrical energy.

Although admittedly a great oversimplification, several essential technological building blocks must be developed in order to field a high-power laser that will have an effective counterspace capability:

1. High fidelity space situational awareness,

- 255 David Wright, Laura Grego, and Lisbeth Gronlund, *The Physics of Space Security*, American Academy of Arts and Science, 2005, Appendix A to Section 11, <https://www.ucsusa.org/sites/default/files/2019-09/physics-space-security.pdf>.
- 256 Wright, Grego, and Gronlund, *The Physics of Space Security*, *ibid.*
- 257 Yousaf Butt, "Effects of Chinese Laser Ranging on Imaging Satellites," *Science and Global Security*, 17:20-35, 2009, <http://scienceandglobalsecurity.org/archive/sqs17butt.pdf>.

2. High power laser device,
3. Precise beam tracking and control, and
4. Adaptive optics to counteract atmospheric turbulence (ground-based).

The use of lasers in satellite countermeasure or weapon applications can be classed into three categories based on their effects:

1. Dazzling of a satellite's imaging sensor,
2. Damage to a satellite's imaging sensor,
3. Damage to the satellite bus or its subsystems.

Laser dazzling is more appropriately considered a countermeasure than a weapon since the effect is not permanent. The dazzling phenomenon consists of directing a relatively low-power laser beam into the optics of an imaging satellite. The laser light will impinge on the sensor's detector array, usually a charge-coupled device (CCD) or a complementary metal-oxide-semiconductor (CMOS), and overwhelm the natural collection of photons. As a result, a number of the pixels of an image will be saturated, thus obscuring a portion of the image scene. The effects may persist in the sensor and associated electronics would be temporary in nature. For example, in a CCD array, it might take several successive readouts of the array to completely clear the electric charge that was induced by the laser. Therefore, the effect may impact a plethora of images, following the laser incident. However, this effect is considered temporary since it will eventually clear on its own with no operator intervention. Laser dazzling could be used as a countermeasure to protect specific ground facilities from being imaged by optical means. The laser source would need to be located near the target it is intended to protect.²⁵⁵

Since imaging sensors are very sensitive to light, relatively low power levels are required to dazzle. For example, Satellite Laser Ranging (SLR) is a mechanism to accurately track satellites that have been equipped with laser retroreflectors. SLR is used for satellites in which the precise knowledge of position and orbits is essential for their mission (e.g., geodetic or navigation satellites). Low-power lasers used for SLR would be of sufficient power to dazzle imaging sensors. The amount of power required to dazzle but not damage is not clear and depends on several factors specific to the particular situation. Factors relating to wavelength, atmospheric conditions, and, in particular, the design of the satellite optics and sensor all contribute. However, rough estimates suggest that even a 10-watt laser could be sufficient to create a dazzling effect and obscure an area on the ground.²⁵⁶ Other research confirms this finding, but also notes that the pulse rate of the laser needs to be taken into account, as the laser could only impact a satellite's optics if it was pointed at the laser during a pulse.²⁵⁷ Ultimately, the most difficult aspect of laser dazzling is not the power of the laser, but the accurate tracking of the satellite.

Damage to a satellite's image sensor, or associated electronics, could be caused when the laser power is of sufficient intensity. Damage to optics would involve a higher power than dazzling. However, the threshold between dazzling and damage is almost impossible to predict; thus, whenever a dazzling attempt is made there may be a risk of damage. This is because the ground area obscured (corresponding to the portion of the sensor dazzled) increases with increasing laser power. At the high end, where a large portion of the array becomes saturated, some of the sensor elements may become subject to sufficient intensity to cause permanent damage. Under some conditions, damage to a portion of the sensor array could be incurred using a continuous wave with a power level as low as 40 watts. This power level would likely only affect a few pixels in the array, but it would be permanently damaged,

nonetheless. A more likely power level to use for a weapons application where significant damage to the sensor was intended would be in the kilowatt range.²⁵⁸

In the case of damage to optical sensors, the satellite will not otherwise be damaged. It can continue to be controlled and operated and the other non-imaging payloads will continue to function.

Damage to the satellite bus could be inflicted with the use of a very high-power laser. The damage would be due to the thermal effects of the absorbed energy causing failure of some essential components of the bus (ex. thermal regulation system, the batteries, or attitude control system). In this scenario, there is a complete failure of the satellite. All satellites would be potentially susceptible to this type of attack, but it would require a very high-powered laser system.

Neutral Particle Beams

High-energy particle beams are generated by accelerating and focusing subatomic particles through the use of powerful electromagnetic fields. Neutral particle beams are a type of particle beam that consists of neutral particles. Neutral beams are required for counterspace applications since, unlike charged beams, they are unaffected by the Earth's magnetic field.

Radio Frequency Weapons

Radio frequency weapons, not to be confused with RF jammers, emit a very intense focused beam of microwave energy. The high-power microwave (HPM) energy can cause damage to electronic circuitry as well as discomfort to humans.

US-Specific Directed Energy Weapons Program for Counterspace

Over the past several decades, the United States has sufficiently developed the technologies required to construct and deploy a ground-based counterspace laser weapon that would be capable of damaging most types of LEO satellites. However, there is no public indication that the United States has transitioned from a research phase to an operational capability.

Most of the historical activities and research is connected to the Strategic Defense Initiative (SDI) in the 1980s and focused on high-power lasers that could be used to intercept ballistic missiles or nuclear warheads but could also be used against satellites. The most publicized US counterspace laser research project involves the Mid-Infrared Advanced Chemical Laser (MIRACL) Program. MIRACL is a chemical laser (deuterium fluoride) capable of emitting a multi-megawatt beam in the infrared spectrum (see Imagery Appendix, pg. 17-25). The project was initially funded by SDIO beginning in 1985, with the goal of conducting research on ballistic missile defense.²⁵⁹ MIRACL was fired against an orbiting satellite in October 1997, with then Secretary of Defense William Cohen putting out a statement that the test was “fully consistent” with US policy and did not violate international law.²⁶⁰ The target was the MSTI-3 (1996-031A, 23868) satellite, a USAF experimental satellite that had been launched in May 1996 and had completed its mission. MSTI-3 carried IR sensors and was an ideal target for an IR laser. Detailed results of the test were not made public. Official statements by the Pentagon indicated that the test was defensive in nature with the purpose of gathering data to “improve computer models used for planning the protection of US satellites” and the Pentagon further stated that “there’s absolutely no intention to use the laser for offensive purposes.”²⁶¹

Regardless of assurances as to the intent of the test, the capability of MIRACL to damage satellites in orbit appeared to have been demonstrated. MIRACL

258 Butt, “Effects of Chinese Laser Ranging on Imaging Satellites,” *ibid.*

259 “High Energy Laser Systems Test Facility,” *White Sands Missile Range*, updated October 26, 2018, <https://www.wsmr.army.mil/testcenter/testing/landf/Pages/HighEnergyLaserSystemsTestFacility.aspx>.

260 “Army to fire laser at satellite in space,” *Tampa Bay Times*, October 3, 1997, <https://www.tampabay.com/archive/1997/10/03/army-to-fire-laser-at-satellite-in-space/>.

261 William Broad, “US to Fire Laser Weapon at a Satellite,” *New York Times*, October 3, 1997, <https://www.nytimes.com/1997/10/03/us/us-to-fire-laser-weapon-at-a-satellite.html>.

262 "MIRACL," *Defense Advanced Research Projects Agency (DARPA)*, accessed February 23, 2019, <https://www.darpa.mil/about-us/timeline/miracl>.

263 "High Energy Laser Systems Test Facility," *White Sands Missile Range*, updated October 26, 2018, <https://www.wsmr.army.mil/testcenter/testing/landf/Pages/HighEnergyLaserSystemsTestFacility.aspx>.

264 Theresa Hitchens, "Missile Defense Agency has new hope for airborne lasers," *Breaking Defense*, June 17, 2024, <https://breakingdefense.com/2024/06/missile-defense-agency-has-new-hope-for-airborne-lasers/>.

265 "Strategic Defense Initiative Program: Zenith Star Space-Based Chemical Laser Experiment," Government Accountability Office, report NSIAD-89-118, April 14, 1989, <https://www.gao.gov/products/nsiad-89-118>.

266 "Strategic Defense Initiative Program: Zenith Star Space-Based Chemical Laser Experiment," *ibid*.

267 P. G. O'Shea, T. A. Butler, M. T. Lynch, K. F. McKenna, M. B. Pongratz, T. J. Zaugg, "A Linear Accelerator In Space: The Beam Experiment Aboard Rocket," *Proceedings of the Linear Accelerator Conference 1990*, Albuquerque, New Mexico, USA, <https://accelconf.web.cern.ch/accelconf/l90/papers/th454.pdf>.

continued to be used for research on other high-power laser applications, such as defense against rockets and missiles, until at least the mid-2000s.²⁶² The MIRACL laser appears to still be actively used in research projects and remains a key component of the High Energy Laser Systems Test Facility at the US Army's White Sands Missile Range.²⁶³

Another notable example was the Low-Power Atmospheric Compensation Experiment (LACE) satellite (1990-015A, 20496), launched in 1990, which was a Naval Research Laboratory project sponsored by the SDIO. The satellite carried three separate sensor arrays capable of characterizing ground-based laser beams of various types and wavelengths. The sensors determined the power received from ground-based lasers and were used to determine the effectiveness of various methods of compensating for atmospheric distortion, an important consideration for ground-based laser ASAT systems.

A third example was the Airborne Laser (ABL), a USAF/Missile Defense Agency (MDA) project, begun in 1996, to test the feasibility of intercepting ballistic missiles in their boost phase using a high-power laser installed in a Boeing 747 aircraft. The aircraft carried a megawatt-class chemical oxygen iodine laser (COIL) along with two lower power lasers for target identification and tracking. During its lifetime, the project demonstrated capabilities by conducting several intercept tests of aerodynamic and ballistic targets. The project came under budgetary pressure and was canceled in 2011. This project did not have a counterspace objective and did not directly develop technologies to target satellites, although some technologies may have been able to contribute to counterspace applications. In June 2024, news emerged that MDA had requested \$11 million to conduct research and development on airborne laser technology, focusing specifically on using low-powered lasers for tracking, with the thinking that (per an MDA spokesperson) the, "systems associated with this risk reduction work are also directly applicable to more advanced systems, including non-kinetic intercept systems."²⁶⁴

There is no publicly available evidence to suggest that the United States currently has space-based laser counterspace capabilities and there are likely significant technological obstacles to fielding such capabilities. However, there were efforts under SDI to develop space-based lasers and neutral particle beams. The Strategic Defense Initiative Organization (SDIO, predecessor to the Missile Defense Agency) was working on a space-based chemical laser in the 1980s that it inherited from DARPA (the Triad Program) and created the Zenith Star Program in 1987 with the goal of testing it in 1990; a GAO report in 1989 noted that at that time, the test date had been pushed well into the 1990s.²⁶⁵ The justification for a space-based laser was that "SDIO needed to demonstrate a capability to deal with responsive threats, or countermeasures, that the Soviets were likely to take in response to a phase I deployment of US space-based interceptor rocket. SDIO concluded that a directed energy weapon may be needed to counter possible Soviet responses to a phase I deployment."²⁶⁶

In 1989, the BEAM Experiment Aboard Rocket used a linear accelerator mounted inside an upper stage to test the propagation of a neutral particle beam in the outer space environment on a suborbital vehicle.²⁶⁷ The experiment was deemed successful because it successfully generated a neutron particle beam, albeit at extremely low power and for only a short period of time. To date, there appears to have been little further development of the technology.

The United States has also conducted significant historical research and development on HPM for broad military applications and terrestrial use. One such application is the Active Denial System, a prototype non-lethal system to

be used at short ranges for stopping, deterring, and turning back suspicious individuals with minimal risk of injury.²⁶⁸ Although, in theory, an HPM weapon in space could damage a satellite if it was sufficiently close, there is no indication of any space-based capability or intent to pursue such by the United States.

In October 2003, the US Air Force awarded an additional \$32.2 million contract to Northrop Grumman to develop the Counter Surveillance and Reconnaissance System (CSRS, pronounced “scissors”), a mobile system that was intended to develop reversible means to temporarily dazzle space-based surveillance and reconnaissance satellites.²⁶⁹ This was on top of an earlier award of \$15 million. At the time the add-on contract was awarded, the goal was to get the work finished by October 2004; by July 2004, that had been pushed back to striving to reach initial operational capability by FY2009.²⁷⁰ Ultimately, the FY2005 Defense appropriations bill, finalized in August 2004, cut the entire funding for the program, with the Senate report noting that the Air Force had decided to stop the program.²⁷¹

Current US DEW Developments and Capabilities

The US military is investing significant research and development funds in various DEW weapons applications. High-power laser prototypes are being developed for tactical use, such as defense against missiles, rockets, artillery, and UAVs.²⁷² While none of these prototypes can be used for a counterspace role, they are furthering the development of component technologies that may apply to counterspace applications.

The United States currently operates several SLR sites, most of which are operated by either NASA or universities. The lone DoD site, the NRL Optical Test Facility at Stafford, VA, would be the likeliest of the ILRS sites to conduct laser dazzling tests or operations. However, there is no indication that this has occurred. Although it is theoretically possible to use SLR facilities to conduct laser dazzling, it is assessed that these sites are not a counterspace threat due to most of them being civilian. Furthermore, laser dazzling would only be useful if the SLR site was geographically located near a sensitive facility so that it could dazzle adversary imaging satellites as they came overhead from imaging that sensitive facility.

There was a renewed discussion in the United States of a space-based missile defense initiative that could also have counterspace applications. The SDIO transitioned into the Ballistic Missile Defense Organization (BMDO) in 1994, and then renamed MDA in 2002. The MDA’s budget request for 2020 included \$34 million for neutral particle beam and laser technologies, with plans for testing a neutral particle beam weapon in orbit by 2023. However, the House version of the defense authorization act for that year asked for an in-depth study first and in September 2019, the Pentagon announced that it was “deferring work on neutral particle beams indefinitely.”²⁷³

Although there have been statements suggesting that the studies into laser space-based defense concepts would address boost phase intercept,²⁷⁴ that limitation is not specified in the 2022 Missile Defense Review, which does not mention lasers at all,²⁷⁵ nor in the budget request information that has been made public. On January 27, 2025, President Donald Trump released an Executive Order (EO) called “An Iron Dome for America.”²⁷⁶ It sets out the mission of “deploying and maintaining a next-generation missile defense shield;” relevant to this threat assessment, it calls for the Secretary of Defense to submit within 60 days an architecture, capabilities requirements, and implementation plan. In the end of February 2025, it was reported that Secretary of Defense Pete Hegseth had released a memo called a “strategic guidance” to describe how

268 Active Denial Technology Fact Sheet, *US Department of Defense Non-Lethal Weapons Program*, May 11, 2016, https://jnlwp.defense.gov/Portals/50/Documents/Press_Room/Fact_Sheets/ADT_Fact_Sheet_May_2016.pdf.

269 Frank Tiboni, “Air Force seeks satellite blinder plans,” *FCW*, October 24, 2003, <https://fcw.com/workforce/2003/10/air-force-seeks-satellite-blinder-plans/224950/>.

270 John A. Tirpak, “Securing the Space Arena,” *Air Force Magazine*, July 1, 2004, <https://www.airforcemag.com/article/0704space/>.

271 Adolfo J. Fernandez, “Military Role in Space Control: A Primer,” *Congressional Research Service Report RL32602*, September 23, 2004, <https://sgp.fas.org/crs/natsec/RL32602.pdf>.

272 “US Army Weapons-Related Directed Energy (DE) Programs: Background and Potential Issues for Congress,” *Congressional Research Service*, updated February 12, 2018, <https://crsreports.congress.gov/product/pdf/R/R45098>; “Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress,” *Congressional Research Service*, updated October 23, 2018, <https://crsreports.congress.gov/product/pdf/R/R44175>.

273 Transcript of *Department of Defense Press Briefing on the President’s Fiscal Year 2020 Defense Budget for the Missile Defense Agency*, US Department of Defense, March 12, 2019, <https://dod.defense.gov/News/Transcripts/Transcript-View/Article/1784150/departement-of-defense-press-briefing-on-the-presidents-fiscal-year-2020-defense/>; Oriana Pawlyk, “Pentagon Halts Work on Directed-Energy Beam to Stop Enemy Missiles,” *Military.com*, September 4, 2019, <https://www.military.com/daily-news/2019/09/04/pentagon-halts-work-directed-energy-beam-stop-enemy-missiles.html>.

274 Patrick Tucker, “Pentagon Wants to Test A Space-Based Weapon in 2023,” *Defense One*, March 14, 2019, <https://www.defenseone.com/technology/2019/03/pentagon-wants-test-space-based-weapon-2023/155581/>.

275 *2022 Missile Defense Review*, US Department of Defense, October 27, 2022, <https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF>.

276 “Executive Order: The Iron Dome for America,” *The White House*, January 27, 2025, <https://www.whitehouse.gov/presidential-actions/2025/01/the-iron-dome-for-america/>.

277 Theresa Hitchens, "Exclusive: Here's who Hegseth may task to put together Trump's Iron Dome plan," *Breaking Defense*, February 6, 2025, <https://breakingdefense.com/2025/02/exclusive-heres-who-hegseth-is-tasking-to-put-together-trumps-iron-dome-plan/>.

278 Nathan Strout, "The Space Force wants to use directed-energy systems for space superiority," *C4ISRNet.com*, June 16, 2021, <https://www.c4isrnet.com/battlefield-tech/space/2021/06/16/the-space-force-wants-to-use-directed-energy-weapons-for-space-superiority/>.

279 Strout, "The Space Force wants to use directed-energy systems for space superiority," *ibid*.

his department will meet that 60-day deadline. In it, the DoD Research & Engineering office is asked to undertake an "assessment" of whether DEW could be part of that architecture, and if so, possible funding options.²⁷⁷ This goes beyond the EO, which did not mention directed-energy weapons.

In June 2021, then Space Force Chief of Space Operations General John "Jay" Raymond was asked during a Congressional hearing whether the United States was working on a DEW portfolio "to be an effective capability for space dominance;" his response was, "Yes sir, we are...We have to be able to protect these capabilities that we rely so heavily on."²⁷⁸ A Space Force spokesperson explained later in a statement that Raymond's response "was confirming that our architecture developments in the face of these threats are appropriate."²⁷⁹

Military Utility /

DEWs, primarily lasers, offer significant potential for military counterspace applications. They offer the possibility of interfering with or disabling a satellite without generating significant debris. The technologies required for ground-based lasers systems are well developed. Ground-based systems can dazzle or blind Earth observation satellites, or even inflict thermal damage on most LEO satellites.

In contrast, the technical and financial challenges to space-based DEW for counterspace remain substantial. These include the mass of the weapon, consumables and disturbance torques (chemical lasers), electrical power generation (solid-state and fiber lasers, particle beams), target acquisition and tracking, and the potential large size of a constellation. The acquisition and tracking challenges are greatly simplified in a co-orbital GEO or LEO scenario.

However, both ground- and space-based DEW counterspace capabilities do have significant drawbacks in assessing their effectiveness. It can be very difficult to determine the threshold between temporary dazzling or blinding and causing long-term damage, particularly since it may depend on the internal design and protective mechanisms of the target satellite that are not externally visible. Moreover, it can be difficult for an attacker to determine whether a non-destructive DEW attack actually worked.

1.5 – US SPACE SITUATIONAL AWARENESS CAPABILITIES

Assessment /

The United States currently possesses the most advanced SSA capabilities in the world, particularly for military applications. US SSA capabilities date to the beginning of the Cold War and leverage significant infrastructure developed for missile warning and missile defense. The core of its SSA capabilities is a robust, geographically dispersed network of ground-based radars and telescopes and space-based telescopes. The United States is investing heavily in upgrading its SSA capabilities by deploying new radars and telescopes in the Southern Hemisphere, upgrading existing sensors, and signing SSA data sharing agreements with other countries and satellite operators. The United States still faces challenges in modernizing the software and computer systems used to conduct SSA analysis and is increasingly looking to leverage commercial SSA capabilities.

Specifics /

SSA is the ability to accurately characterize the space environment and activities in space. Civil SSA combines positional information on the trajectory of objects in orbit (mainly using optical telescopes and radars) with information on space

weather. Military and national security SSA applications also include characterizing objects in space, their capabilities and limitations, and potential threats.

Ground-based radars have historically been the backbone of SSA. Radar consists of at least one transmitter and receiver. The transmitter emits radio waves at a specific frequency, some of which reflect off the target and are measured by the receiver, which can then calculate the location of the target in relation to the radar. The primary advantages of radars are that they can actively measure the distance to a target and some types of radars can accurately track many objects at once. Some radars can also detect the motion of an object and construct a representation of its shape. The main disadvantages of radars are their cost, size, and complexity.

Optical telescopes are also widely used for SSA. Telescopes collect light or other electromagnetic (EM) radiation emitted or reflected by an object and focused into an image using lenses, mirrors, or a combination of the two. The main advantages of using optical telescopes for SSA are their ability to cover large areas quickly and track objects above 5,000 km in altitude. Some telescopes can create high resolution images of space objects. The main disadvantage of optical telescopes is that they require specific lighting conditions and clear skies to see an object, although space-based optical telescopes eliminate some of these limitations.

Other types of sensors can be used for SSA, including sensors that detect radio frequency (RF) or other types of signals from satellites, lasers that measure the distance or range to a satellite very accurately, and infrared sensors that detect heat. Combining data from many different types of sensors, both ground- and space-based, that are also distributed around the globe provides a more complete picture of the space environment and activities in space.

The United States, like Russia, developed its original SSA capabilities as part of the Cold War space and nuclear rivalry. The US Space Surveillance Network (SSN) consists of multiple phased array radars that are primarily used for missile warning along with a few dedicated phased array and mechanical tracking radars, dedicated ground-based electro-optical telescopes, and dedicated space-based optical telescopes. Several of the SSN sensors are located outside of the continental United States and some of those are operated by NATO allies.

For tracking objects in LEO, the SSN originally contained elements of the Ballistic Missile Early Warning System (BMEWS) radars at Clear Space Force Station in Alaska, Pituffik Space Base in Greenland, and Royal Air Force Fylingdales in the United Kingdom (see Imagery Appendix, pg. 17-32). Those radars have been replaced by modern phased array systems. The SSN also contains radars that are part of the Precision Acquisition Vehicle Entry Phased Array Warning System (PAVEPAWS) system developed in the 1980s and currently located at Cape Cod Air Force Station in Massachusetts (see Imagery Appendix, pg. 17-31), Beale Air Force Base in California, and Clear Space Force Station in Alaska. The network also contains radars developed for missile defense, such as the Perimeter Acquisition Radar Attack Characterization System (PARCS) radar, which was created for the Safeguard ABM system at Cavalier Space Force Station in North Dakota and the Cobra Dane radar at Eareckson Air Station in the Aleutian Islands. A dedicated phased array radar for space surveillance is in operation at Eglin Air Force Base in Florida (see Imagery Appendix, pg. 17-33).

The SSN also contains multiple radar and optical sensors that can be used to track objects out to GEO. Major sites include radars at the Lincoln Space Surveillance Complex near Boston, Massachusetts (see Imagery Appendix,

- 280 Sandra Erwin, "L3Harris Wins \$1.2 billion Contract to Maintain, Upgrade Space Surveillance Systems," *SpaceNews*, February 29, 2020, <https://spacenews.com/l3harris-wins-1-2-billion-contract-to-maintain-upgrade-space-surveillance-sensors/>.
- 281 "L3HARRIS To Advance Department Of Defense's Space Domain Awareness Mission," *L3Harris*, October 19, 2023, <https://www.l3harris.com/newsroom/press-release/2023/10/l3harris-advance-department-defenses-space-domain-awareness-mission>.
- 283 Steve Kotecki, "C-band Radar Reaches Full Operational Capability in Australia," *Peterson Air Force Base*, March 15, 2017, <https://www.peterson.af.mil/News/Article/1114478/c-band-radar-reaches-full-operational-capability-in-australia/>.
- 284 Sandra Erwin, "US Space Force Deploying Surveillance Telescope In Australia," *SpaceNews*, April 23, 2020, <https://spacenews.com/u-s-space-force-deploying-surveillance-telescope-in-australia/>; Sandra Erwin, "Space surveillance telescope developed by the US begins operations in Australia," *SpaceNews*, September 30, 2022, <https://spacenews.com/space-surveillance-telescope-developed-by-the-u-s-begins-operations-in-australia/>.
- 285 "Joint US-Australian Space Surveillance Telescope To Be Improved," *Australian Defence Magazine*, July 16, 2020, <https://www.australian-defence.com.au/defence/cyber-space/joint-us-australian-space-surveillance-telescope-to-be-improved/>; Erwin, September 30, 2022, *ibid*.
- 286 Nathan Strout, "New Space Radar Likely to go Online Later This Month," *C4ISRNET*, February 3, 2020, <https://www.c4isrnet.com/battlefield-tech/space/2020/02/03/new-space-radar-likely-to-go-online-this-month/>.
- 287 Andrew Eversden, "New Space Fence radar is officially online," *C4ISRNET*, March 30, 2020, <https://www.c4isrnet.com/intel-geoint/isr/2020/03/30/new-space-fence-radar-is-officially-online/>.
- 288 Sandra Erwin, "Northrop Grumman win \$341 million Space Force contract to develop a deep-space tracking radar," *SpaceNews*, February 23, 2022, <https://spacenews.com/northrop-grumman-wins-341-million-space-force-contract-to-develop-a-deep-space-tracking-radar/>.
- 289 Lisa Soddors, "Deep Space Advanced Radar Capability makes tremendous progress in first year," *Space Systems Command*, February 20, 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4072069/deep-space-advanced-radar-capability-makes-tremendous-progress-in-first-year/>.
- 290 Clarence Oxford, "Northrop Grumman secures contract for second DARC installation," *Space War*, September 1, 2024, https://www.spacewar.com/reports/Northrop_Grumman_secures_contract_for_second_DARC_installation_999.html.
- 291 Sandra Erwin, "Northrop Grumman to get sole-source contract for Space Force radar sites," *SpaceNews*, August 17, 2023, <https://spacenews.com/northrop-grumman-to-get-sole-source-contract-for-space-force-radar-sites/>.

pg. 17-35), and the Reagan Test Site on Kwajalein Atoll in the South Pacific (see Imagery Appendix, pg. 17-37), along with optical telescopes. These include the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) system, which features triplets of 1-meter optical telescopes located at Socorro, New Mexico, Diego Garcia atoll in the Indian Ocean, and the USAF Maui Optical and Supercomputing observatory in Hawaii (see Imagery Appendix, pg. 17-41).

In 2020, L3Harris won a 10-year, \$1.2-billion contract for the Maintenance of Space Situational Awareness Integrated Capabilities (MOSSAIC) program to upgrade the capabilities of the GEODSS sensors and expand the number of telescopes and locations.²⁸⁰ In October 2023, L3Harris announced it had won two contracts worth \$134 million in support of its MOSSAIC work.²⁸¹ There are nine legacy GEODSS telescopes still in use by the Space Force; the follow-on, Ground-based Optical Sensors (GBOSS), is three times more sensitive to light, can scan more quickly, and has twice the field of view as the GEODSS telescopes.²⁸²

Several efforts are underway to develop new capabilities for the SSN. A C-band mechanical tracking radar originally located in Antigua was moved to Naval Communication Station Harold E. Holt near Exmouth, Western Australia (see Imagery Appendix, pg. 17-39) in March 2017.²⁸³ The Space Surveillance Telescope (SST), a 3.5-meter telescope originally developed by DARPA, was also moved to Naval Communication Station Holt (see Imagery Appendix, pg. 17-40) to be jointly operated by the USSF's Space Delta 2 unit and the Royal Australian Air Force.²⁸⁴ It imaged its first objects in March 2020 and was declared operational in September 2022.²⁸⁵

The USSF also has the Space Fence program to develop new S-Band phased arrays to improve tracking of small objects as a replacement for the Navy Space Surveillance System (NAVSPASUR) that was shuttered in 2013. The first S-Band Space Fence was constructed on Kwajalein Atoll (see Imagery Appendix, pg. 17-34), which is anticipated to be able to track small space objects down to a few centimeters.²⁸⁶ The Space Fence became operational in March 2020.²⁸⁷ The USSF envisioned a second Space Fence site in the future, but no funding has been suggested to do so.

A contract for another new radar program, the Deep Space Advanced Radar Capability (DARC), was awarded to Northrop Grumman in February 2022.²⁸⁸ DARC is an effort to develop a new set of radars to detect, track, and identify objects in deep space and consists of three geographically distributed sites that each have multiple transmit and receive radars meshed together; it is designed to have sites in the United States, Australia, and the United Kingdom. In September 2022, Northrop Grumman was awarded the contract to build Site 1 in Western Australia and began this work in October 2023; the first of twenty-seven antennas was completed in February 2024.²⁸⁹ Northrop Grumman won another contract for DARC in September 2024, allowing it to begin preparing for the second site, which will be in the United Kingdom.²⁹⁰ The third site is supposed to be in the United States.²⁹¹

In October 2023, the SSC announced “Project Apollo,” an effort to spur three-month innovation cycles (called “cohorts”) in solving major SSA issues; the first one to be examined was misidentification of objects that could actually be threat intelligence payloads or weapons.²⁹²

DARC has been having issues maintaining its set schedule. USSF’s Gen. Stephen Purdy said in February 2025 that DARC might be one of the “slow” and “expensive” legacy systems that might be better replaced by commercial providers.²⁹³ A June 2025 report by the US Government Accountability Office (GAO) noted that delays in the build of Site 1 because of issues in creating the site’s systems integration lab were “due to the contractor’s lack of expertise in building such a lab” and that seven-month delay had created follow-on delays.²⁹⁴ For example, “the program delayed Site 2 construction by 9 months to April 2027 and deferred operational acceptance by 13 months to November 2029. Similarly, for Site 3, the program postponed both construction start and operational acceptance by 26 months, to September 2029 and January 2032, respectively.”²⁹⁵

In August 2025, Northrop Grumman reported that Site 1’s “calibrated antenna arrays operated as a single system to successfully characterize the movement of multiple satellites and demonstrate the effectiveness of the system’s precision radar tracking technology” and is scheduled to be completed in 2027.²⁹⁶ Despite delays in the sites’ construction, the entire DARC system is still scheduled to be operational by 2032.²⁹⁷

In addition to ground-based sensors, the US SSN also includes multiple space-based optical sensors. The Space-Based Space Surveillance (SBSS) satellite (2010-048A, 37168) is in LEO and has a large, gimbaled telescope that can track space objects in higher orbits.²⁹⁸ The Canadian Sapphire satellite (2013-009C, 39088) is a smaller satellite in a similar orbit that also contributes to the SSN.²⁹⁹ The USSF also operates GSSAP satellites in GEO, which can provide up-close imaging, characterization, and intelligence (see US Co-Orbital ASAT; Section 1.2). ORS-5 SensorSat (2017-050A, 42921) was launched in 2017 and became operational in 2019.³⁰⁰ It keeps an eye on GEO from a LEO orbit of 591 km by 575 km.³⁰¹ TDO-2 (2020-022A, 45464) was launched in March 2020 in order to provide space domain awareness for the USSF by using lasers to get range data on space objects, as well as allow for optical calibration options.³⁰²

292 Frank Wolf, “US Space Force ‘Project Apollo’ to Help Unveil Adversary Cloaking in Space,” *Defense Daily*, October 11, 2023, <https://www.defensedaily.com/u-s-space-force-project-apollo-to-help-unveil-adversary-cloaking-in-space/>; “Space Systems Command now taking applications for Project Apollo to accelerate advances in Space Domain Awareness,” Office of Public Affairs (SSC/PA), October 10, 2023, <https://www.ssc.spaceforce.mil/Portals/3/TAP%20Lab%20Project%20Apollo.pdf>.

293 Theresa Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *Breaking Defense*, March 11, 2025, <https://breakingdefense.com/2025/03/ssc-reviewing-expensive-legacy-programs-for-possible-commercial-shift/>.

294 “Weapon Systems Annual Assessment: DOD Leaders Should Ensure That Newer Programs Are Structured for Speed and Innovation,” Government Accountability Office Report GAO-25-107569, p. 158, June 2025, <https://www.gao.gov/assets/gao-25-107569.pdf>.

295 Hitchens, “Space Systems Command reviewing,” *ibid.*

296 Sandra Erwin, “Deep-space radar in Australia begins tracking satellites for AUKUS partners,” *SpaceNews*, August 12, 2025, <https://spacenews.com/deep-space-radar-in-australia-begins-tracking-satellites-for-aukus-partners/>.

297 Theresa Hitchens, “Northrop Grumman says first DARC test validates radar tracking capability,” *Breaking Defense*, August 15, 2025, <https://breakingdefense.com/2025/08/northrop-grumman-says-first-darc-test-validates-radar-tracking-capability/>; Erwin, *ibid.*

298 “Space-Based Space Surveillance,” *Air Force Space Command*, March 22, 2017, <https://www.afspc.af.mil/About-Us/Fact-Sheets/Article/249017/space-based-space-surveillance-sbss/>.

299 Mike Gruss, “Canada’s Sapphire Satellite Begins Operations,” *SpaceNews*, January 31, 2014, <https://spacenews.com/39343canadas-sapphire-satellite-begins-operations/>.

300 “SMC Sets New Standard Of Success For Acquisition And Operations Of Sensorsat,” *SMC Public Affairs News Release*, October 9, 2019, <https://www.afspc.af.mil/News/Article-Display/Article/1985934/smc-sets-new-standard-of-success-for-acquisition-and-operations-of-sensorsat/>.

301 Joseph Trevithick, “Space Force Has A Unit Dedicated To Orbital Warfare That Now Operates The X-37B Spaceplane,” *TheDrive.com*, October 30, 2020, <https://www.thedrive.com/the-war-zone/37361/space-force-has-a-unit-dedicated-to-orbital-warfare-that-now-operates-the-x-37b-spaceplane>.

302 Nathan Strout, “The Space Force is adding another satellite to its first launch,” *C4ISRNET*, March 10, 2020, <https://www.c4isrnet.com/battlefield-tech/space/2020/03/11/the-space-force-is-adding-another-satellite-to-its-first-launch/>.

303 Theresa Hitchens, "EXCLUSIVE: NRO, SPACECOM Craft CONOPS For War In Space," *Breaking Defense*, May 4, 2020, <https://breakingdefense.com/2020/05/exclusive-nro-spacecom-craft-conops-for-war-in-space/>.

304 Courtney Albon, "Space Force, NRO launch 'Silent Barker' space observation satellites," *C4ISRNet*, September 10, 2023, <https://www.c4isrnet.com/battlefield-tech/space/2023/09/10/space-force-nro-launch-silent-barker-space-observation-satellites/>.

305 Courtney Albon, "Space Force's first Silent Barker satellites to go live in early 2025," *DefenseNews*, December 11, 2024, <https://www.defensenews.com/space/2024/12/11/space-forces-first-silent-barker-satellites-to-be-live-in-early-2025/>.

306 Greg Hadley, "NRO, Space Force Partner to Craft New Moving Targeting Strategy," *Air & Space Forces Magazine*, October 10, 2023, <https://www.airandspaceforces.com/nro-space-force-partnership-targeting-strategy/>.

307 Will Robinson-Smith, "Atlas 5 rocket returns to pad for spy satellite agency launch from Cape Canaveral," *Spaceflight Now*, September 8, 2023, <https://spaceflightnow.com/2023/09/08/atlas-5-rocket-returns-to-pad-for-spy-satellite-agency-launch/>.

308 "Space Situational Awareness: DOD Should Evaluate How It Can Use Commercial Data," *Government Accountability Office*, April 2023, <https://www.gao.gov/assets/gao-23-105565.pdf>.

309 Theresa Hitchens, "Space Force will not partner with NRO for next-generation surveillance satellites," *Breaking Defense*, December 15, 2025, <https://breakingdefense.com/2025/12/space-force-will-not-partner-with-nro-for-next-generation-surveillance-satellites/>.

310 Hitchens, "Space Force will not partner with NRO," *ibid*.

311 Sandra Erwin, "Turion Space secures \$32.6 million military contract for in-orbit space surveillance," *SpaceNews*, December 20, 2024, <https://spacenews.com/turion-space-secures-32-6-million-military-contract-for-in-orbit-space-surveillance/>.

A classified space-based SSA system called "SILENT BARKER" was jointly developed by the USSF and the NRO; it was initially to have been launched in 2022, but a problem was discovered during launch preparation, so the satellite was returned to its manufacturer and the launch rescheduled for August 2023.³⁰³ The mission ended up being launched in September 2023, with three satellites designated USA 346 (2023-140A, 57836), USA 347 (2023-140B, 57837), and USA 348 (2023-140C, 57838) being placed into orbit above GEO at 12 degree inclination.³⁰⁴ After over a year of on-orbit tests, the first series of SILENT BARKER satellites is thought to have become operational as of early 2025.³⁰⁵ NRO Deputy Director Maj. Gen. Christopher Povak explained the difference between SILENT BARKER and GSSAP thusly: "SILENT BARKER is looking at the entirety of that geosynchronous belt consistently. And GSSAP is responsible for doing characterization to detect anomalies or provide intricate characterization of satellites in geosynchronous orbit;" it might be used for targeting from space, but it is hard to say at this point.³⁰⁶ The data collected by SILENT BARKER is to be sent to classified military users like the USSF's National Space Defense Center and the Combined Space Operations Center, while the satellites will be maintained by the NRO.³⁰⁷ According to a 2023 GAO report, another launch was planned for the program in FY2026, at which point it is anticipated to reach full operational capacity; it does not appear to have happened.³⁰⁸ For the follow-on to SILENT BARKER, the Space Force released a request for proposals in November 2025, asking for an optical sensor that would have a "wide field of view" and able to detect "resident space objects at 14.5 visual magnitude with special interest in sensors capable of detection at 16+ visual magnitude" (eg, dimmer objects).³⁰⁹ The Space Force does not intend to operate this follow-on with the NRO.³¹⁰

The USSF awarded a contract in December 2024 to Turion Space to manufacture three small satellites that can be launched in 2026 and 2027 and are capable of providing SSA and debris tracking, with the goal of operating in both LEO and GEO.³¹¹

In April 2019, the head of the Space Development Agency announced they were exploring architectures for extending SSA out to cislunar space.³¹² AFRL's Space Vehicles Directorate is also considering what it calls "xGEO" orbits, those beyond GEO out to cislunar space, with the goal of extending SDA from GEO out past the Moon.³¹³ AFRL announced a project in September 2020 called "Cislunar Highway Patrol System," or CHPS, which was planned to help detect and track objects from GEO to the Moon by improving sensor technologies and algorithms needed for tracking objects.³¹⁴ CHPS became Oracle in November 2022 when a \$72 million contract was awarded to Advanced Space (with partners General Atomics Electromagnetic Systems and Leidos), and is intended to operate near Earth-Moon Lagrange Point 1 (EML1).³¹⁵ Originally intended to launch in 2025, by September 2023, the AFRL had pushed that back to 2027.³¹⁶ In December 2021, AFRL announced its support of a research project called "Space Object Understanding and Reconnaissance of Complex Events (SOURCE)," which is intended to help improve SSA modeling of the xGEO domain.³¹⁷

The data from the SSN sensors is collated and processed by the 18th Space Defense Squadron (18 SDS), located at Vandenberg Space Force Base in California.³¹⁸ The mission was originally done by the 1st Space Control Squadron in Cheyenne Mountain Air Force Station in Colorado but was moved to Vandenberg in 2007 as part of the creation of the Joint Space Operations Center (JSpOC), although much of the communications and data is still routed through Cheyenne Mountain. JSpOC became the Combined Space Operations Center (CSpOC) in July 2018 to improve interoperability with allies and commercial partners.³¹⁹ An alternate command center is located in Dahlgren, Virginia, at what used to be the control facility for the NAVSPASUR. In April 2022, the unit at Dahlgren was renamed the 19th Space Defense Squadron (19 SDS) with a new focus on xGEO SDA.³²⁰ Both report to Space Delta 2, garrisoned at Peterson SFB, Colorado.³²¹

- 312 Theresa Hitchens, "SDA's Kennedy: Cislunar Space the Next Military Frontier," *Breaking Defense*, April 17, 2019, <https://breakingdefense.com/2019/04/sdas-kennedy-cislunar-space-the-next-military-frontier/>.
- 313 Theresa Hitchens, "AFRL Targets Space Ops In New Orbits," *Breaking Defense*, June 5, 2020, <https://breakingdefense.com/2020/06/afri-to-de-mo-ops-in-nontraditional-orbits-for-space-force/>.
- 314 Sandra Erwin, "Air Force Research Laboratory Announces New Space Experiments," *SpaceNews*, September 2, 2020, <https://spacenews.com/air-force-research-laboratory-announces-new-space-experiments/>.
- 315 Theresa Hitchens, "Oracle's vision: Understanding cislunar satellite images poses AFRL's 'biggest' challenge," *Breaking Defense*, November 28, 2022, <https://breakingdefense.com/2022/11/oracles-vision-understanding-cislunar-satellite-images-poses-afrls-biggest-challenge/>; "Oracle: Space Situational Awareness System Mission Beyond GEO," *Advanced Space*, accessed February 22, 2025, <https://advancedspace.com/missions/oracle/>.
- 316 Sandra Erwin, "Air Force Research Laboratory delays lunar experiment," *SpaceNews*, September 15, 2023, <https://spacenews.com/air-force-research-laboratory-delays-lunar-experiment/>.
- 317 Theresa Hitchens, "AFRL jumpstarts early research on cislunar monitoring, satellite servicing," *Breaking Defense*, December 17, 2021, <https://breakingdefense.com/2021/12/afri-jumpstarts-early-research-on-cislunar-monitoring-satellite-servicing/>.
- 318 "18th Space Control Squadron," *Peterson Air Force Base*, August 6, 2018, <https://www.peterson.af.mil/About/Fact-Sheets/Display/Article/1060346/18th-space-control-squadron/>.
- 319 "Combined Space Operations Center Established At Vandenberg AFB," Joint Force Space Component Command Public Affairs, *Air Force Space Command*, July 18, 2018, <https://www.afsfc.af.mil/News/Article-Display/Article/1579285/combined-space-operations-center-established-at-vandenberg-afb/>.
- 320 Theresa Hitchens, "The USSF stood up the 19th Space Defense Squadron in April 2022 so it can track objects in xGEO space," *Breaking Defense*, April 21, 2022, <https://breakingdefense.com/2022/04/to-infinity-and-beyond-new-space-force-unit-to-monitor-xgeo-beyond-earths-orbit/>.
- 321 Stephen Brady, "Space Delta 2 monitors deep space," *Peterson Space Force Base Press Release*, accessed February 20, 2022, <https://www.peterson.spaceforce.mil/News/Article/2564700/space-delta-2-monitors-deep-space/>.

- 322 Anyone can sign up for an account at <https://space-track.org> as long as they sign a user agreement.
- 323 Cristina Chaplain, "Space Command and Control: Comprehensive Planning and Oversight Could Help DOD Acquire Critical Capabilities and Address Challenges," *US Government Accountability Office*, October 2019, <https://www.gao.gov/assets/710/702424.pdf>.
- 324 Sandra Erwin, "Space Force's troubled space-tracking system is officially shut down," *SpaceNews*, January 27, 2022, <https://space-news.com/space-forces-troubled-space-tracking-system-is-officially-shut-down/>.
- 325 Theresa Hitchens, "Seeing in the dark: Space Force works, slowly, to improving monitoring of the heavens," *Breaking Defense*, April 5, 2022, <https://breakingdefense.com/2022/04/seeing-in-the-dark-space-force-works-slowly-to-improve-monitoring-of-the-heavens/>.
- 326 "Space Systems Command Expands Space Command and Control Capabilities to Accelerate Operational Timelines for Warfighters," *Space Systems Command*, January 30, 2025, <https://www.ssc.spaceforce.mil/Newsroom/Article-Display/Article/4065348/space-systems-command-expands-space-command-and-control-capabilities-to-accelerate>.
- 327 Shellie-Anne Espinosa, "National Space Defense Center Transitions to 24/7 Operations," *Air Force Space Command Public Affairs*, January 26, 2018, <http://www.afspc.af.mil/News/Article-Display/Article/1423932/national-space-defense-center-transitions-to-247-operations/>.
- 328 Sandra Erwin, "Air Force Eyes Commercial Options to Gain Intelligence on Space Threats," *SpaceNews*, September 18, 2018, <https://space-news.com/air-force-eyes-commercial-options-to-gain-intelligence-on-space-threats/>.
- 329 Bridget Bonnette, "Joint Task Force-Space Defense Commercial Operations cell receives new name," *Joint Task Force-Space Defense Public Affairs*, December 29, 2023, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/3629834/joint-task-force-space-defense-commercial-operations-cell-receives-new-name/>.
- 330 Sandra Erwin, "US Space Command's commercial operations group gets expanded role," *SpaceNews*, September 22, 2024, <https://space-news.com/u-s-space-commands-commercial-operations-group-gets-expanded-role/>.
- 331 Erwin, "US Space Command's commercial operations group gets expanded role," *ibid*.
- 332 Theresa Hitchens, "Space Force cell explores reorg to push commercial data to military," *Breaking Defense*, September 17, 2025, <https://breakingdefense.com/2025/09/space-force-reorganizing-to-add-commercial-space-monitoring-data-analysis-into-operations/>.

A significant portion of the satellite catalog maintained by the 18th SDS and SSA analysis products such as conjunction assessments and re-entry predictions are made publicly available on the Space Track website.³²² Efforts to improve the software and computer systems used by the 18th SDS have run into longstanding problems and delays.³²³ In January 2022, the USSF shut down the Joint Space Operations Center Mission System (JMS) program, which was intended to improve SSA but was instead beleaguered by delays and cost overruns.³²⁴ Currently, the USSF is pursuing multiple new programs to try and upgrade or replace the legacy computer systems still being used for the operational SSA mission.³²⁵ The latest iteration is the Advanced Tracking and Launch Analysis System (ATLAS) program, which is being developed by L3Harris and is intended to integrate "all SDA, C2, Intelligence, Operational and System Readiness-relevant data."³²⁶

A new facility, originally called the Joint Interagency Combined Space Operations Center (JICSpOC) and later renamed to the National Space Defense Center (NSDC), was created to improve collaboration between military and intelligence communities to respond to attacks in space and became operational in January 2018.³²⁷ A main function of the NSDC is to leverage military and commercial SSA capabilities to detect and characterize attacks on US national security satellites.³²⁸ Part of that is done through the Joint Task Force-Space Defense Commercial Operations cell, later renamed the Joint Commercial Operations (JCO).³²⁹ In October 2024, the JCO started taking over the Tactical Surveillance, Reconnaissance, and Tracking (TacSRT) program as it moved from pilot to operational status.³³⁰ TacSRT uses commercial images and analytics to create products that are described by a USG official to be "completely shareable in a tactically relevant timeline for folks who need it quickly."³³¹ In September 2025, JCO was reported to be undergoing a reorganization to allow it to share commercial SSA data with all Combatant Commands and to be able to buy needed commercial data and services.³³²

As of July 2025, the US military has 33 SSA data sharing agreements with countries, plus well over 150 more with companies, universities, as well as foreign and intergovernmental agencies.³³³ The primary purpose of these agreements is to enable the US military to share more data and analysis with other entities, beyond what is publicly available on the Space Track website. In some cases, the agreements allow for a two-way exchange of SSA data between the parties.

The United States has significant space weather capabilities that are provided by the USAF, the National Oceanographic and Atmospheric Administration (NOAA), and NASA. NOAA operates the National Space Weather Prediction Center (SWPC) that collates data from a wide variety of satellites operated by NASA, the USSF, and international partners. In 2015, the Obama administration issued the Space Weather Strategy and Action Plan, which outlined the implementation approach for improving space weather capabilities.³³⁴ An updated version was issued by the Trump administration in 2019.³³⁵

Military Utility /

The United States possesses sophisticated SSA capabilities that allow it to track, identify, and characterize nearly all objects bigger than 10 centimeters in Earth orbit. While the US SSN possesses shortcomings in geographic coverage of LEO due to its northern location, the United States is actively working to close those gaps by deploying additional sensors to the Southern Hemisphere. Although the United States has never publicly acknowledged an explicit link between its SSA capabilities and offensive counterspace programs, it likely maintains the ability to effectively detect, track, characterize, and target any adversary national security satellites.

1.6 – US COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Assessment /

The United States has had established doctrine and policy on counterspace capabilities for several decades, although not always publicly expressed. Most US presidential administrations since the 1960s have directed or authorized research and development of counterspace capabilities, and in some cases greenlit testing or operational deployment of counterspace systems. These capabilities have typically been limited in scope and designed to counter a specific military threat, rather than be used as a broad coercive or deterrent threat. Current US military doctrine includes space domain awareness and offensive and defensive space operations as among the primary mission areas for joint action and “suppression of enemy space capabilities” as the goal for its offensive space operations.

The United States has reorganized its military space activities as part of a renewed focus on space as a warfighting domain. Since 2014, US policymakers have placed increased focus on space security, and have increasingly talked publicly about preparing for a potential “war in space.” This rhetoric has been accompanied by a renewed focus on reorganizing national security space structures and increasing the resilience of space systems. This has culminated in the reestablishment of US Space Command (USSPACECOM) and the creation of the US Space Force (USSF), which respectively assumed the responsibilities of US Strategic Command for space warfighting and Air Force Space Command (AFSPC) for operating, training, and equipping of space forces. The missions of these new organizations are largely a continuation of previous military space missions, although some have advocated for expanding their focus to include cislunar activities and more offensive weapons. The United States has also begun developing offensive counterspace capabilities, describing them

333 “USSPACECOM and Uruguayan Air Force Sign Space Situational Awareness Information Sharing Agreement,” USSPACECOM Release No. 2024-04-09-02, April 9, 2024, <https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/3739659/usspacecom-and-uruguayan-air-force-sign-space-situational-awareness-information/>; “Space Operations: DOD Is Pursuing Efforts to Collaborate with Allies and Partners but Needs to Address Key Challenges,” Government Accountability Office, GAO-25-108043, July 8, 2025, <https://www.gao.gov/products/gao-25-108043>.

334 “National Space Weather Action Plan,” *National Science and Technology Council*, October 2015, https://www.sworm.gov/publications/2015/swap_final_20151028.pdf.

335 “National Space Weather Strategy and Action Plan,” *Office of Science and Technology Policy*, March 2019, <https://aerospace.org/sites/default/files/2019-03/Natl%20Space%20Weather%20Strategy%20Mar19.pdf>.

- 336 Brent Scowcroft, "Follow-up on Satellite Vulnerability," memo to President Gerald Ford, March 15, 1976; Brent Scowcroft, "Soviet Anti-Satellite Capability," memo to President Gerald Ford, April 26, 1976.
- 337 National Security Decision Memorandum-345, January 18, 1977; Presidential Directive/NSC-37, May 11, 1978.
- 338 "National Space Policy of the United States of America," *The White House*, December 9, 2020, p. 4, <https://web.archive.org/web/20201209213138/https://www.whitehouse.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf>.
- 339 "United States Space Priorities Framework," *The White House*, December 2021, p. 6, <https://www.whitehouse.gov/wp-content/uploads/2021/12/United-States-Space-Priorities-Framework--December-1-2021.pdf>.

as "low-debris-causing weapons," although the United States has publicly stated it will not test destructive DA-ASAT missile weapons. The United States also continues to hold annual space wargames and exercises that increasingly involve close allies and commercial partners.

Specifics /

US National Space Policy on Counterspace

The United States has had established doctrine and policy on counterspace capabilities for several decades, although not always publicly expressed. Most recent US presidential administrations have directed or authorized research and development of counterspace capabilities, and in some cases greenlit testing or operational deployment of counterspace systems. These capabilities have typically been limited in scope and designed to counter a specific military threat, rather than be used as a broad coercive or deterrent threat.

For example, a series of policy memos in the mid-1970s recommended the development of a limited offensive counterspace capability to destroy a limited number of militarily-important Soviet space systems in a crisis or war.³³⁶ The goal was not to deter the Soviets from attacking US space capabilities, but rather create the capability to reduce the Soviet ability to use space against the United States in a conflict while limiting escalation against US satellites to those in LEO. The memos specifically highlighted the use of Soviet space systems for targeting long-range anti-ship missiles against US naval forces as the most critical capability to counter. The memos culminated in presidential decision directives by the Ford and Carter administrations to develop a limited ASAT capability, along with complementary space arms control initiatives.³³⁷ The ASAT capability eventually became the ASM-135 missile launched from an F-15 fighter aircraft.

More recent US presidential decision directives are still classified, but there is evidence to suggest there is increasing policy support for limited offensive counterspace capabilities. For example, the most recent national space policy, issued by the first Trump administration in December 2020, states, "Purposeful interference with space systems, including supporting infrastructure, will be considered an infringement of a nation's rights. Consistent with the defense of those rights, the United States will seek to deter, counter, and defeat threats in the space domain that are hostile to the national interests of the United States and its allies. Any purposeful interference with or an attack upon the space systems of the United States or its allies that directly affects national rights will be met with a deliberate response at a time, place, manner, and domain of our choosing."³³⁸

In December 2021, the Biden administration unveiled its Space Priorities Framework, which states, "The United States will defend its national security interests from the growing scope and scale of space and counterspace threats...To deter aggression against US, allied, and partner interests in a manner that contributes to strategic stability, the United States will accelerate its transition to a more resilient national security space posture and strengthen its ability to detect and attribute hostile acts in space. The United States also will take steps to protect its military forces from space-enabled threats."³³⁹

The second Trump administration has not produced an official national space policy yet, but President Trump did release an executive order in December 2025 that gives an idea of his priorities for this term. "Ensuring American Space Superiority" lists as one priority, "Securing and defending American vital national and economic security interests in, from, and to space," and says that it will do so by:

(i) “developing and demonstrating prototype next-generation missile defense technologies by 2028 to progressively and materially enhance America’s air and missile defenses pursuant to Executive Order 14186 of January 27, 2025 (The Iron Dome for America);

(ii) “ensuring the ability to detect, characterize, and counter threats to United States space interests from very low-Earth orbit and through cislunar space, including any placement of nuclear weapons in space.”³⁴⁰

US Military Doctrine on Counterspace

The link between these policy statements and offensive counterspace capabilities can be found in the official US military doctrines on space operations. Two different historical doctrines existed on space operations: an Air Force doctrine developed by AFSPC³⁴¹ and a joint doctrine developed by US Strategic Command (Joint Publication 3-14 (JP 3-14): Joint Space Operations).³⁴² The most recent publicly available versions of these doctrines are August 2018 and October 2020, respectively. However, JP 3-14 was reported to have been updated in August 2023, and while it is officially unclassified, DoD officials have determined they wish to keep it within the Department as a “limited distribution publication.”³⁴³ The August 2023 update reportedly describes SPACECOM’s area of responsibility as “astrographic,” a term it created to describe 100 km above mean sea level to “exgeosynchronous” orbit, which it deems to include lunar and cislunar orbits, as well as the Lagrange points.³⁴⁴ It includes space domain awareness and offensive and defensive space operations as among the primary mission areas for joint action. The doctrinal document describes how either direct or enabling capabilities support each mission area, and distinguishes the two as following: “The key discriminator between direct and enabling capabilities is whether it can impose a cost or not. If it does, it is a direct capability.”³⁴⁵ Finally, it gets rid of the terms “space control” and “counterspace,” and sets out the goal of “suppression of enemy space capabilities” for its offensive space operations, as “space superiority” was reportedly deemed to be too much of a difficult end-state to describe or reach.³⁴⁶

The USSF released its first space doctrine in June 2020 with its Space Capstone Publication which articulated how it views spacepower. Included in its guiding principles are that “[t]he US must adapt its national security space organizations, doctrine, and capabilities to deter and defeat aggression and protect national interests in space,” that spacepower is inherently global and multidomain, and that military space forces employ spacepower “in, from, and through the space domain” which necessitates “close collaboration and cooperation with the US Government, Allies, and partners.”³⁴⁷

In July 2023, the USSF released “Space Doctrine Publication 3-0, Operations” (SDP 3.0), to describe how the USSF Guardians will support USSPACECOM and the joint forces.³⁴⁸ In the section detailed “Combat Power Projection,” it talks about offensive and defensive military force, which it calls “fires and protection,” and goes on to say that, “Offensive space operations attack the adversary in, from, or to space. These operations seek to impose cost on the adversary, compel a change in behavior, secure a position of advantage, or deny the adversary’s military forces freedom of action. Defensive space operations seek to repel or defeat adversary attacks in, from, or to the space domain. These operations aim to maintain status quo, regain the initiative, deny the adversary a position of advantage, or protect freedom of action of friendly forces.”³⁴⁹ And in emphasizing the importance of joint all-domain operations, it notes that “the most effective operation to deny, disrupt, damage, or destroy an adversary’s space capability, and preserve freedom of action in space, may originate from a domain other than space.”³⁵⁰ The

340 “Ensuring American Space Superiority,” The White House, December 18, 2025, <https://www.whitehouse.gov/presidential-actions/2025/12/ensuring-american-space-superiority/>.

341 “Counterspace Operations,” *Annex 3-14 Counterspace Operations*, August 27, 2018, <https://www.dod.mil/Doctrines-Publications/AFDP-3-14-Counterspace-Ops/>.

342 “Joint Publication 3-14: Space Operations,” October 26, 2020.

343 Theresa Hitchens, “EXCLUSIVE: New Joint Force space doctrine clarifies Space Command’s ‘offensive,’ ‘defensive’ ops,” *Breaking Defense*, October 27, 2023, <https://breakingdefense.com/2023/10/exclusive-new-joint-force-space-doctrine-clarifies-space-commands-offensive-defensive-ops/>.

344 Hitchens, “EXCLUSIVE: New Joint Force space doctrine,” *ibid*.

345 Hitchens, “EXCLUSIVE: New Joint Force space doctrine,” *ibid*.

346 Hitchens, “EXCLUSIVE: New Joint Force space doctrine,” *ibid*.

347 “Space Capstone Publication Spacepower: Doctrine for Space Forces,” *USSF*, June 2020, https://www.spaceforce.mil/Portals/1/Space%20Capstone%20Publication_10%20Aug%202020.pdf.

348 *Space Doctrine Publication (SDP) 3-0, Operations Space Training and Readiness Command (STARCOM)*, OPR: STARCOM Delta 10, July 19, 2023, [https://www.starcom.spaceforce.mil/Portals/2/SDP%203-0%20Operations%20\(19%20July%202023\).pdf?ver=nHRhKpy49X-VtcSVRaQRNg%3d%3d](https://www.starcom.spaceforce.mil/Portals/2/SDP%203-0%20Operations%20(19%20July%202023).pdf?ver=nHRhKpy49X-VtcSVRaQRNg%3d%3d).

349 *Space Doctrine Publication (SDP) 3-0, Operations Space Training and Readiness Command (STARCOM)*, *ibid*, p. 33.

350 *Space Doctrine Publication (SDP) 3-0, Operations Space Training and Readiness Command (STARCOM)*, *ibid*, pp. 25-26.

- 351 Theresa Hitchens, "Space Force's new 'lexicon': Move to define concepts wins praise, courts concerns," *Breaking Defense*, October 2, 2024, <https://breakingdefense.com/2024/10/space-forces-new-lexicon-move-to-define-concepts-courts-concerns/>.
- 352 Hitchens, "Space Force's new 'lexicon': Move to define concepts wins praise, courts concerns," *ibid.*
- 353 Hitchens, "Space Force's new 'lexicon': Move to define concepts wins praise, courts concerns," *ibid.*
- 354 Hitchens, "Space Force's new 'lexicon': Move to define concepts wins praise, courts concerns," *ibid.*
- 355 Theresa Hitchens, "Exclusive: NRO, SPACECOM Craft CONOPS for War in Space," *Breaking Defense*, May 4, 2020, <https://breakingdefense.com/2020/05/exclusive-nro-spacecom-craft-conops-for-war-in-space/>.
- 356 Hitchens, "Exclusive: NRO, SPACECOM Craft CONOPS for War in Space," *ibid.*
- 357 2022 *Unified Command Plan*, A Presidential Document by the Executive Office of the President, April 28, 2023, <https://www.federalregister.gov/documents/2023/04/28/2023-09182/2022-unified-command-plan>.
- 358 Theresa Hitchens, "Exclusive: Milley to OK New Unified Command Plan; Defines SPACECOM's Roles," *Breaking Defense*, August 26, 2020, <https://breakingdefense.com/2020/08/exclusive-milley-to-sign-new-unified-command-plan-defines-spacecoms-roles/>.
- 359 "USSPACECOM Assumes Missile Defense Mission," USSPACECOM Press Release No. 2023-05-01, May 30, 2023, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/3411944/usspacecom-assumes-missile-defense-mission/>.
- 360 "USSPACECOM Assumes Missile Defense Mission," *ibid.*

new terms shift space doctrine to be more in line with how the US military describes joint operations in the land, air, and sea domains.

A September 2024 memo by the USSF's Saltzman, "Military Space Operations Terms of Reference," laid out the USSF's three core functions.³⁵¹ The first is space control, which can be offensive or defensive, and whose end goal is "Space Superiority, a degree of control that allows forces to operate at a time and place of their choosing without prohibitive interference from space or counterspace threats, while also denying the same to an adversary."³⁵² Orbital warfare is listed as the first mission under space control and is defined as "Combat operations conducted through fires, movement, and maneuver to control the space domain."³⁵³ The second is global mission operations, or activities to "deliver space capabilities to the Joint Force and the nation," while the third is space access.³⁵⁴ While this lexicon does not exactly line up with other planning documents, like the JP 3-14, it is a helpful tool in capturing the USSF's thinking on these matters.

The NRO and USSPACECOM announced in May 2020 that they were working on a shared "playbook" for how to protect military and intelligence satellites during a conflict as part of a joint concept of operations (CONOPS).³⁵⁵ According to the NRO's deputy director, this is intended to "strengthen and synchronize our defensive operations" and to clarify who defends what.³⁵⁶ The latest version of the Unified Command Plan (UCP 2022), which outlines the relationships between the combatant commands, was signed by President Joe Biden in April 2023.³⁵⁷ This document elucidates USSPACECOM's roles and responsibilities compared to the other combat commands.³⁵⁸ The most recent version transferred missile defense responsibilities from USSTRATCOM to USSPACECOM: specifically, per US Army Gen. James Dickinson, USSPACECOM commander, "the three mission areas of missile warning, missile defense and space domain awareness" are now "under one command as the Global Sensor Manager."³⁵⁹ While USSTRATCOM's Joint Functional Component Command for Integrated Missile Defense (JFCC IMD) will also transfer to USSPACECOM, a statement released by USSPACECOM noted that "USSTRATCOM along with US Northern Command will retain and continue to perform the Integrated Threat Warning and Attack Assessment missions."³⁶⁰

Recent Policy Shifts

Since 2014, US policymakers have placed increased focus on space security, and have increasingly talked publicly about preparing for a potential “war in space” and about space being a “warfighting domain.” Between May and August 2014, the Department of Defense convened a Space Strategic Portfolio Review (SPR),³⁶¹ which concluded there was a need to identify threats in space, be able to withstand aggressive counterspace programs, and counter adversary space capabilities.³⁶² Following the SPR, senior military leadership began to talk publicly about the inevitability of conflict on earth extending to space and the need for the military to prepare to defend itself in space.³⁶³ There was also increased focus on preparing to “fight a war in space,” even though senior US military leaders expressed no desire to start one.³⁶⁴ In November 2021, General David Thompson, vice chief of space operations for the Space Force, encapsulated much of the besieged language US government officials have been using to describe the current state of space when he told a reporter that US satellites were being targeted by reversible attacks “every single day.”³⁶⁵ A shift in tone was also seen in academic writings from US military journals calling for renewed focus on fighting wars in space and offensive space control.³⁶⁶ The US Congress also weighed in, calling in 2014 for a study on how to deter and defeat adversary attacks on US space systems, and specifically the role of offensive space operations.³⁶⁷ This concern was echoed in the 2023 National Defense Authorization Act, released in December 2022, which acknowledged “the need to shift to a more resilient and defendable national security space architecture” and required DoD to create a “strategy and requirements for the protection of DoD satellites.”³⁶⁸

On March 23, 2018, the Trump administration issued a new National Space Strategy (NSS) that echoed similar themes as expressed at the end of the Obama administration but with more aggressive rhetoric.³⁶⁹ The aggressive rhetoric from the Trump administration increased in the latter half of 2018 and throughout 2019. In various speeches and rallies promoting the USSF, President Trump called for the United States to “dominate” space. In his remarks during the signing ceremony for establishing the USSF, President Trump said the United States was developing “a lot of new defensive weapons and offensive weapons” that they were now “going to take advantage of” with the USSF.³⁷⁰ Yet official US policy statements on space security issues issued by the first Trump administration, or at least the public ones, reflected a more moderate tone and did not explicitly outline the development of new offensive space weapons.³⁷¹

³⁶¹ Dyke Weatherington, testimony before the House Committee on Armed Forces, *Strategic Forces Subcommittee*, March 25, 2015, p.3, <https://docs.house.gov/meetings/AS/AS29/20150325/103106/HHRG-114-AS29-Wstate-WeatheringtonD-20150325.pdf>.

³⁶² Mike Gruss, “US spending on space protection could hit \$8 billion through 2020,” *SpaceNews*, July 2, 2015, <http://spacenews.com/u-s-spending-on-space-protection-could-hit-8-billion-through-2020>.

³⁶³ John E. Hyten, “Overcoming Our Space Vulnerabilities,” *Speech at the Space and Missile Defense Symposium*, August 12, 2014, <http://www.afspc.af.mil/About-Us/Leadership-Speeches/Speeches/Display/Article/731712/overcoming-our-space-vulnerabilities/>; Bob Work, “Remarks at the Space Symposium,” April 12, 2016, <https://www.defense.gov/News/Speeches/Speech-View/Article/723498/remarks-at-the-space-symposium/>.

³⁶⁴ Steve Liewer, “The World is Still a Very Dangerous Place”: Gen. Hyten Takes Helm of StratCom at a Time of Increasing Global Tensions,” *Omaha World-Herald*, November 4, 2016, http://www.omaha.com/news/military/the-world-is-still-a-very-dangerous-place-gen-hyten/article_6d2e4828-a1ec-11e6-a1d2-5f806ae563fa.html; “AFSPC Commander Announces Space Enterprise Vision,” *Air Force Space Command Public Affairs*, April 11, 2016, <http://www.afspc.af.mil/News/Article-Display/Article/730817/afspc-commander-announces-space-enterprise-vision/>.

³⁶⁵ Josh Rogin, “Opinion: A shadow war in space is heating up fast,” *Washington Post*, November 30, 2021, <https://www.washingtonpost.com/opinions/2021/11/30/space-race-china-david-thompson/>.

³⁶⁶ B.T. Cesul, “A Global Space Control Strategy,” *Air and Space Power Journal*, November-December 2014: <https://www.files.ethz.ch/isn/185638/ASPJ-Nov-Dec-2014Full.pdf>; Adam P. Jodice, Mark R. Guerber, “Space Combat Capability... Do We Have It?” *Air and Space Power Journal*, November-December 2014, <https://www.files.ethz.ch/isn/185638/ASPJ-Nov-Dec-2014Full.pdf>.

³⁶⁷ House Resolution 3979 – Carl Levin and Howard P. “Buck” McKeon National Defense Authorization Act for Fiscal Year 2015, 113th United States Congress, <https://www.congress.gov/bill/113th-congress/house-bill/3979/text>.

³⁶⁸ Sandra Erwin, “NDAA compromise bill wants more focus on satellite protection, responsive launch,” *SpaceNews*, December 7, 2022, <https://spacenews.com/ndaa-compromise-bill-wants-more-focus-on-satellite-protection-responsive-launch/>.

³⁶⁹ “President Donald J. Trump is unveiling an America first National Space Strategy,” *The White House*, March 23, 2018, <https://aero-space.csis.org/wp-content/uploads/2018/09/Trump-National-Space-Strategy.pdf>.

³⁷⁰ The White House, “Remarks by President Trump at Signing Ceremony for Space Policy Directive-4 (Space Policy Comments Excerpt)”, *SpaceRef.com*, February 19, 2019, <http://space-ref.com/news/viewsr.html?pid=52251>.

³⁷¹ For example, the formal strategy proposal for the Space Force does not include the word “dominate”. See <https://media.defense.gov/2019/Mar/01/2002095012/-1/-1/1/UNITED-STATES-SPACE-FORCE-STRATEGIC-OVERVIEW.PDF>.

- 372 Michael Sheetz, "Pentagon calls for stop to anti-satellite weapons testing after Russian demo debris threatened ISS," *CNBC*, December 1, 2021, <https://www.cnbc.com/2021/12/01/pentagon-calls-for-stop-to-anti-satellite-weapons-testing.html>.
- 373 "Fact Sheet: Vice President Harris Advances National Security Norms in Space," *The White House*, April 18, 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harris-advances-national-security-norms-in-space/>.
- 374 "Multilateral Space Security Initiatives," *Secure World Foundation*, last updated November 5, 2024, <https://swfound.org/multilateral-space-security-initiatives/>.
- 375 *A Strategic Framework for Space Diplomacy*, US Department of State, May 2, 2023, p. 25, <https://www.state.gov/wp-content/uploads/2023/05/Space-Framework-Clean-2-May-2023-Final-Updated-Accessible-5.25.2023.pdf>.
- 376 Lloyd Austin, "Tenets of Responsible Behavior in Space," US Department of Defense, July 7, 2021, <https://media.defense.gov/2021/Jul/23/2002809598/-1/-1/0/TENETS-OF-RESPONSIBLE-BEHAVIOR-IN-SPACE.PDF>.
- 377 DoD Directive 3100.10: Space Policy, August 30, 2022, <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/310010p.PDF>.
- 378 DoD Directive 3100.10: Space Policy, *ibid*.
- 379 "DoD Directive 3100.10 Space Policy," Office of the Under Secretary of Defense for Policy, change 1 effective October 15, 2024, <https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/310010p.PDF>.
- 380 Theresa Hitchens, "New DoD space policy directive clarifies Space Force, Space Command roles," *Breaking Defense*, October 18, 2024, <https://breakingdefense.com/2024/10/new-dod-space-policy-directive-clarifies-space-force-space-command-roles/>.
- 381 Theresa Hitchens, "EXCLUSIVE: US Strategic Space Review signed out, but no unclassified version is coming," *Breaking Defense*, November 1, 2022, <https://breakingdefense.com/2022/11/exclusive-us-strategic-space-review-signed-out-but-no-unclassified-version-is-coming/>.
- 382 Sandra Erwin, "US national security space strategy emphasizes resilient systems, responsible behavior," *SpaceNews*, December 14, 2022, <https://spacenews.com/u-s-national-security-space-strategy-emphasizes-resilient-systems-responsible-behavior/>.
- 383 Lloyd Austin, "Tenet Derived Responsible Behaviors in Space," *US Department of Defense*, February 9, 2023, <https://www.spacecom.mil/Newsroom/Publications/Pub-Display/Article/3318615/tenet-derived-responsible-behaviors-in-space/>.

In December 2021, Deputy Secretary of Defense Kathleen Hicks stated, "We would like to see all nations agree to refrain from anti-satellite weapons testing that creates debris,"³⁷² leading to some speculation that the United States might be soon supporting an ASAT test moratorium. The United States did indeed formally announce in April 2022 that it was making the commitment not to conduct destructive anti-satellite missile tests.³⁷³ 38 countries total have made that commitment.³⁷⁴ The US State Department's "Strategic Framework for Space Diplomacy," released in May 2023, discussed goals for national security in order to "Promote US and allied security through bilateral and multilateral efforts that enhance capabilities and reduce risks of unintended conflict or escalation."³⁷⁵

The Department of Defense is also increasing its focus on resiliency and norms of behavior as a way in which to also ensure its continued access to and use of space. In July 2021, Secretary of Defense Lloyd Austin released the first "Tenets of Responsible Behavior in Space," a set of norms that USSPACECOM would use to guide their military space operations.³⁷⁶ In August 2022, an update to DoD Directive 3100.10, "Space Policy," was released that directed compliance with the tenets.³⁷⁷ Directive 3100.10 also directed the DoD to develop and field capabilities that counter hostile uses of space; develop capabilities, resilient architectures, and options for capability reconstitution to "reduce vulnerabilities and deny benefits from attacking US space systems; and promote long-term sustainability of the space environment; cooperate with like-minded international partners to establish, demonstrate, and uphold norms of safe and responsible behavior; and cooperate with other US Government departments and agencies to act as a good steward of the domain."³⁷⁸ An updated version of 3100.10 was released on October 14, 2024. It says the director of USSPACECOM "Synchronizes and deconflicts global offensive and defensive space operations in coordination with other CCMDS; the Military Services; US Government departments and agencies, allies, and partners; and other entities in accordance with joint campaign objectives."³⁷⁹ "Offensive" was not in the 2022 version of the document.³⁸⁰

In November 2022, it was reported that the United States had finished its most recent Strategic Space Review, conducted jointly by the Director of National Intelligence and the Office of the Secretary of Defense, but that an unclassified version would not be released.³⁸¹ DoD officials were able to broadly discuss what it included: listed as priorities were for the DoD to, in the words of Assistant Secretary of Defense for Space Policy John Plumb, "build a resilient national security space architecture" and "lead in the responsible and peaceful use of space," as part of its guidance "to protect and defend our national security interests" against counterspace attacks.³⁸²

In February 2023, USSPACECOM released an updated version of the tenets that added eight specific proposed behaviors for the Department of Defense's operations in the space area of responsibility.³⁸³

In March 2023, General Chance Saltzman, Chief of Space Operations, unveiled the broad strokes of a new “theory of success” for the USSF through a “Commander’s Note” issued to the service.³⁸⁴ General Saltzman stated that the formative purpose of the USSF was to “contest, and when directed, control the space domain on behalf of the joint force.” In doing so, the USSF needed to focus on three core tenets: space domain awareness, using resilience to deter attack, and ‘responsible’ counterspace activities that avoided destruction of satellites that would create orbital debris. He followed this up with “Competitive Endurance: A Proposed Theory of Success for the Space Force,” in January 2024, which defines space superiority as the ability to “employ space capabilities in support of military objectives while also preventing adversaries from using their own.”³⁸⁵ It echoes his earlier document on the three core tenets for this theory of success: avoiding operational surprise, denying first-mover advantage, and undertaking responsible counterspace campaigning.³⁸⁶ The latter refers to how the USSF plans to achieve its space offensive and defensive space operations needs while avoiding destruction of satellites that would create large amounts of orbital debris.

DoD released its *Space Policy Review and Strategy of Protection of Satellites* in September 2023, done in response to Congressional legislation requiring it.³⁸⁷ The review gave an assessment of threats to the space environment, focusing on China and Russia and clarified how DoD plans to defend against threats: “Assure critical space-based missions by accelerating the transition to more resilient architectures and by protecting and defending critical systems against counterspace threats; Strengthen the ability to detect and attribute hostile acts in, from, and to space; and Protect the Joint Force from adversary hostile uses of space.”³⁸⁸ It discussed the need to “deter aggression and, if deterrence fails, to prevail in conflict,” and stated that DoD would “balance the development, testing, and employment of these capabilities with our need to maintain a stable and sustainable space environment.”³⁸⁹ It also had a section on normative behaviors in space, noting, “In collaboration with the Department of State, the Department of Defense is committed to promoting standards and norms that ensure the domain remains secure, stable, and accessible.”³⁹⁰

On April 2, 2024, DoD released its *Commercial Space Integration Strategy*, followed quickly by the release of USSF’s *Commercial Space Strategy* on April 10, 2024. The DoD strategy identifies four priorities for integrating commercial space capabilities into national security space architectures: “Ensure access to commercial solutions across the spectrum of conflict; Achieve integration prior to crisis; Establish the security conditions to integrate commercial space solutions; and Support the development of new commercial space solutions for use by the joint force.”³⁹¹ The USSF’s strategy is aligned with that of the DoD’s. It prioritizes “Tactical Surveillance, Reconnaissance, and Tracking; Space-Based Environmental Monitoring; Positioning, Navigation, and Timing; and Space Access, Mobility and Logistics; as well as the continued integration of commercial capabilities into mature mission areas like Satellite Communication, Launch, and Space Domain Awareness,” and says that when making decisions on how to integrate commercial space capabilities, it will consider the operational utility, feasibility, resilience by design, and speed of fielding in doing so.³⁹²

In the year or two preceding the latest update to this document (February 2026), US officials have started taking a much more openly aggressive posture when discussing anticipated space capabilities and needs, citing Chinese and Russian threats as the reason why. A USSPACECOM planning document released in August 2024 lists in its FY2026 priorities and mission needs “Integrated Space Fires and Protection,” and for the following year, “Integrated

384 Theresa Hitchens, “Space Force chief outlines 3-part ‘competitive endurance’ theory aimed at ‘space superiority,’” *Breaking Defense*, March 7, 2023, <https://breakingdefense.com/2023/03/space-force-chief-outlines-3-part-competitive-endurance-theory-aimed-at-space-superiority/>.

385 Todd Harrison, “Where the Space Force’s new ‘theory of success’ succeeds,” *Defense One*, January 22, 2024, <https://www.defenseone.com/ideas/2024/01/where-space-forces-new-theory-success-succeeds/393526/>.

386 Todd Harrison, “Where the Space Force’s new ‘theory of success’ succeeds,” *ibid.*

387 *Space Policy Review and Strategy on Protection of Satellites*, Submitted in compliance with the reporting requirements contained in Section 1611 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2022 & Section 1602 of the NDAA for FY 2023, US Department of Defense, September 2023, <https://media.defense.gov/2023/Sep/14/2003301146/-1/-1/0/COMPREHENSIVE-REPORT-FOR-RELEASE.PDF>.

388 *Space Policy Review and Strategy on Protection of Satellites*, p. 7.

389 *Space Policy Review and Strategy on Protection of Satellites*, *ibid.*

390 *Space Policy Review and Strategy on Protection of Satellites*, p. 13.

391 “DoD Releases 2024 DoD Commercial Space Integration Strategy,” *US Department of Defense*, April 2, 2024, <https://www.defense.gov/News/Releases/Release/Article/3728370/dod-releases-2024-dod-commercial-space-integration-strategy/>.

392 “USSF releases Commercial Space Strategy to increase competitive advantage,” *Air Force News Service*, April 10, 2024, <https://www.spaceforce.mil/News/Article-Display/Article/3736616/ussf-releases-commercial-space-strategy-to-increase-competitive-advantage/>.

- 393 USSPACECOM Capability and Resource Integration Directorate (J8) Brochure, August 2024, accessed February 28, 2025, <https://www.spacecom.mil/Portals/57/USSPACECOM%20J8%20Tri-fold%2014%20Aug%202024%20APPROVED.pdf>.
- 394 Greg Hadley, "Whiting Calls for 'Space Fires' in Rare Hint About Offensive Weapons," *Air & Space Forces Magazine*, August 8, 2024, <https://www.airandspaceforces.com/spacecom-boss-space-fires/>.
- 395 Space Doctrine Publication (SDP) 3-0, Operations Space Training and Readiness Command (STARCOM) OPR: STARCOM Delta 10, July 19, 2023, [https://www.starcom.spaceforce.mil/Portals/2/SDP%203-0%20Operations%20\(19%20July%202023\).pdf](https://www.starcom.spaceforce.mil/Portals/2/SDP%203-0%20Operations%20(19%20July%202023).pdf).
- 396 Joint Publication 3-0, Joint Operations, US Department of Defense, August 11, 2011, <https://www.moore.army.mil/mssp/security%20topics/Potential%20Adversaries/content/pdf/JP%203-0.pdf>.
- 397 Stephen Clark, "The US military is now talking openly about going on the attack in space," *Ars Technica*, December 13, 2024, <https://arstechnica.com/space/2024/12/the-us-military-is-now-talking-openly-about-going-on-the-attack-in-space/>.
- 398 Clark, "The US military is now talking openly," *ibid.*
- 399 Theresa Hitchens, "New C2 software for mobile satellites will support future orbital warfare ops," *Breaking Defense*, December 12, 2024, <https://breakingdefense.com/2024/12/new-c2-software-for-mobile-satellites-will-support-future-orbital-warfare-ops/>.
- 400 Theresa Hitchens, "Army moves to expand 'space control' planning, 'interdiction' capabilities," *Breaking Defense*, July 23, 2024, <https://breakingdefense.com/2024/07/army-moves-to-expand-space-control-planning-interdiction-capabilities/>.
- 401 The Department of the Air Force In 2050, *Department of the Air Force Report to Congressional Committees*, Public Law 118-31, Section 923, December 2024, <https://www.airandspaceforces.com/app/uploads/2025/01/DAF-2050-Final-30-Dec.pdf>.
- 402 The Department of the Air Force In 2050, *Department of the Air Force Report to Congressional Committees*, *ibid.*
- 403 Sandra Erwin, "Air Force chief's parting warning: US must transform Space Force to counter China," *SpaceNews*, January 13, 2025, <https://spacenews.com/air-force-chiefs-parting-warning-u-s-must-transform-space-force-to-counter-china/>.
- 404 Eric Lipton, "Departing Air Force Secretary Will Leave Space Weaponry as a Legacy," *New York Times*, December 29, 2024, <https://www.nytimes.com/2024/12/29/us/politics/frank-kendall-air-force.html>.
- 405 Courtney Albon, "US Space Force moves to make its systems battle-ready by 2026," *DefenseNews*, October 29, 2024, <https://www.defensenews.com/space/2024/10/29/us-space-force-moves-to-make-its-systems-battle-ready-by-2026/>.

Space Fires."³⁹³ That same month, USSPACECOM head Gen. Stephen N. Whiting told a symposium audience, "We need space fires to enable us to establish space superiority."³⁹⁴ "Space fires" has not been officially defined as a concept. *Space Force Publication 3-0, Operations*, which came out in July 2023, stated, "All-domain fires may mitigate threats to space assets and threaten the adversary's ability to exploit the domain," but goes on to list non-kinetic options like enhanced GPS, EW, and defensive cyberspace capabilities.³⁹⁵ This new way of discussing needs is different, and it appears to hew much more closely to how the rest of the US military refers to fires, defined in a 2011 joint publication as "to use available weapons and other systems to create a specific lethal or nonlethal effect on a target."³⁹⁶ According to Whiting, "We need joint all-domain fires to be able to do that, everything from across the gamut of cyber, non-kinetic, kinetic, and those can come from any domain. But we need to have the ability to influence targets, just like every other domain does."³⁹⁷ Saltzman of the USSF further clarified, "Weapons systems aren't inherently offensive or defense. Is an aircraft carrier offensive or defense? Yes. Is an F-35 offensive or defense? Yes. So when we get in this fight about whether or not a spacecraft—is this an offensive weapon? No, it's just a capability."³⁹⁸ In referring to why the United States is so interested in developing maneuvering satellites, Lt. Gen. Doug Schiess, commander of Space Forces – Space, stated, "I think there [are] things that we will need to be able to, I guess I'll say, 'dogfight' in space."³⁹⁹

The Space Force is not the only US military branch thinking along these lines: an *Army Space Vision* planning document published in January 2024 listed as one of the two main space missions of the Army to be: "Interdict adversary space capabilities by delivering necessary fires and effects at echelon to protect friendly forces from observation and targeting by counter-satellite communications, counter-surveillance and reconnaissance, and navigation warfare operations."⁴⁰⁰

In December 2024, the Air Force released a report looking at what it anticipated being threats and its needs in 2050. When discussing what the USSF might look like in 2050, it said, "The greatest changes will be in the competitive deployment of distributed and disaggregated systems and in the increased and more capable inventories of counterspace weapons systems, both on orbit and terrestrially."⁴⁰¹ Regarding counterspace, it said, "Space Force counterspace systems will include a cost-effective mix of weapons, both terrestrial and on orbit. There will be a high premium for deep magazines that can neutralize a large number of threat satellites in a short period of time. By 2050, directed energy systems, both on orbit and on the surface of the earth, are likely to have achieved adequate power levels to meet this need;" it also noted, "Kinetic weapons designs will have to take into account space debris challenges and the priority of application towards low density high value target sets."⁴⁰² In briefing the contents of this report, Secretary of the Air Force Frank Kendall said, "We are going to have to do something to counter the militarization of space that China has embarked upon, largely to target our joint force and largely to deny us space capabilities," and that, "We're going to need a much bigger, much more powerful Space Force."⁴⁰³ His take overall was that "The threat is there. It's a domain we have to be competitive in." As such, Kendall said that while he was USAF Secretary, the United States has begun working on "low-debris-causing weapons."⁴⁰⁴ It is unclear what exactly that entails. USSF officials in October 2024 discussed improvements the Space Force is making to its command and control infrastructure in order to close gaps and incorporate four classified systems into it, stating, "It's really all about being ready for contested space by 2026 and having the people, the processes, the tools, the doctrine, everything in place so that we can operate effectively."⁴⁰⁵

The Space Force released its capstone operations document, *Space Force Doctrine Document (SFDD)-1*, in April 2025. In the forward, Chief of Space Operations Gen. Chance Saltzman wrote, “Space is a warfighting domain, not a collection of supporting activities. In conflict, space will be a contested environment. We are the military Service dedicated to fighting in it...It is our job to organize, train, and equip space forces, but we are also responsible for conducting warfighting operations in space.”⁴⁰⁶ To emphasize this last point, he wrote, “Guardians are, and always will be, warfighters.”⁴⁰⁷

SFDD-1’s section titled “Space Warfare” describes it as “the Space Force must be prepared to conduct warfare to deter or compel adversary behavior, undermine adversary intent, and enable joint all-domain application of force, through force or the threat of force in, from, and to the space domain.”⁴⁰⁸ How to do so is primarily through four avenues:

- “Deterring or denying attacks on friendly space capabilities by holding adversary space forces at risk.
- “Compelling an adversary to cease aggressive action in any domain by disrupting, denying, degrading, or destroying the space capabilities they rely on to achieve their military objectives.
- “Undermining an adversary’s strategy and their intent to attrit friendly space capabilities through forcible action in, from, and to the space domain.
- “Enabling the application of force in all domains by providing a space-enabled combat edge to terrestrial forces.”⁴⁰⁹

Space superiority is defined as “the degree of control that allows forces to operate at a time and place of their choosing without prohibitive interference from space or counterspace threats, while also denying the same to an adversary.”⁴¹⁰

Later that same month, the Space Force released *Space Warfighting: A Framework for Planners*, or its *Space Warfighting Framework*.⁴¹¹ This Framework strives to give an approach to how to define and work on space superiority, which it says is “a necessary precondition for Joint Force success;” explains the relationship of space superiority with counterspace efforts and space control; divides actions between offensive and defensive ones; and elucidates how the Space Force intends to achieve space superiority.⁴¹² Offensive counterspace actions include: “orbital strike (pursuit, stand-off); space link interdiction (electromagnetic attack, cybernetwork attack); terrestrial strike (ground-based fires, maritime-based fires, air-based fires, space-based fires).”⁴¹³ Defense counterspace actions include: “active space defense (escort, counterattack, suppression of adversary counterspace targeting); passive space defense (threat warning, military deception, hardening, dispersal, dissagregation [from the original], mobility, redundancy).”⁴¹⁴ Three mission areas are given for counterspace operations:

- “Orbital Warfare (OW). Combat operations conducted through fires, movement, and maneuver to control the space domain.
- “Electromagnetic Warfare (EW). Combat operations through the electromagnetic spectrum to negate space or counterspace threats.
- “Cyberspace Warfare (CW). Combat operations conducted through the cyber domain through fires, movement, and maneuver to control the space domain.”⁴¹⁵

The Space Force released its *International Partnership Strategy* in July 2025.⁴¹⁶ Listed as its three goals are “**Secure** collective national interests in, from and to space by empowering Allies and partners to be combat multipliers,” “**Communicate** to ensure interoperable data, capabilities and activities while

406 “Space Force Doctrine Document – 1 (SFDD-1),” *The Space Force*, Space Training and Readiness Command (STARCOM), OPR: STARCOM Delta 10, April 3, 2025, https://www.starcom.spaceforce.mil/Portals/2/Space%20Force%20Doctrine%20Document%20FINAL_4Apr25.pdf.

407 “Space Force Doctrine Document – 1 (SFDD-1),” *ibid.*

408 “Space Force Doctrine Document – 1 (SFDD-1),” *ibid.*

409 “Space Force Doctrine Document – 1 (SFDD-1),” *ibid.*

410 “Space Force Doctrine Document – 1 (SFDD-1),” *ibid.*

411 “USSF defines path to space superiority in first Warfighting framework,” United States Space Force, April 17, 2025, <https://www.spaceforce.mil/news/article-display/article/4156245/ussf-defines-path-to-space-superiority-in-first-warfighting-framework/>.

412 “Space Warfighting: A Framework for Planners,” United States Space Force, March 2025, [https://www.spaceforce.mil/Portals/2/Documents/SAF_2025/Space_Warfighting_-_A_Framework_for_Planners_BLK2_\(final_20250410\).pdf](https://www.spaceforce.mil/Portals/2/Documents/SAF_2025/Space_Warfighting_-_A_Framework_for_Planners_BLK2_(final_20250410).pdf).

413 “Space Warfighting: A Framework,” *ibid.*

414 “Space Warfighting: A Framework,” *ibid.*

415 “Space Warfighting: A Framework,” *ibid.*

416 Sandra Erwin, “Space Force unveils first international strategy, while GAO flags barriers to space cooperation,” *Space News*, July 8, 2025, <https://spacenews.com/space-force-unveils-first-international-strategy-while-gao-flags-barriers-to-space-cooperation/>.

- 417 "US Space Force International Partnership Strategy," *Space Force*, June 2025, https://www.spaceforce.mil/Portals/2/Documents/SAF_2025/USSF%20International%20Partnership%20Strategy.pdf.
- 418 "Space Force International Partnership Strategy," *ibid.*
- 419 "Erwin, "Space Force unveils first international strategy," *ibid.*
- 420 "Space Operations: DOD Is Pursuing Efforts to Collaborate with Allies and Partners but Needs to Address Key Challenges," Government Accountability Office, GAO-25-108043, July 8, 2025, <https://www.gao.gov/products/gao-25-108043>.
- 421 "Space Force Vector 2025," *Space Force*, November 13, 2025, https://www.spaceforce.mil/Portals/2/Documents/SAF_2025/Space_Force_Vector_13_Nov_25.pdf.
- 422 "Space Force Vector 2025," *ibid.*
- 423 "Space Force Vector 2025," *ibid.*
- 424 Sandra Erwin, "Space Force rolls out new naming scheme for satellites and space weapons," *SpaceNews*, December 11, 2025, <https://space-news.com/space-force-rolls-out-new-naming-scheme-for-satellites-and-space-weapons/>.
- 425 Erwin, "Space Force rolls out new naming scheme," *ibid.*
- 426 Erwin, "Space Force rolls out new naming scheme," *ibid.*
- 427 Erwin, "Space Force rolls out new naming scheme," *ibid.*
- 428 Courtney Albon, "Space Force Starts Briefing Stakeholders on 15-Year Vision," *Air & Space Forces Magazine*, February 23, 2026, <https://www.airandspaceforces.com/space-force-briefing-stakeholders-2040-15-year-vision/>.

maximizing information sharing across all classification levels," and "**Integrate** with Allies and partners across the full spectrum of Force Design, Force Development and Force Employment (Generation and Operations)" (bold-face in the original).⁴¹⁷ The desired end state is to "enable our Allies and partners to be combat multipliers."⁴¹⁸

Interestingly, that same day, the GAO released a report calling out challenges DOD has had in working with partners and allies in space, particularly in regards to classification and system and data integration.⁴¹⁹ These have ripple effects elsewhere; for example, classification restrictions hamper one of the primary ways DOD works to integrate allies: in exercises. The GAO noted, "Space Force officials told us that they are often unable to share classified planning concepts for exercises with foreign officials, which can make it challenging to meaningfully incorporate allies and partners into an exercise."⁴²⁰ The GAO also was concerned about the limited amount of Space Force personnel available to work on partnerships and that given the overlapping roles of many DOD organizations, often partners are not clear on who to reach out to. It pointed out, "For a given geographic area of responsibility, there can be 10 or more different DOD organizations conducting space-related security cooperation efforts."

In November 2025, the Space Force released *Vector 2025* as a guidance for how it wants Guardians to approach the Space Force's service activities, listed as "Force Design, Force Development, Force Generation, and Force Employment to achieve our formative purpose, Space Superiority."⁴²¹ Its theory of success, building off of Saltzman's Competitive Endurance, has three "core tenets": "Avoid operational surprise," "Deny first-mover advantage," and "Responsible counterspace campaigning."⁴²² The latter is defined as counterspace efforts that can be undertaken "without generating hazardous debris that might imperil our own space operations."

The Space Force unveiled a new taxonomy for its operational systems in December 2025.⁴²⁴ According to Chief of Space Operations Gen. Chance Saltzman, "[W]e've chosen to represent each of our mission areas with specific symbology. These symbols conjure the character of the systems, the importance of their mission and the identity of the guardians to employ them."⁴²⁵ Its seven mission areas will be taking names from the following: orbital warfare, Norse myths; cyber warfare, mythological creatures; electronic warfare, serpents; navigation warfare, sharks; missile warning, sentinels; SSA, ghosts; and satellite communication, constellations.⁴²⁶ The Space Force also is switching to a new spacecraft naming scheme, where the first two letters refer to the mission, which are then followed by a number.⁴²⁷

In February 2026, the Space Force started to brief to select audiences an early version of its 15-year roadmap, *Objective Force 2025*, which strives to identify personnel, equipment, and systems that it will need through 2040.⁴²⁸ It focuses on satellite communications, SSA, and navigation warfare, and is being driven by what threats the Space Force believes it will face in that timeframe and how technology may evolve.

As of February 2026, US policy is still not to deliberately create debris on orbit through destructive DA-ASAT missile tests. This is due to concerns about what creating debris would do to the United States' ability to operate in space; as RAF Air Marshal Paul Godfrey, a British officer assigned to USSF HQ as Assistant Chief of Space Operations for Future Concepts and Partnerships, said in November 2024, "It doesn't mean you can't think about these sorts of things or understand how the adversary might do these things, but I think collectively,

we all need policy discussions, understanding the risk of throwing all of that debris out there. Do we really want to do that? And actually is that the element that deters anyone from going to war in space? And does that mean that we're more aligned on the left-hand edge of the scale of reversible effects?"⁴²⁹ However, Project 2025 (which is not an official US guidance document but was written by many people who have joined Trump's second administration and which has to date proved a fairly reliable guidance to the United States' priorities and actions under the new administration) says, for space, that the United States should "Seek arms control and 'rules of the road' understandings only when they are unambiguously in the interests of the US and its allies, and prohibit their unilateral implementation."⁴³⁰

US Space and Counterspace Organization

Since the early 2000s, there has been an ongoing debate about the organization of US military space activities. The recruit, train, and equip functions normally done by a service were assigned to the Department of the Air Force, and the operational warfighting functions were assigned to US Strategic Command (USSTRATCOM). In the 2010s, the debate was revitalized by the increased concern expressed above over adversary counterspace capabilities, and also a desire to increase coordination with allies and commercial partners. Since 2010, there have been numerous efforts to bridge this gap. The 2010 edition of the then-biennial Schriever wargame exercised the concept of a Combined Space Operations Center (CSpOC) that integrated allies and commercial partners into the decision-making during the scenarios.⁴³¹ Following the wargame, USSTRATCOM began working on plans to make the CSpOC a reality. Initially, it was brought to life in the form of the Combined Space Operations (CSpO) concept, which involved each partner creating their own national space operations center and establishing lines of communication and coordination between them. The founding partners were the United States, Australia, Canada, and the United Kingdom.⁴³² New Zealand was added in 2015; France and Germany joined in 2019; and Italy, Japan, and Norway came onboard in December 2023.⁴³³ In addition to maintaining their own national centers, US Strategic Command's JSpOC was renamed the CSpOC and included CSpO exchange officers and a Commercial Integration Cell (CIC).⁴³⁴

The organizational debate came to a head in the mid-2010s when the US Congress criticized the USAF for its handling of space programs and forced a debate over reorganizing national security space, potentially by creating a separate entity such as a Space Corps.⁴³⁵ Then President Donald Trump added further impetus to this debate by making a surprise call in June 2018 for the creation of a separate Department of the Space Force.⁴³⁶ But *Space Policy Directive (SPD)-4*, released by the Trump administration in February 2019, settled on a more moderate approach that would create the Space Force as a new military service within the Department of the Air Force.⁴³⁷ Separately, there were also calls to resurrect US Space Command (USSPACECOM) as the combatant command to take over space warfighting duties from USSTRATCOM.⁴³⁸

429 Greg Hadley, "Weaponizing Space," *Air & Space Forces Magazine*, November 1, 2024, <https://www.airandspaceforces.com/article/weaponizing-space/>.

430 Editors Paul Dans and Steven Groves, "Mandate for Leadership: The Conservative Promise," by Project 2025, Presidential Transition Project, The Heritage Foundation, 2023, https://static.project2025.org/2025_MandateForLeadership_FULL.pdf.

431 Larry James, "The Challenge of Integration: Lessons from Schriever Wargame 2010," *High Frontier*, Vol 7 No 1, November 2010, <https://www.afsfc.af.mil/Portals/3/documents/HF/AFD-101116-028.pdf>.

432 Cheryl Pellerin, "Stratcom, DoD Sign Space Operations Agreement with Allies," *Defense.gov*, September 23, 2014, <https://www.defense.gov/Explore/News/Article/Article/603303/stratcom-dod-sign-space-operations-agreement-with-allies/>.

433 USSPACECOM Public Affairs, "Combined Space Operations Initiative Welcomes France and Germany," *United States Space Command*, February 12, 2020, <https://www.spacecom.mil/MEDIA/NEWS-ARTICLES/Article/2083368/combined-space-operations-initiative-welcomes-france-and-germany/>; David Vergun, "More Nations Meet to Address Space Security," *DoD News*, December 7, 2023, <https://www.defense.gov/News/News-Stories/Article/Article/3610656/more-nations-meet-to-address-space-security/>.

434 "Combined Space Operations Center / 614th Air Operations Center," *US Strategic Command*, July 2018, https://www.stratcom.mil/Portals/8/Documents/CSpOC_Factsheet_2018.pdf.

435 Sandra Erwin, "Congressman Rogers: A Space Corps is 'Inevitable,'" *SpaceNews*, December 2, 2017, <http://spacenews.com/congressman-rogers-a-space-corps-is-inevitable/>.

436 Katie Rogers, "Trump orders establishment of Space Force as sixth military branch," *New York Times*, June 18, 2018, <https://www.nytimes.com/2018/06/18/us/politics/trump-space-force-sixth-military-branch.html>.

437 The White House, "Text of Space Policy Directive-4: Establishment of the United States Space Force," *The White House*, February 19, 2019, <https://media.defense.gov/2019/Mar/01/2002095015/-1/-1/1/SPACE-POLICY-DIRECTIVE-4-FINAL.PDF>.

438 The White House, "Text of a memorandum from the President to the Secretary of Defense regarding the establishment of the United States Space Command," *The White House*, December 18, 2018, <https://aerospace.org/sites/default/files/2019-01/US%20Space%20Command%20memo%2018Dec18.pdf>.

- 439 Jim Garamone, "Pentagon Rolls Out Space Command," *US Department of Defense*, August 29, 2019, <https://www.defense.gov/Explore/News/Article/Article/1948420/pentagon-rolls-out-space-command/>.
- 440 Theresa Hitchens, "SPACECOM to Write New Ops War Plan: 100km and Up," *Breaking Defense*, September 16, 2019, <https://breaking-defense.com/2019/09/spacecom-to-write-new-ops-war-plan-100km-and-up/>.
- 441 Commander's Strategic Vision, January 2021, p. 6.
- 442 Audrey Decker, "Space Command HQ will move to Alabama, Trump says," *Defense One*, September 2, 2025, <https://www.defenseone.com/policy/2025/09/space-command-hq-will-move-alabama-trump-says/407835/>.
- 443 Decker, "Space Command HQ will move to Alabama, Trump says," *ibid*.
- 444 Sandra Erwin, "Space Force reorganizes command structure to streamline operations," *SpaceNews*, December 13, 2023, <https://space-news.com/space-force-reorganizes-command-structure-to-streamline-operations/>.
- 445 "US Space Forces Indo-Pacific marks two years of accomplishments, growth," *US Space Forces Indo-Pacific*, November 22, 2024, <https://www.spaceforce.mil/News/Article-Display/Article/3976333/us-space-forces-indo-pacific-marks-two-years-of-accomplishments-growth/>.
- 446 "Space Force Component Activation Ceremony," *US Central Command*, November 30, 2022, <https://www.centcom.mil/MEDIA/PRESS-RELEASES/Press-Release-View/Article/3232417/space-force-component-activation-ceremony/>.
- 447 "USEUCOM, AFRICOM, Space Force activate new service component command," *United States European Command Public Affairs*, December 4, 2023, <https://www.eucom.mil/article/42579/useucom-africom-space-force-activate-new-service-component-command>.
- 448 "US Space Forces Korea," *US Space Force*, accessed February 20, 2025, <https://www.spaceforce.mil/About-Us/US-Space-Forces-Korea/>; Seth Robson, "New Japan-based Space Force unit will guard troops from above, regional commander says," *Stars and Stripes*, December 3, 2024, https://www.stripes.com/branches/space_force/2024-12-03/space-force-japan-yokota-16041867.html.
- 449 Andrea Jenkins, "Space Forces Southern activated at Davis-Monthan AFB," *Air Forces Southern*, January 21, 2026, <https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/4385010/space-forces-southern-activated-at-davis-monthan-afb/>; Nicholas Slayton, "Space Force stands up new command for the Northern Hemisphere," *Task & Purpose*, February 2, 2026, <https://taskandpurpose.com/news/space-force-northern-hemisphere/>.

USSPACECOM was officially re-established as the 11th combatant command on August 29, 2019, in a ceremony at the White House Rose Garden.⁴³⁹ General John Raymond was named as Commander of USSPACECOM, which was established as a geographic combatant command with authority for all US military operations above 100 km altitude.⁴⁴⁰ The mission of USSPACECOM is to deter aggression and conflict, defend US and allied interests, deliver space combat power, and develop ready and lethal joint warfighters.⁴⁴¹ Its headquarters were at Peterson Space Force Base, Colorado, but this was disputed by some in Congress, who wanted it to be in Huntsville, Alabama. In September 2025, President Trump announced that it would be moving there.⁴⁴²

Initially, USSPACECOM was intended to consist of two subordinate commands, each of which was composed of several already existing commands and operations centers. Combined Force Space Component Command (CFSCC) planned, tasked, directed, monitored, and assessed the execution of combined and joint space operations for theater effects. The Joint Task Force Space Defense (JTF-SD), in unified action with mission partners, deterred aggression, defended capabilities, and defeated adversaries throughout the continuum of conflict.³⁴⁹ The two (JTF-SD and CFSCC) were combined in December 2024 into the US Space Forces-Space Command (SPACEFORSPACE), which is intended to organize, train, and equip forces for the USSF and oversee all space forces for USSPACECOM.⁴⁴⁴ US Space Forces Indo-Pacific (SPACEFOR-INDOPAC) was created as the space component command for US Indo-Pacific Command at Joint Base Pearl Harbor-Hickam in November 2022,⁴⁴⁵ while US Central Command started US Space Forces Central Command at its headquarters in Macdill Air Force Base in December 2022 to support CENTCOM's growing space needs.⁴⁴⁶ In December 2023, US Space Forces Europe and Africa (SPACEFOREUR-AF) was stood up as a services component command for US European Command and US Africa Command at their headquarters at Rammstein Air Base with the goal of enhancing joint space capabilities in Europe and Africa.⁴⁴⁷ Furthermore, INDOPACOM created US Space Forces – Korea (SPACEFOR-KOR) as a USSF field component for US Forces Korea in December 2022 and US Space Forces - Japan in December 2024.⁴⁴⁸ US Space Forces Southern (SPACEFOR-SOUTH) was activated in January 2026 at Davis-Monthan Air Force Base, Arizona (although it had been made operational as of December 1, 2025), while US Space Forces Northern (SPACEFOR-NORTH) was stood up later in January 2026 at Peterson Space Force Base, Colorado.⁴⁴⁹

In May 2020, General Raymond signed the first operations order as Commander of USSPACECOM for Operation Olympic Defender (OOD), USSPACECOM's plan to protect US and allied satellites during a conflict.⁴⁵⁰ OOD was created by USSTRATCOM in 2013 and opened for ally participation in 2018.⁴⁵¹ The United Kingdom became the first ally to join OOD in July 2019.⁴⁵² Australia joined in 2020, New Zealand agreed to join in September 2024 and France and Germany joined in October 2024, after previously rejecting an offer to join in 2021.⁴⁵³ The group is working on how to share SSA data in order to develop a common operating picture of space and is now called Multi-National Force-OOD.⁴⁵⁴

The USSF was formally created on December 20, 2019, with President Trump's signing of the *National Defense Authorization Act for Fiscal Year 2020*.⁴⁵⁵ The signing followed an intense debate between the House, Senate, and White House throughout much of 2019. The compromise signed into law more closely resembles the Space Corps idea pushed by the House in 2017 than the separate department President Trump wanted in June 2018.⁴⁵⁶ The USSF is a separate military service with independent powers to train, equip, and operate, but exists within the Department of the Air Force to reduce overhead. Initially, the USSF consisted only of members of the USAF and was stood up over 18 months, beginning by re-designating AFSPC as the USSF. The USSF now has about 10,000 active duty Guardians (with an additional 5000 civilian employees)⁴⁵⁷ but Space Force officials have been urging for that number to increase, given the extent of their portfolio, arguing to as much as double that number over the next decade.⁴⁵⁸

450 Theresa Hitchens, "Major Milestone' as Allies Join SPACECOM's War Plan," *Breaking Defense*, May 21, 2020, <https://breakingdefense.com/2020/05/major-milestone-as-allies-join-spacecoms-war-plan/>.

451 Hitchens, "Major Milestone," *ibid*.

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The USSF is organized into multiple commands: training is handled by the Space Training and Readiness Command (STARCOM); operations by Combat Forces Command (CFC, formerly the Space Operations Command; rebranded to reflect the warfighting nature of the Space Force)⁴⁵⁹; and acquisitions by Space Systems Command (SSC).⁴⁶⁰ Within each command are a number of Space Deltas, many of which are rebranded space operations squadrons that formerly existed under AFSC. The Space Warfighting Analysis Center (SWAC) is intended to develop "force design" for USSF mission areas, like ISR or missile warning and tracking, and is headquartered in Washington, DC.⁴⁶¹ The Space Futures Command was started in February 2024 as a way in which to look at future threats. The SWAC is being moved under Space Futures Command, along with two new organizations, a Wargaming Center and a Concepts and Technology Center.⁴⁶² The Space Futures Command was originally intended to be operational by the end of 2024, but by September 2024, USSF's Salzman was clarifying the timeline: "[S]tanding up a new field command is no small task, but we made significant progress since February. We've identified a team... and they're going to make it happen if not by the end of this year, I guarantee you within a year."⁴⁶³ By October 2025, however, it was rumored to not be happening; according to an anonymous Pentagon official, "Futures Command is dead."⁴⁶⁴

STARCOM was activated in August 2021 and is charged with training the Guardians (what members of the USSF are called), building out space doctrine and tactics, and establishing testing and evaluation of the USSF.⁴⁶⁵ As part of this training, STARCOM is looking at what level of baseline capability is needed for the USSF's National Space Test and Training Range, with the goal of having physical and digital ranges in order to provide realistic training for Guardians; the Range is run by newly-established Space Delta 11.⁴⁶⁶ The Space Force announced in January 2026 that it would be creating later in the year a contractor pool for Guardians to receive physical/live training in EW, cyber, and orbital warfare; reportedly, the latter will eventually have dedicated satellites on orbit to it for practice.⁴⁶⁷ In fact, a satellite was launched in February 2026 just for that purpose.⁴⁶⁸ Space Force's Operational Test and Training Infrastructure (OTTI) program has seen its budget grow from \$40 million to approximately \$600 million.⁴⁶⁹

SSC is based on Air Force Space Command's Space and Missile Systems Center and is headquartered at Los Angeles Air Force Base in California. SSC announced a reorganization in March 2022 that is intended to help acquisitions become better integrated and to "pivot significantly to a resilient architecture."⁴⁷⁰ The USSF created the Space Force Acquisition Council as part of its efforts to carry out the responsibilities of being designated the lead integrator for joint space requirements; representatives from the SSC, MDA, and NRO, among others, discuss their programs with the goal of making their work complementary.⁴⁷¹

USSF is also actively developing dedicated space intelligence capabilities. In October 2021, the Space Force Intelligence Activity (SFIA) was created as an interim step until the National Space Intelligence Center (NSIC) was established in June 2022 at Wright-Patterson Air Force Base in Ohio and run by Space Force Delta 18.⁴⁷² In June 2024, it was redesignated as a Field Operating Agency for the USSF in order for it "to support both current and future requirements for detailed, long-term intelligence analysis in support of operations, acquisitions, future concept development and service-wide force design needs," and is run by the 1st Space Analysis Squadron and 2nd Space Analysis Squadron.⁴⁷³ Space Delta 7 activated its 75th Intelligence, Surveillance and Reconnaissance Squadron (ISRS) in August 2023 as the first targeting unit supporting the USSF. It has three missions: "target analysis, target development and target engagement."⁴⁷⁴ In September 2025, the Space Force created a Space Intelligence Production Center (SIPC) at the Springfield-Beckley Air National Guard Base, Ohio. This new center is meant to streamline intelligence delivery to both warfighters and policymakers; it will combine Space Delta 7's 76th Intelligence, Surveillance and Reconnaissance Squadron (ISRS) and NSIC's 4th Intelligence Analysis Squadron (IAS).⁴⁷⁵

Both the USSF and USSPACECOM have also taken specific organizational steps to address the cyber security of space capabilities. In April 2021, USSPACECOM announced it was standing up a Joint Cyber Center to focus on cybersecurity of satellites and space-based communications and to help it integrate with other DoD cyber organizations.⁴⁷⁶ In May 2021, the Space Systems Command of the USSF stated it was developing a digital twinning technology to improve the cyber security of future military space architectures.⁴⁷⁷ The USSF's Space Delta 6 (the "Cyber" Delta) was planning to expand the number of squadrons it had in summer 2022 so it could provide nearly all the other Space Deltas with cyber squadrons to protect their mission systems. There are now nine squadrons and eight detachments that are operating in 13 locations.⁴⁷⁸ STARCOM stood up the USSF's first cyber range squadron - the 33rd Range Squadron (RGS) - in December 2024 in order to enhance its test and training infrastructure.⁴⁷⁹ In general, cybersecurity is a serious concern for the USSF: SpOC head Lieutenant General Stephen Whiting called cybersecurity, "the soft underbelly of these global space networks."⁴⁸⁰

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Members of Congress have been discussing creating a Space National Guard as a reserve component for the USSF to tap into the expertise at the state level: about 1000 Air National Guard members support USSF operations.⁴⁸¹ The 2024 defense authorization bill required the Secretary of Defense to submit a study to Congress in March 2024 about various options for doing so.⁴⁸² The report (dated April 2024) looked at three different options: keep the Air National Guard (ANG) units that focus on space where they are; transfer the ANG units to the USSF; and create a Space National Guard. It recommended transferring the ANG units to the USSF, given the latter's flexibility in personnel management and the ability to have full- and part-time forces, although it did note that all three options were feasible.⁴⁸³ In January 2024, a bill was introduced in the Senate to create a Space National Guard, something the Biden White House opposed due to concerns about creating "new bureaucracy with far-reaching and enduring implications and expense."⁴⁸⁴ This bill had also been introduced in 2022 and 2023.⁴⁸⁵ In August 2024, when President Donald Trump was on the campaign trail, he said that as president, he would create a Space National Guard to serve as the USSF's primary combat reserve.⁴⁸⁶ In March 2025, Congressional legislators introduced in both houses again a bill to establish a Space National Guard.⁴⁸⁷ However, this became largely moot when the Space Force announced in August 2025 that it would be taking over all the missions done by Air National Guard units.⁴⁸⁸

In January 2024, the US Army released a memo to give guidance for how it can use space to support multidomain operations (MDO), which calls for it to be able to integrate capabilities in support of Army warfighting functions (to include PNT, force tracking, environmental monitoring, space domain awareness, and geospatial information), as well as the need to be able to "interdict adversary space capabilities by delivering necessary fires and effects to protect friendly forces from observation and targeting by counter-satellite communications, counter-surveillance and reconnaissance, and navigation warfare operations."⁴⁸⁹ The Army announced in May 2025 that it was creating a career track for enlisted soldiers: 40D for Space Operations Specialist.⁴⁹⁰ It also indicated it would start including counterspace capabilities in its strategic priorities for its budget requests, starting in the FY 2027 budget.⁴⁹¹ The Army has also started working on a new space policy to guide its strategy, doctrine, requirements, and acquisitions in order to incorporate new counterspace missions; this rewrite of Army Regulation 900.1 (last updated in 2011) is anticipated to be released in the summer of 2026.⁴⁹²

US Counterspace Budget and Exercises

Despite this increased rhetoric, the unclassified US national security space budget contains a relatively small amount of funding for dedicated counterspace programs (excluding SSA) but has seen recent increases. Between FY2016 and FY2017, the total unclassified research, development, testing, and evaluation (RDT&E) budget for counterspace programs increased from \$24.1 million to \$41.9 million,⁴⁹³ and it increased again in FY2018 to \$68.38 million.⁴⁹⁴ Nearly all of the increase was to support the development of the 10.3 version of the CCS electronic warfare system. The FY2018 budget also included \$28.8 million to purchase two new 10.2 versions of CCS for active-duty USAF and Air National Guard units.⁴⁹⁵ The FY2019 budget for these same programs decreased to \$26.7 million.⁴⁹⁶ It is possible that additional dedicated counterspace programs, and possibly programs with potential counterspace utility, are funded through the classified budget. The United States also spends nearly \$8 billion a year on missile defense capabilities, several of which could have counterspace applications.⁴⁹⁷

In March 2019, the Pentagon released its FY2020 budget request, which listed “investing in the emerging space and cyber warfighting domains” as a major priority. While there was an overall increase of 22 percent in requested funding for military space programs, space control and counterspace programs saw a 46 percent decrease in requested funding.⁴⁹⁸ The majority of this change was a shift of an AF TENCAP program to another budget line. Other programs such as CCS, BOUNTY HUNTER, and Offensive Counterspace C2 continued at modest funding levels.⁴⁹⁹ In February 2020, the Pentagon released its FY2021 budget request, which included an increase of 36 percent in funding for counterspace programs, mainly due to accelerating the development of additional CCS systems. The Pentagon also asked for \$77 million in overseas contingency operations funding to support counterspace operations.⁵⁰⁰ The DoD budget request released in April 2022 asked for \$63 million for counterspace systems in FY2023 as part of its procurement budget line, increasing to \$67 million in FY2024, and then dropping considerably to \$4 million in FY2025 and eventually \$2 million in FY2027.⁵⁰¹ \$60 million was eventually appropriated for it in FY2023.⁵⁰² RDT&E for the Space Force included \$58 million for space control programs and anticipated increases every year through FY2027, when the annual request is planned to be for \$63 million.⁵⁰³ The final amount appropriated in FY2023 for space control technology was \$50 million.⁵⁰⁴ The FY2025 request for procurement of the CCS system as part of the USSF’s counterspace program element was \$4.2 million, then dropping to roughly \$2 million for the next four fiscal years.⁵⁰⁵ The FY2026 request for CCS was \$29 million for RDT&E and \$2 million for procurement.⁵⁰⁶

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- 517 "STARCOM executes first JNTC-accredited, largest SPACE FLAG exercise ever," *Space Training and Readiness Command Public Affairs*, August 22, 2022, <https://www.spaceforce.mil/News/Article/3135368/starcom-executes-first-jntc-accredited-largest-space-flag-exercise-ever/>; Jason Cutshaw, "Army space professionals participate in exercise Space Flag," *US Army Public Affairs*, December 28, 2022, https://www.army.mil/article/263011/army_space_professionals_participate_in_exercise_space_flag.
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- 519 Greg Hadley, "Space Forces Aims for Bigger Exercises, More Realistic Training," *Air & Space Forces Magazine*, December 15, 2024, <https://www.airandspaceforces.com/space-force-training-boss-exercises-infrastructure/>.

The Pentagon's FY2026 Mandatory Funding Allocation Plan, released in February 2026, indicates that it intends to spend in FY 26 an additional \$528 million on DARC and SILENT BARKER, as well as an additional \$1 billion on the X-37B and \$3.65 billion on the "Development, procurement, and integration of United States military satellites and the protection of United States military satellites."⁵⁰⁷

It was reported in February 2026 that the White House's Office of Management and Budget (OMB), which is in charge of releasing federal funding, was holding back around \$14 billion of funding relevant to military space.⁵⁰⁸ This includes "\$7.2 billion for space-based sensors; \$3.6 billion for military satellites and their protection; \$2 billion for separate, targeting-related military satellites; \$800 million for next-generation intercontinental ballistic missile defense systems; \$350 million for space command-and-control systems; and \$125 million for space communication systems." It is not known why OMB is doing this, if it is indeed happening.

The United States has also held multiple wargames and exercises over the last 25 years to practice and refine its counterspace doctrine. The most well-known is the Schriever Wargame, which began in 1998 as a biennial tabletop exercise to look at how advanced space technologies influenced future conflicts in space. In recent years, the Schriever Wargame has become an annual event that also explored policy and strategy issues, diplomatic, economic, military, and information activities, and included participation from a growing number of allied military and commercial partners. The 16th version of this wargame was held in March 2023, and had 350 participants from seven countries, 14 commercial service providers, and 25 US government commands and agencies.⁵⁰⁹ The 17th iteration of the Schriever Wargame was held in August 2025, included policy-makers from Australia, Canada, France, Germany, Italy, Japan, New Zealand, Norway, and the United Kingdom, and had an Indo-Pacific focus.⁵¹⁰ It included a special access cell so that the participants could share information about special access programs.⁵¹¹ The next version of the wargame will be in 2027 and for the first time, will have allies involved in its creation and planning, as opposed to the United States doing all of it.⁵¹²

USSPACECOM holds an annual conference, Global Sentinel, to practice combined space operations. The most recent iteration was held in April 2025 and included operators from 29 countries plus NATO.⁵¹³ According to Maj. Gen. Richard L. Zellmann, Combined Joint Force Space Component deputy commander, the exercises the group worked through ran the gamut from "a normal, standard launch all the way to direct-ascent, satellite weapons and everything in between."⁵¹⁴

In 2017, the USAF also held the first Space Flag exercise. Modeled after the USAF's Red Flag air combat exercise at Nellis Air Force Base, the Space Flag exercise focused on practicing and training for space warfare.⁵¹⁵ The 13th Space Flag (Space Flag 22-1) was held in December 2021 and was the third Space Flag that included partners like Australia, the United Kingdom, and Canada.⁵¹⁶ Space Flag 22-3 was held in August 2022 and included for the first time the 5th Electronic Warfare Squadron; it was followed in December 2022 by Space Flag 23-1, which included US Army space operations officers and members from the Australian, Canadian, and UK militaries.⁵¹⁷ Space Flag 24-1, held in May 2024, was reorganized to include tactical and operational levels of warfare.⁵¹⁸ Space Flag 25-1 was held in December 2024 and was the biggest version of that digital exercise yet, with the participation of "56 squadrons, 11 Deltas, 85 operational planners, 31 tactical planners, 111 ops crew members, 373 participants," per a USSF official.⁵¹⁹ The Space Force held its biggest training event, "Resolute Space," in July 2025, which involved 700 Guardians,

as well as international participants and personnel from the US Joint Force.⁵²⁰ The intent of Resolute Space was “to incorporate, at scale, space-based and space-enabled capabilities to include, but not limited to, space electromagnetic warfare, space domain awareness, orbital warfare, and navigational warfare” and incorporated Guardians from bases in the United States and overseas.⁵²¹

Space Force officials have talked about the need to engage in more maneuver-based exercises to reflect the changed requirements of the domain that they are operating in. Gen. Stephen Whiting, commander of SPACECOM, has discussed creating what he calls the “Apollo maneuvers” exercises that involve “spectrum maneuvering,” satellite maneuvering, and responsive launch.⁵²²

The USAF’s Advanced Battle Management System (ABMS) held an exercise in April 2020 that was intended to support USSPACECOM as its space assets came under simulated attack.⁵²³ In July 2023, US SOUTHCOM held its first defensive space control operation during Resolute Sentinel 23, where forces from the region and USSOUTHCOM responded to electromagnetic interference as part of the Operation Thundergun Express exercise.⁵²⁴ Resolute Sentinel 24 was held in June 2024, again with the goal of improving operability. Operators from Brazil, Colombia, and Peru used commercially-provided data, however, since not all operators were able to access USSF tools.⁵²⁵

523 Theresa Hitchens, “Attack On US Satellites Focus Of Next ABMS Test: Goldfein,” *Breaking Defense*, March 3, 2020, <https://breakingdefense.com/2020/03/attack-on-us-satellites-focus-of-next-abms-test-goldfein/>.

524 Jennifer Whitaker, “RS23 Space Team ACEs Space Deployment,” *Air Forces (Southern) Public Affairs*, July 18, 2023, <https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/3464169/rs23-space-team-aces-space-deployment/>.

525 Courtney Sebastianelli, “RS24 enhances global space domain awareness with partner nations,” *USSOUTHCOM News*, June 10, 2024, <https://www.southcom.mil/MEDIA/NEWS-ARTICLES/Article/3802887/rs24-enhances-global-space-domain-awareness-with-partner-nations/>.

55.7558°N

02

RUSSIA

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For the first several decades of the Space Age, the Soviet Union developed a robust set of governmental space programs that matched, and sometimes exceeded, the United States in many areas. While often not quite as technologically advanced as their US counterparts, the Soviets nonetheless managed to field significant national security space capabilities.

During the Cold War, the Soviet Union developed a range of counterspace capabilities as part of its strategic competition with the United States. Many of these capabilities were developed for specific military utility, like destroying critical US military satellites or countering perceived threats, such as the Reagan administration's Strategic Defense Initiative. Some of them underwent significant on-orbit testing and were considered operationally deployed. However, the Soviet Union also signed bilateral arms control agreements with the United States that put limits on the use of counterspace capabilities against certain satellites. Many of these programs were scrapped or mothballed in the early 1990s as the Cold War ended and funding dried up.

There is strong evidence that Russia has embarked on a set of programs over the last decade to regain offensive counterspace capabilities. In some cases, the evidence suggests legacy capabilities are being brought out of mothballs, and in other cases, the evidence points to new capabilities being developed, such as the Nudol direct-ascent anti-satellite (DA-ASAT) weapon. In all cases, Russia has a strong technical legacy to draw upon. Under President Vladimir Putin, Russia also has renewed political will to obtain counterspace capabilities for much the same reason as China: to bolster its regional power and limit the ability of the United States to impede on Russia's freedom of action.

There is also significant evidence that Russia is actively employing non-destructive counterspace capabilities in current military conflicts. There are multiple, credible reports of Russia using jamming and other electronic warfare measures in Syria and Ukraine, as well as cyber counterspace weapons, and there are indications that these capabilities are tightly integrated into Russian military operations in other regions as well.

The following sections summarize Russian counterspace development across co-orbital, direct-ascent, electronic warfare, directed energy, and space situational awareness categories, along with a summary of Russia's policy, doctrine, and military organizational framework on counterspace.

2.1 – RUSSIAN CO-ORBITAL ASAT

Assessment /

Since 2010, Russia has been testing technologies for rendezvous and proximity operations (RPO) in both LEO and GEO that could lead to or support a co-orbital ASAT capability, and some of those efforts have links to a Cold War-era LEO co-orbital ASAT program. Additional evidence suggests Russia may have started a new co-orbital ASAT program called Burevestnik, potentially supported by a surveillance and tracking program called Nivelir. The technologies developed by these programs could also be used for non-aggressive applications, including surveilling and inspecting foreign satellites, and most of the on-orbit RPO activities done to date match these missions. However, Russia has deployed two "sub-satellites" at a high velocity, which suggests at least some of their LEO RPO activities are of a weapons nature.

Specifics /

During the Cold War, the Soviet Union had multiple efforts to develop, test,

- 1 Anatoly Zak, "IS Anti-satellite System," *Russian Space Web*, last modified July 13, 2017, <http://www.russianspaceweb.com/is.html>.
- 2 J.-C. Liou, "History of On-Orbit satellite Fragmentations," *NASA Orbital Debris Program Office*, 15th Edition, July 4, 2018, <https://ntrs.nasa.gov/api/citations/20180008451/downloads/20180008451.pdf>.
- 3 Bart Hendrickx, "Naryad-V and the Soviet Anti-Satellite Fleet," *Space Chronicle*, Vol 69, 2016, available at <https://www.semanticscholar.org/paper/Naryad-V-and-the-Soviet-Anti-Satellite-Fleet-Hendrickx/414e786666492c48af754bdf5f383e34cea77c6f>.

and deploy co-orbital ASAT capabilities. Many different concepts for the deployment of co-orbital weapons were considered, including lasers, missile platforms, manned and unmanned gunnery platforms, robotic manipulators, particle beams, shotgun-style pellet cannons, and nuclear space mines, but most died on the drawing board. Kinetic co-orbital ASATs are one of the few known to have achieved operational status.

IS and IS-M

The first known serious effort was the Istrebitel Sputnikov (IS) or "satellite fighter" system, which was conceived in the late 1950s and began development in the 1960s.¹ The system featured a launch vehicle based on the R-36 (US designation SS-9) missile based from dedicated launch pads at Baikonur Cosmodrome in southern Kazakhstan (see Imagery Appendix, pg. 17-10). After being launched into orbit, the interceptor would separate from the booster, make multiple changes to its orbit so that it passed close to the target object, and then explode to release shrapnel that had an approximate effective range of 50 m. A shortcoming of the system is that it needed at least two orbits to do this, and the target object had several hours to detect the attack and alter its own trajectory.

The IS system was tested in orbit multiple times over three decades, with several actual intercepts against targets between 230 and 1,000 km and the creation of over 950 pieces of orbital space debris larger than 10 cm. Many of the events are described in detail in the NASA History of On-orbit Satellite Fragmentations.²

Table 2-1 shows the known tests of the IS system and its follow-ons. The first round of testing began in 1963 and concluded in 1971, with the system being declared operational in February 1973.³

TABLE 2-1 – IS TESTS CONDUCTED BY THE SOVIET UNION⁴

DATE	TARGET OBJECT	INTERCEPTOR	NOTES
Nov. 1, 1963	None	Polyot 1	Engine and maneuvering test
Apr. 12, 1964	None	Polyot 2	Engine and maneuvering test
Oct. 27, 1967	None	Cosmos 185 (IS)	First test launch of IS interceptor
Oct. 20, 1968	Cosmos 248	Cosmos 249, Cosmos 252 (IS)	Attacked twice: by Cosmos 249 on Oct. 20 and by Cosmos 252 on Nov. 1
Oct. 23, 1970	Cosmos 373	Cosmos 374, Cosmos 375 (IS)	Attacked twice: by Cosmos 374 on Oct. 23 and by Cosmos 375 on Oct. 30
Feb. 25, 1971	Cosmos 394	Cosmos 397 (IS)	Successful intercept, debris created
Mar. 18, 1971	Cosmos 400	Cosmos 404 (IS)	Longer test flight with new approach from above to intercept target
Dec. 3, 1971	Cosmos 459	Cosmos 462 (IS)	Successful intercept, debris created
Feb. 16, 1976	Cosmos 803	Cosmos 804, Cosmos 814 (IS)	Attacked twice: by Cosmos 804 on Feb. 16 and by Cosmos 814 on April 13. Non-intercept tests
Jul. 9, 1976	Cosmos 839	Cosmos 843 (IS)	Intercepted satellite, but possible failure
Dec. 17, 1976	Cosmos 880	Cosmos 886 (IS)	Successful intercept, debris created
May 23, 1977	Cosmos 909	Cosmos 910, Cosmos 918 (IS)	Attacked twice: by Cosmos 910 on May 23 and by Cosmos 918 on Jun. 17 (both failures)
Oct. 26, 1977	Cosmos 959	Cosmos 961 (IS)	Successful intercept, no debris created
Dec. 21, 1977	Cosmos 967	Cosmos 970 (IS)	Successful intercept, no debris created from the test itself. Cosmos 970 was ordered to self-destruct afterwards; that is what created debris from this test
May 19, 1978	Cosmos 967	Cosmos 1009 (IS-M)	Successful intercept, no debris created
Apr. 18, 1980	Cosmos 1171	Cosmos 1174 (IS-M)	Unsuccessful intercept, debris created (Cosmos 1174 was ordered to self-destruct afterwards)
Feb. 2, 1981	Cosmos 1241	Cosmos 1243, Cosmos 1258 (IS-M)	Attacked twice: Cosmos 1243 on Feb. 2 and Cosmos 1258 on Mar. 14 (both failures)
Jun. 18, 1982	Cosmos 1375	Cosmos 1379 (IS-PM)	Successful intercept, debris created

⁴ Data compiled from multiple sources and available here: https://docs.google.com/spreadsheets/u/1/d/1e5GtZEzdo6xk41i2ei3c8jRZDjvP4Xwz3BVsuHwi48/edit?usp=drive_web.

- 5 Data compiled from multiple sources and available here: https://docs.google.com/spreadsheets/u/1/d/1e5GtZEzdo6xk41i2_ei3c8jRZD-jvP4Xwz3BVtUHwi48/edit?usp=drive_web.
- 6 Pavel Podvig, "Is China Repeating the Old Soviet and US Mistakes?", *Russian Strategic Nuclear Forces*, January 19, 2007, http://russianforces.org/blog/2007/01/is_china_repeating_the_old_sov.shtml.
- 7 Laura Grego, "A History of Anti-Satellite Programs," *Union of Concerned Scientists*, January 2012, https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf.
- 8 Grego, "A History of Anti-Satellite Programs," *ibid*, p. 5.
- 9 Anatoly Zak, "Origin of the Almaz project," *Russian Space Web*, http://www.russianspaceweb.com/almaz_origin.html, accessed February 17, 2022.
- 10 Bart Hendrickx and Dwayne A. Day, "Diamonds and DORIANs: program troubles, operations, cancellation, and legacy (part 3)," *The Space Review*, January 2, 2024, <https://www.thespacereview.com/article/4717/1>.
- 11 Anatoly Zak, "Here Is the Soviet Union's Secret Space Cannon," *Popular Mechanics*, November 16, 2015, <https://www.popularmechanics.com/military/weapons/a18187/here-is-the-soviet-unions-secret-space-cannon/>.
- 12 Anatoly Zak, "Soviet space rocket-propelled grenade revealed," *Russian Space Web*, <http://russianspaceweb.com/almaz-shield2.html>, accessed February 17, 2022.

From 1976–77, eight additional tests of the system were conducted, publicly demonstrating an ability to operate effectively in a broader swathe of orbits from 150 to 1,600 km, culminating in the deployment of an upgraded version of the system, dubbed IS-M.⁵ IS-M was allegedly capable of targeting satellites at altitudes of up to 2,200 km, and inclinations of 50 to 130 degrees, with an estimated kill probability of 70–80 percent.⁶ IS-M also reduced attack time by increasing speed and maneuverability to allow rendezvous with the target in a single orbit.⁷ The final test of the IS-M system occurred in 1982; in 1983, a moratorium was declared on all ASAT tests,⁸ though modernization efforts apparently continued.

Soviet documents from the late 1980s indicate there were two more planned upgrades to the IS system, the IS-MU (14F10) and the IS-MD (75P6), also known as Naryad. IS-MU was designed to be an even more capable LEO co-orbital interceptor, and the IS-MD would be able to intercept satellites in GEO. There are no records of either system moving past the drawing board or confirmation of being tested in space, and both were ended in 1993. However, some components, including the network's SSA, targeting, and control systems, are known to have been maintained in working condition and also to have undergone comprehensive upgrades and modernization over the last decade.

Almaz Space Station

During the 1970s, the Soviet Union developed a series of classified military space stations known as the Almaz program ("diamond" in Russian). The program began in the 1960s, before the civil and publicly-known Salyut space station program, and was a response to the American Manned Orbiting Laboratory (MOL) program.⁹ The concept was to use crewed space stations to conduct military missions such as imagery and reconnaissance that was not possible by robotic satellites at that time. Three Almaz space stations flew between 1973 and 1975 under the official/cover names of OPS-1/Salyut 2, OPS-2/Salyut 3, and OPS-3/Salyut 5.

Two of the three Almaz space stations, Salyut 2 and Salyut 3, carried weapon systems that were purportedly for "defensive" purposes but could be used offensively in certain situations.¹⁰ The main weapon system was the R-23 Kartech, a modified 23 mm tailgun from a Tu-22 bomber that was mounted on the forward belly of the station.¹¹ The cannon was reportedly only test-fired once at the end of OPS-2/Salyut-3 and had significant limitations. As the cannon was fixed to the station, the entire station needed to be re-orientated to aim it, and due to orbital mechanics likely only had a relatively short range.

The cannon was slated to be replaced by a more advanced missile system starting with the OPS-4 space station but never did, as the program was canceled. The missile system was known as "Shield-2" and would have been a radar-guided missile capable of hitting another space object up to 100 km (60 miles) away.¹² The Shield-2 system reportedly used a series of small solid rocket charges to propel itself, which could also be detonated in close proximity to the target to create shrapnel.

Naryad

Towards the end of the Cold War, the Soviet Union began developing a new and more capable co-orbital system known as Naryad-V (14F11). The key technologies of the Naryad-V were a silo-based solid fuel rocket launch vehicle derived from the UR-100NUTTH (SS-19) paired with a new and very capable liquid fuel upper stage. The combination was designed to allow the system to target an extremely wide range of orbits between 0 to 130 degrees inclination and altitudes of 150 to 40,000 km,¹³ and rapid launches of large numbers at once. At one meeting regarding the program in 1990, the prospect was discussed of launching as many as one hundred in a single volley.¹⁴

As with the later versions of the IS, the Naryad development was cut short by the fall of the Soviet Union.

Table 2-2 shows the known testing history of the Naryad program. The Naryad launch vehicle had two sub-orbital flight tests in November 1990 and December 1991, both from Baikonur Cosmodrome.¹⁵ A third orbital flight test from Baikonur was conducted in December 1994, with a Rockot booster delivering the Radio ROSTO amateur radio satellite (1994-085A, 23439) into a 1,900 by 2,145 km orbit.¹⁶ It is rumored that the launch had a second payload, which may have been the Naryad interceptor, that fragmented shortly after launch. Twenty-seven pieces of orbital space debris were catalogued, of which 24 are still on orbit along with the ROSTO satellite.

TABLE 2-2 – SUSPECTED NARYAD FLIGHT TESTS

DATE	BOOSTER	PAYLOAD	LAUNCH SITE	LAUNCH PAD	ORBIT
Nov. 20, 1990	Rockot/Briz-K	Naryad-V anti-satellite	Baikonur	Site 131	Sub-orbital
Dec. 20, 1991	Rockot/Briz-K	Experimental, Naryad test?	Baikonur	Site 175/1	Sub-orbital
Dec. 26, 1994	Rockot/Briz-K	Radio-ROSTO, Naryad test?	Baikonur	Site 175/1	1,900 km; 65°

After the fall of the Soviet Union, the components of the Naryad program found new commercial uses, leading to speculation that the program could be revived. The rocket became the Rockot launch vehicle and operated from Plesetsk Cosmodrome (see Imagery Appendix, pg. 17-06), where it had 31 successful launches and placed more than 90 satellites into orbit.¹⁷ The Naryad upper stage was developed into the Briz-KM and Briz-M, which are mainstays of Russian space launches to GEO.¹⁸ Russian military officials have claimed that some “basic [ASAT] assets [were] retained” in connection to the “Naryad-VN” and “Naryad-VR” systems, to be employed if the United States or China were to put weapons in space.¹⁹ It remains unclear precisely what those designations refer to, or what the difference between the two subsystems might be.

Recent Rendezvous and Proximity Operations in LEO

More recently, a resurgence of Russian RPO has driven substantial anxiety in the United States and elsewhere over concerns that they are aimed at developing new co-orbital ASAT capabilities. Since 2013, Russia has launched several satellites into LEO and GEO that have demonstrated the ability to rendezvous with other space objects, and in some cases after periods of dormancy.

- 13 Pavel Podvig, “Is China Repeating the Old Soviet and US Mistakes?”, *Russian Strategic Nuclear Forces*, January 19, 2007, http://russianforces.org/blog/2007/01/is_china_repeating_the_old_sov.shtml.
- 14 Bart Hendrickx, “Naryad-V and the Soviet Anti-Satellite Fleet,” *Space Chronicle*, Vol 69, 2016, available at <https://www.semantic-scholar.org/paper/Naryad-V-and-the-Soviet-Anti-Satellite-Fleet-Hendrickx/414e786666492c48af754bdf5f383e34cea77c6f> and Pavel Podvig, “Did Star Wars Help End the Cold War? Soviet Response to the SDI Program,” *Russian Forces*, March 17, 2013, http://russian-forces.org/podvig/2013/03/did_star_wars_help_end_the_col.shtml, p.18.
- 15 Anatoly Zak, “UR-100”, *Russian Space Web*, updated June 27, 2013, http://www.russianspaceweb.com/baikonur_ur100.html; “Rockot Launch Vehicles,” updated December 24, 2017, <http://www.russianspaceweb.com/rockot.html>.
- 16 Mark Wade, “Radio,” *Astronautix*, accessed March 22, 2018, <http://www.astronautix.com/r/radio.html>.
- 17 For an updated list of Rokot launches, see http://en.wikipedia.org/wiki/Rokot#Launch_table, last edited January 25, 2025.
- 18 Anatoly Zak, “Briz-K/KM,” *Russian Space Web*, last updated March 18, 2021, <http://www.russianspaceweb.com/briz.html>.
- 19 Anatoly Zak, “Russian Anti-Satellite Systems,” *Russian Space Web*, updated November 30, 2017, <http://www.russianspaceweb.com/naryad.html>; Anatoly Zak, “The Hidden History of Soviet Satellite-Killer,” *Popular Mechanics*, November 1, 2013, <https://www.popularmechanics.com/space/satellites/a9620/the-hidden-history-of-the-soviet-satellite-killer-16108970/>.

- 20 Brian Weeden, "Dancing in the Dark Redux: Recent Russian Rendezvous and Proximity Operations in Space," *The Space Review*, October 5, 2015, <http://www.thespacereview.com/article/2839/1>.
- 21 Jonathan McDowell, "Jonathan's Space Report No. 697," May 17, 2014, <https://planet4589.org/space/jsr/back/news.697.txt>.
- 22 Jonathan McDowell, Tweet, January 12, 2020, <https://twitter.com/planet4589/status/1216265783644389376?s=20>. Total amount of orbital debris derived from the public US military satellite catalog at <https://space-track.org>.
- 23 Thread at the Novosti Kosmonavtiki forums, dated May 16, 2014, http://novosti-kosmonavtiki.ru/forum/forum12/topic14232/?PAGEN_1=5.
- 24 Posting on the Novosti Kosmonavtiki forums, dated November 28, 2014, <http://novosti-kosmonavtiki.ru/forum/messages/forum12/topic14778/message1315049/#message1315049>.
- 25 Пашков, Дмитрий, "Cosmos-2491/RS-46 (R4UAB)," Youtube, December 2, 2014, <https://www.youtube.com/watch?v=jHKOsdhMVDk#t=14>. The Russian government publicly disclosed the existence of the amateur radio payloads, which were activated at the end of the main mission.

The first known event was on December 25, 2013, when a Russian Rockot launch vehicle from Plesetsk Cosmodrome placed three small satellites into LEO in what appeared to be another routine launch to replenish the Rodnik constellation.²⁰ The Rodnik satellites were store-and-dump communications satellites, which store messages uploaded from end users and then downlink them when the satellite passes over a receiving station. The launch was publicly announced, and shortly afterward the Russian Defense Ministry announced that the three spacecraft (Cosmos 2488, 2013-076A, 39483; Cosmos 2489, 2013-076B, 39484; Cosmos 2490, 2013-076C, 39485) had successfully separated from the upper stage (Breeze-KM R/B, 20113-076D, 39486). However, the US military catalogued a fourth payload from the launch (Cosmos 2491, 2013-076E, 39497), and over the following months, evidence emerged from official and open sources to confirm it.²¹

From launch through the end of 2019, Cosmos 2491 did not make any significant changes to its orbit and remained at a relatively high LEO altitude of 1,500 km. On December 23, 2019, Cosmos 2491 did make a small maneuver of approximately 1.5 m/s, which was accompanied by the release of 51 pieces of orbital debris that were eventually catalogued by the US military.²² Given the relatively low energy of the event, it is likely that the propulsion system of Cosmos 2491 failed immediately after launch and the orbital change and fragmentation event was caused by the explosive release of the residual fuel. As of February 2026, Cosmos 2491 is still in a high LEO orbit of close to 1,500 km altitude.

On May 23, 2014, another Rockot launch took place from Plesetsk with what appeared to be another Rodnik replenishment mission. Once again, the Russian government publicly declared that the launch carried three military satellites (Cosmos 2496, 2014-028A, 39761; Cosmos 2497, 2014-028B, 39762; Cosmos 2498, 2014-028C, 39763). Two days later, hobbyist satellite observers indicated that a fourth payload (Cosmos 2499, 2014-028E, 39765) was on the launch. By mid-June, hobbyists reported that Cosmos 2499, had begun a series of maneuvers to match orbits with the Briz-KM upper stage (2014-028D, 39764) that placed it in orbit.²³ The process took several months, and it was not until the end of November when Cosmos 2499 passed within a kilometer of the Briz-KM.²⁴ Amateur radio operators also reported that Cosmos 2499 appeared to be using the same radio frequencies as Cosmos 2491, suggesting they used the same Yubileiny-2 microsatellite bus.²⁵ After drifting apart, Cosmos 2499 did another series of maneuvers in January 2015 to put itself in an orbit that kept it a few km above and several hundred km away from the Briz-KM. On March 26, 2016, Cosmos 2499 made another orbit adjustment that slowly brought it closer to the Briz-KM by about tens of km per day.

Since 2016, Cosmos 2499 appears to have reached end-of-mission, but has experienced two additional events. On October 23, 2021, Cosmos 2499 experienced a fragmentation event and then another on January 4, 2023, releasing a total of 59 catalogued fragments. The most likely cause of these incidents is rupture of an onboard fuel tank or some other anomaly, and given that Cosmos 2491 also experienced a fragmentation event in 2019, this suggests a potential design flaw in the 14F153 satellite series. As of February 2026, Cosmos 2499 is still in orbit but inactive.

On March 31, 2015, a third Rockot launch took place from Plesetsk with what was publicly declared as carrying three Gonets-M satellites (Gonets M11, 2015-020A, 40552; Gonets M12, 2015-020B, 40553; Gonets M13, 2015-020C, 40554) and a classified military payload (Cosmos 2504, 2015-020D, 40555). The Gonets serve as a civilian version of the Strela/Rodnik store-and-dump LEO communications constellation. Cosmos 2504 began a small series of

maneuvers in early April to bring it close to the Briz-KM upper stage (2015-020E, 40556) that placed it in orbit. At some point during that pass, the Briz-KM's orbit was disturbed by an unknown perturbation, which could have been the result of a minor collision between the two space objects. If it was, the impact was very slight and did not result in additional debris being generated. It is also unknown if the impact was planned or an accident. On July 3, 2015, Cosmos 2504 made another significant maneuver, lowering both its apogee and perigee significantly by around 50 km each, further separating itself from the Briz-M. In late July 2016, the USAF catalogued six small pieces of debris attributed to the Briz-KM upper stage but did not release a cause. On March 27, 2017, after more than a year of dormancy, Cosmos 2504 made a series of maneuvers that lowered its orbit, and on April 20, it passed within two km of a piece of Chinese space debris from its 2007 ASAT test.²⁶ This suggests that Cosmos 2504 has a satellite inspection or observation mission and may have been looking for intelligence on the Chinese direct-ascent interceptor program. Cosmos 2504 maneuvered again on December 10, 2019, to lower its perigee by 40 km, although the reason is not yet known.²⁷ As of February 2026, Cosmos 2504 was still in orbit but inactive.

On June 23, 2017, a Russian Soyuz 2-1v rocket was launched from Plesetsk (see Imagery Appendix, pg. 17-07) with two military payloads. One payload was rumored to be the first of the new series of military geodetic satellites, used to create extremely precise maps of the Earth's shape and gravitational field.²⁸ Russian officials declared that the launch also included a "space platform which can carry different variants of payloads" which was designated Cosmos 2519 (2017-037A, 42798).²⁹ In late July and early August, Cosmos 2519 made a series of small maneuvers. Publicly available information strongly suggested that Cosmos 2519 had a remote sensing mission.³⁰ Shortly thereafter on August 23, Russian officials announced that a small satellite, designated Cosmos 2521 (2017-037D, 42919) had separated from the platform and was, "intended for the inspection of the condition of a Russian satellite."³¹ Subsequently, Russia reported that the satellite-inspector completed a series of proximity operations experiments and returned to the Cosmos 2519 host satellite on October 26.³² On October 30, Russia announced that another small satellite, Cosmos 2523 (2017-037E, 42986), separated from Cosmos 2521 and would have a satellite inspection function but it is not known to have approached other satellites.³³ Jonathan McDowell calculated that Cosmos 2523 was released at a relative velocity of 27 meters per second (60 miles per hour).³⁴ Comments from senior US military leadership suggest they consider the deployment of Cosmos 2523 to have been an ASAT test, given its relatively large deployment velocity.³⁵ Throughout March, April, and June 2018, Cosmos 2519 and 2521 conducted several RPOs of each other.³⁶ Since March 2018, Cosmos 2519 and Cosmos 2521 did not approach any other space objects but made small adjustments to their orbits, likely to forestall natural orbital decay.³⁷ Cosmos 2521 eventually re-entered the atmosphere on September 12, 2019³⁸ and Cosmos 2519 re-entered on December 23, 2021.³⁹ As of February 2026, Cosmos 2523 remains in orbit.

Links to Project Nvelir and Burevestnik

Further open source research done by analyst Bart Hendrickx suggests that the Cosmos 2491, 2499, 2504, and 2521 satellites are part of a project started in 2011 to develop space-based space situational awareness (SSA) capabilities and may play a supporting role for other counterspace weapons.⁴⁰ Publicly available documents and patents suggest a link between those Cosmos satellites and

26 Anatoly Zak, "Russia Goes Ahead with Anti-Satellite System," *Russian Space Web*, updated December 15, 2017, <http://www.russianspaceweb.com/Cosmos-2504.html>.

27 Gwiz posting to the NASASpaceflight.com forums, December 11, 2019, <https://forum.nasaspaceflight.com/index.php?topic=32816.msg2024319#msg2024319>.

28 Anatoly Zak, "Soyuz-2-1v Launches a Secret Satellite," *Russian Space Web*, August 30, 2017, <http://www.russianspaceweb.com/napryazhenie.html>.

29 "Спутник 'Космос-2519' Минобороны РФ будет фотографировать космические объекты [Sputnik 'Cosmos-2519' of the Russian Defense Ministry Will Photograph Space Objects]," *MilitaryRussia.ru*, June 24, 2017, <http://www.militarynews.ru/story.asp?rid=1&nid=454841>.

30 Bart Hendrickx, posting on the NASASpaceflight.com Forums, February 27, 2018, <https://forum.nasaspaceflight.com/index.php?PHPSESSID=35dsgsej5k8t-t51h7fo7re8e04&topic=43064.msg1793720#msg1793720>.

31 "С запущенного в интересах Минобороны космического аппарата выведен в космос спутник-инспектор," *Interfax.ru*, August 23, 2017, <http://www.interfax.ru/russia/576068>.

32 Jonathan McDowell, "Jonathan's Space Report No. 742," November 25, 2017, <https://planet4589.org/space/jsr/back/news.742.txt>.

33 Bart Hendrickx, posting on the NASASpaceflight.com forums, March 3, 2018, <https://forum.nasaspaceflight.com/index.php?topic=43064.msg1795369#msg1795369>.

34 Jonathan McDowell, "Nivelir (Cosmos-2519 et al): A new series of Russian military satellites," *Jonathan's Space Page*, accessed February 2, 2020, <https://planet4589.org/space/plots/niv/index.html>.

35 W.J. Hennigan, "Exclusive: Strange Russian Spacecraft Shadowing US Space Satellite, General Says," *Time.com*, February 10, 2020, <https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/>.

36 Jonathan McDowell, "Jonathan's Space Report No. 752," August 17, 2018 <https://planet4589.org/space/jsr/back/news.752.txt>.

37 "US Spots Maneuvers of Russian Military Satellite," *TASS*, August 31, 2019, <https://tass.com/science/1075876>.

38 "The United States Reported that Russia Lost a Military Satellite Inspector," *TASS*, September 13, 2019, <https://tass.ru/kosmos/6882787>.

39 "Russian military satellite that worked with inspector spacecraft burns in atmosphere," *TASS*, December 23, 2021, <https://tass.com/science/1380133>.

40 Bart Hendrickx, posting on the NASASpaceflight.com forums, February 1, 2019, <https://forum.nasaspaceflight.com/index.php?topic=43064.msg1906972#msg1906972>.

- 41 Bart Hendrickx, posting on the NASASpaceflight.com forums, October 22, 2019, <https://forum.nasaspaceflight.com/index.php?topic=48521.msg2007320#msg2007320>.
- 42 Bart Hendrickx, "Russia develops co-orbital anti-satellite capability," *Jane's Intelligence Review*, September 27, 2018, https://www.janes.com/images/assets/463/83463/Russia_develops_co-orbital_anti-satellite_capability.pdf.
- 43 Bart Hendrickx, posting on the NASASpaceflight.com forums, April 8, 2020, <https://forum.nasaspaceflight.com/index.php?topic=45734.msg2066800#msg2066800>.
- 44 Bart Hendrickx, "Burevestnik: a Russian air-launched anti-satellite system," *The Space Review*, April 27, 2020, <https://www.thespacereview.com/article/3931/1>.
- 45 Bart Hendrickx, posting on the NASASpaceflight.com forums, October 22, 2019, <https://forum.nasaspaceflight.com/index.php?topic=48521.msg2007320#msg2007320>.
- 46 Hendrickx, *ibid*.
- 47 Hendrickx, *ibid*.
- 48 Bart Hendrickx, "Burevestnik: a Russian air-launched anti-satellite system," *The Space Review*, April 27, 2020, <https://www.thespacereview.com/article/3931/1>.

procurement for a project designated Nivelir ("Dumpy level") and under the control of the Central Scientific Research Institute for Chemistry and Mechanics (TsNIIKhM), which was involved in the original IS co-orbital ASAT program. Nivelir appears to have two series of satellites under it, 14F150 (Cosmos 2519 and 14F153 (Cosmos 2491, 2499, 2504, and 2521).⁴¹ Hendrickx also uncovered evidence suggesting there is an active Russian co-orbital ASAT program codenamed Burevestnik ("Petrel") or project 14K168, also managed by TsNIIKhM and also started in 2011.⁴² Burevestnik appears to involve ground-based infrastructure at Plesetsk Cosmodrome near Noginsk-9 (see Imagery Appendix, pg. 17-08), which was the location of the ground control center for the Soviet-era IS co-orbital ASAT and is near the headquarters for the Russian military space surveillance network. TsNIIKhM also supplied the explosive warhead for the IS, which targeted LEO satellites. Additional reports suggest Burevestnik includes a three-stage solid fuel rocket built by NPO Iskra.⁴³ It appears this rocket is intended to be launched from a modified MiG-31 fighter aircraft (labeled MiG-31BM) to serve as a quick-response system to place the Burevestnik ASATs into orbit. The concept is a new version of the Ishim proposal from the early 2000s and using a fighter as a launch platform would enable significant flexibility for launch times and orbits to target.⁴⁴

FIGURE 2-1 — MiG-31BM CARRYING A BUREVESTNIK LAUNCHER



Credit: ShipSash

The Nivelir inspection and Buresvestik co-orbital ASAT programs share a lot of technologies. They appear to use the same bus, thermal catalytic thrusters, and fuel tanks as the Burevestnik co-orbital ASATs and may also support the Burevestnik program either by testing RPO technology or providing tracking and targeting support. Additional research suggests Burevestnik might utilize low-temperature solid-fuel generators that produce nitrogen gas to defend spacecraft from attacks.⁴⁵ The aerosol created by such gas generators would have both a masking and damaging effect, most likely meaning that they could be used not only to conceal the satellite under attack from the interceptor, but also to disable some of the interceptor's systems (such as optical devices).⁴⁶ Other research discusses the use of electrostatically charged finely dispersed particles to remove oppositely charged orbital debris in GEO, which could also have offensive applications.⁴⁷ Another possibility is that the interceptors might use explosive charges to generate fragments, as indicated by a contract given to the Krasnoarmeysk Scientific Research Institute of Mechanization (KNIIM) and a company called OOO Expotekhvzryv as part of Burevestnik.⁴⁸

Another Rodnik replenishment mission was launched from Plesetsk on

November 30, 2018, and again there was a fourth object (Object E, 2018-097E, 43755) placed into orbit in addition to the three Rodnik communications satellites (Cosmos 2530, 2018-097A, 43751; Cosmos 2531, 2018-097B, 43752; Cosmos 2532, 2019-097C, 43753). While the separation profile of Object E matched the deployment of Cosmos 2504 and other inspector satellites, Russian media reports stated that the fourth object was a dummy payload that replaced a laser reflector satellite at the last minute.⁴⁹ Since reaching orbit, no signals or maneuvers have been detected by the fourth object, suggesting it is indeed a piece of debris or inert payload.

On July 10, 2019, Russia launched another set of four military payloads on a Soyuz-2-1v from Plesetsk (see Imagery Appendix, pg. 17-07), designated by the US military as Cosmos 2535 (2019-039A, 44421), Cosmos 2536 (2019-039B, 44422), Cosmos 2537 (2019-039C, 44423), and Cosmos 2538 (2019-039D, 44424). All four objects were registered with the United Nations in August 2019.⁵⁰ The satellites were placed into a 97.88° inclination and 612 by 623 km orbit and one of the four satellites was detected broadcasting on the same frequency as Cosmos 2521, indicating it may be part of the Nivelir program.⁵¹ On August 1, 2019, Russia announced that two of the satellites, Cosmos 2535 and Cosmos 2536, would be engaged in satellite inspection and satellite servicing activities.⁵² According to data compiled by Jonathan McDowell, the two satellites conducted a series of RPO experiments between August 7 and 19, 2019, with approach distances as close as 30 km before backing off to 180 to 400 km.⁵³ Shortly before the RPO, nine debris objects were released in the vicinity of the two satellites, with apogees as high as 1,400 km, suggesting a significant energetic event.⁵⁴ The other two satellites, Cosmos 2537 and Cosmos 2538, have not maneuvered and may be radar calibration targets. In early October 2019, several additional debris objects were detected, although it is uncertain which parent object they came from. This, along with differences between this launch and previous Nivelir missions, has led some to suspect that they may be part of the Burevestnik co-orbital ASAT program and could be involved in the testing of aerosols or charged particles. Cosmos 2535 and Cosmos 2536 continued their RPO activities in December 2019, which resulted in the release of six more debris objects. In total, 30 catalogued debris objects have been associated with this launch, 12 of which are still in orbit.⁵⁵ As of February 2026, Cosmos 2535 and 2536 are still on orbit but inactive.

On November 25, 2019, Russia conducted another launch of a Soyuz-2-1v from Plesetsk (see Imagery Appendix, pg. 17-7) with an announced military payload on board. The satellite was catalogued by the US military as Cosmos 2542 (2019-079A, 44797) in a 97.9° inclination and 370 by 860 km orbit. The mission of the satellite as announced by Russia was to conduct space surveillance as well as Earth remote sensing.⁵⁶ Outside experts have indicated it is likely the second satellite in the Nivelir 14F150 series.⁵⁷ On December 6, Cosmos 2542 released a small subsatellite that was catalogued by the US military as Cosmos 2543 (2019-079D, 44835) and publicly announced by Russia.⁵⁸ Cosmos 2543 remained within 2 km of Cosmos 2542 for three days before it conducted a series of maneuvers to raise its apogee to 590 km by December 16.⁵⁹ Subsequent analysis by amateur observers strongly suggests that the purpose of these maneuvers was to place Cosmos 2543 in an orbit where it can observe a classified US intelligence satellite, USA 245 (2013-043A, 39232), which was launched in 2013 and is believed to be the latest generation of electro-optical imagery satellite operated by the National Reconnaissance Office. The orbits of Cosmos 2543 and USA 245 are synchronized such that Cosmos 2543 came within 20 km of USA 245 several times in January 2020 and since then periodically comes within 150 to 300 km of USA 245 while the latter is illuminated by the Sun and can observe both sides of USA 245 continuously for up to a week at a time.⁶⁰

49 Иван Синергиев, "С космодрома Плесецк запущена ракета-носитель «Рокот» с военными спутниками," *Коммерсантъ*, November 30, 2018, <https://www.kommersant.ru/doc/3814723>.

50 Russian Federation, "Information Furnished in Conformity with the Convention on Registration of Objects Launched into Outer Space," ST/SG/SER.E/906, August 15, 2019, <http://unoosa.org/oosa/en/osoindex/data/documents/ru/st/stsgser.e906.html>.

51 Cees Bassa, Twitter, July 12, 2019, <https://twitter.com/cgbassa/status/1149662117819060224>.

52 "Российский военный спутник-инспектор проверил другой космический аппарат России на орбите," *TASS*, August 1, 2019, <https://tass.ru/kosmos/6724059>.

53 Jonathan McDowell, "Space Activities in 2019," January 12, 2020, pp. 25-28, <https://planet4589.org/space/papers/space19.pdf>.

54 McDowell, "Space Activities in 2019," *ibid.*

55 Data compiled from the public catalog maintained by the US military at <https://Space-Track.org>.

56 "Успешный пуск ракеты-носителя «Союз-2.1в», *TASS*, November 26, 2019, <https://www.roscosmos.ru/27793/>.

57 Bart Hendrickx, posting to the NASASpaceflight.com forums, November 25, 2019, <https://forum.nasaspaceflight.com/index.php?topic=49501.msg2019200#msg2019200>.

58 "Минобороны провело в космосе эксперимент по отделению малого спутника от дупиро аппарата" *TASS*, December 6, 2019, <https://tass.ru/armiya-i-opk/7285111>.

59 Jonathan McDowell, "Space Activities in 2019," January 12, 2020, p. 29, <https://planet4589.org/space/papers/space19.pdf>.

60 Initial observations and analysis were developed by multiple observers on the See-Sat mailing list as documented here <http://www.satobs.org/seesat/Dec-2019/0108.html>. Additional analysis provided by Michael Thompson in a tweet thread posted January 30, 2020, https://twitter.com/M_R_Thomp/status/1222990126650994698. Further analysis by Jonathan McDowell in a tweet thread posted February 1, 2020, <https://twitter.com/planet4589/status/1223420130576818176?s=20>.

- 61 W.J. Hennigan, "Exclusive: Strange Russian Spacecraft Shadowing US Spy Satellite, General Says," *Time*, February 10, 2020, <https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/>.
- 62 "В МИД ответили на обвинения США в преследовании американского спутника", *РИА Новости*, February 17, 2020, <https://ria.ru/20200217/1564880619.html>.
- 63 Michael Thompson (@M_R_Thomp), "Cosmos 2542, the Russian inspection satellite of recent interest, was set to make another set of close passes to USA 245 sometime in the next week," Twitter thread, March 11, 2020, https://twitter.com/M_R_Thomp/status/1237763403231440896?s=20.
- 64 Bart Hendrickx, posting on the NASASpaceflight.com forums, May 15, 2020, <https://forum.nasaspaceflight.com/index.php?topic=49501.msg2082452#msg2082452>.
- 65 Bart Hendrickx, posting on the NASASpaceflight.com forums, June 15, 2020, <https://forum.nasaspaceflight.com/index.php?topic=49501.msg2096595#msg2096595>.
- 66 "Успешно испытан новый военный спутник-инспектор – Минобороны России," *ИНТЕРФАКС-АВН*, July 15, 2020, <https://www.militarynews.ru/story.asp?rid=0&nid=534933&lang=RU>.
- 67 Jonathan McDowell (@planet4589), "I have recalculated the ejection velocity of the Kosmos-2543 projectile. The delta-V between Kosmos-2543 and object 45915 is somewhere between 140 m/s and 186 m/s," Twitter, July 24, 2020, <https://twitter.com/planet4589/status/1286831091857403904?s=20>.
- 68 Jonathan McDowell (@planet4589), "More on Kosmos-2543 and object 45915. The object was ejected during a pass in view of Plesetsk, as seen here," Twitter, July 25, 2020, <https://twitter.com/planet4589/status/1287052396749881344>.
- 69 USSPACECOM Public Affairs Office, "Russia conducts space-based anti-satellite weapons test," US Space Command, July 23, 2020, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2285098/russia-conducts-space-based-anti-satellite-weapons-test/>.
- 70 Ministry of Defence (@DefenceHQ), "Air Vice-Marshal @HarvSmyth, director of the UK's Space Directorate, has responded to a recent Russian satellite test in space," Twitter, July 23, 2020, <https://twitter.com/DefenceHQ/status/1286312151469166592?s=20>.
- 71 "Comment by the Information and Press Department regarding statements by US and British officials about the testing of a Russian satellite," the Ministry of Foreign Affairs of the Russian Federation, July 24, 2020, https://www.mid.ru/en/foreign_policy/news/-/asset_publisher/cKNonkJE02Bw/content/id/4253360.

The close proximity of Cosmos 2543 to USA 245 sparked concerns from the US military. General John Raymond, then Chief of Space Operations for the USSF and Commander of USSPACECOM, stated, "We view this behavior as unusual and disturbing," and compared it to the 2017 separation of Cosmos 2523 that the US military considers to be a weapons test.⁶¹ In a response published by RIA Novosti, the Russian Foreign Ministry denied those accusations, claimed that they were part of a propaganda campaign against Moscow, and stated that Cosmos 2543 did not pose a threat to USA 245 and did not violate any norms or principles of international law.⁶²

A few weeks later, it appears both countries made changes in their satellites' orbits to increase the separation of the two objects. On March 11, 2020, hobbyist tracking showed USA 245 conducted a small maneuver to increase its distance from Cosmos 2542.⁶³ And in late April, Cosmos 2542 lowered its perigee to increase the separation and create a gradual separation in planes between the two satellites.⁶⁴ Cosmos 2542 was decommissioned in May 2023 and re-entered the atmosphere on October 24, 2023.

In June 2020, Cosmos 2543 made a series of maneuvers to place it into RPO with Cosmos 2535, including close approaches within 60 kilometers.⁶⁵ A month later, the Russian Ministry of Defense issued a press report stating that the two satellites had conducted a close-up study of a domestic satellite with the help of specialized equipment on a small satellite.⁶⁶ On July 15, a small piece of orbital debris was spotted in the vicinity of the two satellites that appeared to have separated from Cosmos 2543 at a relative velocity of between 140 and 186 meters per second (313 to 415 miles per hour).⁶⁷ The US military catalogued the released object (Object E, 2019-079E, 45915) on July 16 in a 783 x 504 km orbit, with Cosmos 2543 still in a 617 x 603 km orbit. Jonathan McDowell noted that the release occurred while the objects passed over Plesetsk.⁶⁸ The event was similar in nature to the release of Cosmos 2523 in October 2017, and eventually, two more pieces of small debris were catalogued in proximity to the satellites.

In a press release, USSPACECOM characterized the event as a space-based satellite weapons test and stated that the Russian satellites "displayed characteristics of a space-based weapon."⁶⁹ The head of the United Kingdom's Space Directorate, Air Vice Marshal Harvey Smyth, also released a public statement on Twitter expressing concerns and calling on Russia to avoid further testing.⁷⁰ The following day, the Russian Ministry of Foreign Affairs again denied those claims, stating that this was part of a campaign to discredit Russia's activities in space and that Russia was committed to the peaceful exploration and use of outer space by all states.⁷¹

Cosmos 2535 and Cosmos 2543 remained in close proximity through August 2020, and by August 13, they were joined by Cosmos 2536.⁷² In late September 2020, Cosmos 2535 and Cosmos 2536 were close enough that they are presumed to have docked.⁷³ In mid-October, Cosmos 2536 separated away from Cosmos 2535 to a distance of 20 kilometers.⁷⁴ Cosmos 2543 re-entered the Earth's atmosphere August 26, 2024.

On August 1, 2022, another Russian Soyuz 2.1v launch vehicle from Plesetsk (see Imagery Appendix, pg. 17-07) placed a mysterious satellite, dubbed Cosmos 2558 (2022-089A, 53323) into LEO. The launch timing and initial orbit appeared to coincide with the orbital plane of USA 326 (2022-009A, 51445), a classified NRO imagery satellite that was launched in February 2022. Analysis suggested that the orbits of Cosmos 2558 and USA 326 were very similar in inclination and would periodically come within 60 to 70 km in altitude.⁷⁵ On August 18, 2022, USSPACECOM released a statement condemning Russia for this behavior, calling the activities of Cosmos 2558 "dangerous and irresponsible behavior."⁷⁶ Further analysis confirmed that as of September 2022, Cosmos 2558 had altered its orbit to continue to match the orbital plane of USA 326, although it is not in an actual proximity orbit.⁷⁷ Cosmos 2558 and USA 326 appear to be staying in similar orbits, with Cosmos 2558 getting within 50 km of USA 326 once a week.⁷⁸ In June 2025, Cosmos 2558 released an object, later called Object C (2022-089C, 64627).⁷⁹ Cosmos 2558 is thought to be part of the Nivelir inspector satellite program, as it has been in the orbital plane of USA 326 since its launch. Object C was observed to be maneuvering in respect to Cosmos 2558 through the summer of 2025.⁸⁰

On December 1, 2022, a Soyuz 2.1b launched from Plesetsk placed Cosmos 2565 (2022-163A, 54381) into a 900 km by 239 km at 67.15 degree LEO.⁸¹ Cosmos 2565 is believed to be an electronic intelligence satellite in the Lotos-S1 series, given its orbit matching previous satellites in that constellation. Two days later, Cosmos 2565 had raised its orbit to 912 km by 899 km and released a small satellite, Cosmos 2566 (2022-163C, 54383). In late December, a third object, labeled Object D (2022-163D, 54817) was released from Cosmos 2566. On October 27, 2023, another Soyuz 2.1b from Plesetsk placed Cosmos 2570 (2023-165A, 58148), believed to be another in the Lotos series, into a similar orbital profile. It also released another satellite, Cosmos 2571 (2023-165B, 58172), after circularizing, which once again released a third satellite, catalogued as Object D (2023-165C, 58428) in late November. Commercial satellite tracking firm LeoLabs reported that Object D had maneuvered and performed at least one close pass of Cosmos 2571, potentially as part of an imaging attempt.⁸² However, the activities of these sets of satellites do not appear to constitute sustained RPO, and the deployment of their sub satellites is substantially different than that of Cosmos 2523.

- 72 Bart Hendrickx, posting on the *NASASpaceflight.com* forums, August 13, 2020, <https://forum.nasaspaceflight.com/index.php?topic=49501.msg2119753#msg2119753>.
- 73 Jonathan McDowell (@planet4589), "Kosmos-2535 and Kosmos-2536 have now been within 1 km of each other for a month (and are likely docked). Latest TLEs might suggest they are now separated again, but too early to really be sure - might just be noise in the data," *Twitter*, September 24, 2020, <https://twitter.com/planet4589/status/1309225961070751745?s=20>.
- 73 Jonathan McDowell (@planet4589), "After 1.5 months in the close vicinity of Kosmos-2535 (and maybe docked to it) Kosmos-2536 separated from it on Oct 12 and has now retreated to 20 km from it," *Twitter*, October 16, 2020, <https://twitter.com/planet4589/status/1317161112392126464?s=20>.
- 74 Jonathan McDowell (@planet4589), "After 1.5 months in the close vicinity of Kosmos-2535 (and maybe docked to it) Kosmos-2536 separated from it on Oct 12 and has now retreated to 20 km from it," *Twitter*, October 16, 2020, <https://twitter.com/planet4589/status/1317161112392126464?s=20>.
- 75 Marco Langbroek, "Kosmos 2558, a Russian inspector satellite targeting the US IMINT satellite USA 326?," *SatTrackCam Leiden (b)log*, August 2, 2022, <https://sattrackcam.blogspot.com/2022/08/kosmos-2558-russian-inspector-satellite.html>.
- 76 Brett Tingley, "Pentagon space chief condemns 'irresponsible' launch of Russian inspector satellite," *Space.com*, August 18, 2022, <https://www.space.com/russia-inspector-satellite-kosmos-2558-irresponsible-behavior>.
- 77 Marco Langbroek, "Kosmos 2558 keeping its orbit close to USA 326?," *SatTrackCam Leiden (b)log*, September 9, 2022, <https://sattrackcam.blogspot.com/2022/09/kosmos-2558-keeping-its-orbit-close-to.html>.
- 78 Scott Tilley (@coastal8049), "Nico Janssen noted that the NRO Keyhole USA 326 pursued by COSMOS 2558 had changed it's orbit. We know that historically that KH satellites will typically use their S-band transmitters around orbital changes so I looked for it today and it appears I was rewarded!" posting on X, April 9, 2023, <https://x.com/coastal8049/status/1645197516395397120?s=20>; Marco Langbroek, "The Russian KOSMOS 2576 launch of May 16, and USA 314: another 'inspector satellite'?" [UPDATED], *SatTrackCam Leiden (b)log*, May 20, 2024, <https://sattrackcam.blogspot.com/2024/05/the-russian-kosmos-2576-launch-of-may.html>.
- 79 Marco Langbroek, "Kosmos 2558 released an object on orbit on June 26 [UPDATED]," *SatTrackCam Leiden (b)log*, June 29, 2025, <https://sattrackcam.blogspot.com/2025/06/kosmos-2558-released-object-on-orbit-on.html>.
- 80 Langbroek, "Kosmos 2558 released an object," *ibid.*
- 81 Anatoly Zak, "Soyuz launches military payload," *Russian Space Web*, November 25, 2023, <https://www.russianspaceweb.com/lotos-s1-807.html>.
- 82 Theresa Hitchens, "LeoLabs: Russia, China time suspicious satellite activity for some US holidays," *Breaking Defense*, December 12, 2023, <https://breakingdefense.com/2023/12/leolabs-russia-china-time-suspicious-space-activity-for-some-us-holidays/>.

- 83 Andrew Jones, "Secretive Russian military satellites release mystery object into orbit," *Space.com*, April 3, 2025, <https://www.space.com/space-exploration/satellites/secretive-russian-military-satellites-release-mystery-object-into-orbit>.
- 84 Greg Gillinger, "Checking In With Cosmos 2581/2582/2583," *The Integrity Flash Issue* 133, November 10, 2025, <https://isruniversity.com/2025/11/10/issue-133/#section1>.
- 85 Marco Langbroek, "RPO Galore: the complex proximity operations of Kosmos 2581, Kosmos 2582, Kosmos 2583 and 'Object F,'" *SatTrack-Cam Leiden (b)log*, June 29, 2025, <https://sattrackcam.blogspot.com/2025/06/rpo-galore-complex-proximity-operations.html>.
- 86 Langbroek, "RPO Galore," *ibid*. Great breakdowns of the moves, complete with diagrams, are available here: Greg Gillinger, "Another Look At Cosmos 2581, 2582 & 2583," *The Integrity Flash Issue* 118, April 8, 2025, <https://isruniversity.com/2025/04/07/issue-118/#section1>; and Greg Gillinger, "Dance-Off in LEO: Cosmos 2581 and 2582," *The Integrity Flash Issue* 116, March 9, 2025, <https://isruniversity.com/wp-content/uploads/2025/03/116-9-Mar-2025-Integrity-Flash.pdf>.
- 87 Langbroek, "RPO Galore," *ibid*.
- 88 Langbroek, "RPO Galore," *ibid*.
- 89 Greg Gillinger, "Checking In With Cosmos 2581/2582/2583," *ibid*.
- 90 Anatoly Zak, "Proton Successfully Returns to Flight Delivering a Secret Olymp Satellite," *Russian Space Web*, October 19, 2015, <http://www.russianspaceweb.com/olymp.html>.
- 91 United Nations Secretariat, "Note verbale" dated 10 December 2015 from the Permanent Mission of the Russian Federation to the United Nations (Vienna) addressed to the Secretary-General, February 1, 2016, <https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=ST/SG/SER.E/761>.

Three satellites were launched in February 2025 on a Soyuz-2.1V launch vehicle from Plesetsk: Cosmos 2581 (2025-026A, 62902), Cosmos 2582 (2025-026B, 62903), and Cosmos 2583 (2025-026C, 62904).⁸³ Their given mission was just that they were for the "Ministry of Defense."⁸⁴ Originally, Cosmos 2581 was put in an orbit of 595 x 578 km; Cosmos 2582, 597 x 576 km orbit; and Cosmos 2583, 597 x 580 km.⁸⁵ Cosmos 2581 and Cosmos 2582 started conducting RPOs, at times getting less than 1 km from each other, with Cosmos 2582 moving and Cosmos 2581 being the recipient of the RPOs.⁸⁶ In March 2025, Cosmos 2583 released "Object F" (2025-026F, 63330) and started conducting RPOs with it.⁸⁷ Cosmos 2583 maneuvered away from Object F in May 2025 to get close to Cosmos 2581 (at times, getting within several hundred meters in early June 2025); they were joined by Cosmos 2582 in late June 2025.⁸⁸ These RPOs continued throughout the year; US commercial SSA company COMPSOC released data that showed Cosmos 2581 and Cosmos 2583 conducting RPOs in October 2025, getting within 80 m of each other at least once.⁸⁹

Recent Rendezvous and Proximity Operations in GEO

Russian RPO activities have also occurred in GEO. On September 28, 2014, a Proton-M SLV was launched from Baikonur Cosmodrome. Onboard was a satellite built for the Russian Ministry of Defence and Federal Security Service (FSB), which was destined for the GEO region. The name of the satellite is not precisely known, with manufacturer documents referring to it as "Olymp" or "Olymp-K."⁹⁰ Russian filings with the United Nations reference the satellite as "Luch,"⁹¹ which is a series of Russian "bent pipe" data relay satellites, while the USAF called it Luch (Olymp) (2014-058A, 40258).

The launch proceeded the same as many other Russian GEO launches. The initial set of burns placed the Briz-M upper stage and Luch payload into an initial highly elliptical GTO. Roughly nine hours after launch, the Briz-M upper stage executed a burn to (mostly) circularize the orbit at near GEO altitude and also zero out the inclination. After separating from Luch, the Briz-M then conducted another burn to boost it out of the active GEO belt and into a disposal orbit above GEO in accordance with the IADC debris mitigation guidelines.

Over the next several months, Luch conducted a series of maneuvers that brought it close to other operational satellites around the GEO belt. The launch process left Luch at approximately 57 degrees east longitude, roughly due south of Yemen and the tip of the Arabian Peninsula. It originally began to drift eastward, towards the Indian Ocean, but around October 7, changed its orbit to begin drifting westward back towards Africa at a relatively high rate. Towards the end of October, it began to slow its drift rate, and around October 28, appeared to settle into position at around 52–53 degrees east. The only known Russian orbital slot nearby was that of the Express AM-6, a Russian commercial communications satellite that was launched on October 21, 2014. Luch stayed in this general area for nearly three months.

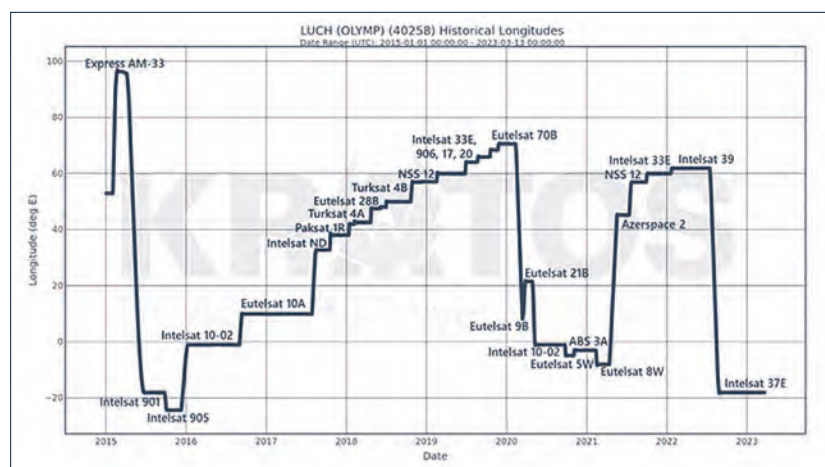
In late January 2015, Luch began to move again. By January 31, it had begun to drift eastwards again, at what began as a fairly relatively high rate and slowed over time. It eventually arrived near 95–96 degrees east longitude, almost due south from Myanmar, around February 21. Observers once again wondered why Luch was in this area and hypothesized that it might be due to the presence of the Russian Luch 5V satellite (2014-023A, 39727), which was launched on April 28, 2014.

Around April 4, 2015, Luch began to move again. This time it began to drift westward at a lower rate, eventually coming to a stop around 18.1 degrees west, due south of the very western tip of Africa, on June 25, 2015. Observers began to wonder why it stopped at this location, noticing that there were no

Russian satellites in the area. However, this location did place Luch in between two operational Intelsat satellites, Intelsat 7 (1998-052A, 25473) at 18.2 degrees west and Intelsat 901 (2001-024A, 26824) at 18 degrees west, where it remained until mid-September.

On September 25, 2015, Luch left its parking spot between the Intelsat satellites and began to drift again, heading westward. Over the next several months, it made several more stops around the GEO belt. In September 2018, the French Defense Minister stated that Luch made a “too close approach” of a French-Italian military communications satellite in late 2017.⁹² Jonathan McDowell noted that the satellite was likely Athena-Fidus (2014-006B, 39509) and the close approach likely happened around October 20, 2017, as part of a move to place Luch close to Paksat-1R (2011-042A, 37779), a Pakistani communications satellite.⁹³ In spring 2019, Luch even approached China’s TJS-3 satellite and its apogee kick motor, getting within 30 km of them; this appears to have been the first time a Russian satellite conducted this type of RPO with a Chinese satellite.⁹⁴ During its time on orbit, Luch parked near more than two dozen commercial communications satellites for periods ranging from a few weeks to nine months,⁹⁵ and typically close enough to be within the typical ground terminal uplink window.⁹⁶ The closest known approach was with 1.8 km of Intelsat 36.⁹⁷ It was put in a graveyard orbit in October 2025⁹⁸; prior to that, the last time it had been seen maneuvering was in August 2022. In January 2026, a Swiss SSA company posted videos of Luch undergoing a fragmentation event and tumbling.⁹⁹ It is unclear what the cause was; possibilities include an impact with a piece of debris or non-passivated fuel sources exploding.¹⁰⁰ It was equipped with KM-60 Hall-effect ion thrusters that were known to be designed to be ignited 8,250 times and operate over 4000 hours.¹⁰¹ The orbital history of Luch is documented in Figure 2-2.

FIGURE 2-2 – LUCH (OLYMP) ORBITAL HISTORY



A compilation of Luch’s orbital history and satellites visited before it was placed in a graveyard orbit in October 2025. Credit: Kratos.

Open source research has revealed more details about the originals of the Luch Olymp program. The ground-based RF tracking firm Kratos conducted an analysis of the activities of both Luch Olymp satellites and concluded they are likely being used for a signals intelligence mission, which is done by parking close enough to a target satellite to collect RF signals uplinked to it.¹⁰² This conclusion is corroborated by sources from within the Russian space agency who have stated that the satellite is called Olimp and had been ordered by the FSB for a signals intelligence mission, which it accomplishes by parking close enough to a target satellite to intercept uplinked radiofrequency signals.¹⁰³

- 92 John Leicester, Sylvie Corbert, Aaron Mehta, “Espionage: French defense head charges Russia of dangerous games in space,” *Defense News*, September 7, 2018, <https://www.defensenews.com/space/2018/09/07/espionage-french-defense-head-charges-russia-of-dangerous-games-in-space/>.
- 93 Jonathan McDowell (@planet4589), “OK, let’s talk about this story about Luch-Olimp passing “too closely” to the French-Italian military communications satellite ATHENA-FIDUS,” Twitter thread, September 7, 2018, <https://twitter.com/planet4589/status/1038147610073341953>.
- 94 David D. Chen and Peter Singer, “Fast movers: Chinese satellites zoom around for inspections—or interference,” *Defense One*, May 20, 2024, <https://www.defenseone.com/threats/2024/05/fast-movers-meet-chinese-satellites-zoom-around-inspections-or-interference/396714/>.
- 95 Marco Langbroek, “LUCH (Olymp-K), an eavesdropping SIGINT snooping around commercial comsats,” *SatTrackCam Leiden (b) log*, April 6, 2021, <https://sattrackcam.blogspot.com/2021/04/luch-olymp-k.html/>.
- 96 Bob Hall, “Luch Space Activities,” *AGI web series*, Ep. 14, June 26, 2019, <https://youtu.be/D67dg9P3eDY>.
- 97 Hall, “Luch Space Activities,” *ibid*.
- 98 Slingshot Aerospace, “Slingshot Orbital Alert: Russia’s Luch (Olymp) has parked in Graveyard Orbit,” *LinkedIn*, October 29, 2025, https://www.linkedin.com/posts/slingshot-aero-space_slingshot-orbital-alert-russias-luch-activity-7389344239664459776-C73Y/.
- 99 s2a systems, “LUCH (OLYMP) has started to tumble in its graveyard orbit tonight,” *Twitter*, January 30, 2026, https://x.com/s2a_systems/status/2017162450001420602.
- 100 Andrew Jones, “Russian ‘inspector’ satellite appears to break apart in orbit, raising debris concerns,” *Space.com*, January 30, 2026, <https://www.space.com/space-exploration/launch-es-spacecraft/russian-inspector-satellite-appears-to-break-apart-in-orbit-raising-debris-concerns>.
- 101 Bart Hendrickx posting on the *NASASpaceflight.com* forum, April 10, 2025, <https://forum.nasaspaceflight.com/index.php?PHPSESSID=mth-3l3pmgs5u49fmqvflqbj7c&topic=34315.msg2678514#msg2678514>.
- 102 Michael Clonts, “Espionage in Orbit: Satellite or Spy?,” *Kratos*, April 17, 2023, <https://www.kratosdefense.com/constellations/articles/espionage-in-orbit-satellite-or-spy>.
- 103 Bart Hendrickx, “Olimp and Yenisi-2: Russia’s secretive eavesdropping satellites (part 1),” *The Space Review*, November 20, 2023, <https://www.thespacereview.com/article/4696/1>.

104 Justin Mooney, "Russian Proton-M launches Olymp-K-2 military satellite," *Nasaspaceflight.com*, March 12, 2023, <https://www.nasaspaceflight.com/2023/03/proton-olymp-k-2/>.

105 Brian Weeden, "Our Satellite Dashboard shows this new Luch hung out near the Space Force WGS F2 near 60E from April 7 to May 5, then the Eutelsat 9A/9B/10A at 9E and 10E from May 20 until Sept 23, at times coming well within 10 km", posting on X, October 4, 2023, <https://twitter.com/brianweeden/status/1709622408288543076>.

106 Marco Langbroek, "Dark moves at Geosynchronous altitude: Mentor 6 and Luch (Olymp) 2 have repositioned," *SatTrackCam Leiden (b)log*, April 23, 2024, <https://sattrackcam.blogspot.com/2024/04/dark-moves-at-geosynchronous-altitude.html>.

107 Marco Langbroek, "The Russian SIGINT satellite LUCH (OLYMP) 2 has arrived at its new destination, next to THOR 7," *SatTrackCam Leiden (b)log*, July 7, 2024, <https://sattrackcam.blogspot.com/2024/07/the-russian-sigint-satellite-luch-olymp.html>.

108 "The Russian SIGINT satellite LUCH (OLYMP-K) 2 has moved again," *SatTrackCam Leiden (b)log*, September 21, 2024, <https://sattrackcam.blogspot.com/2024/09/the-russian-sigint-satellite-luch-olymp.html>.

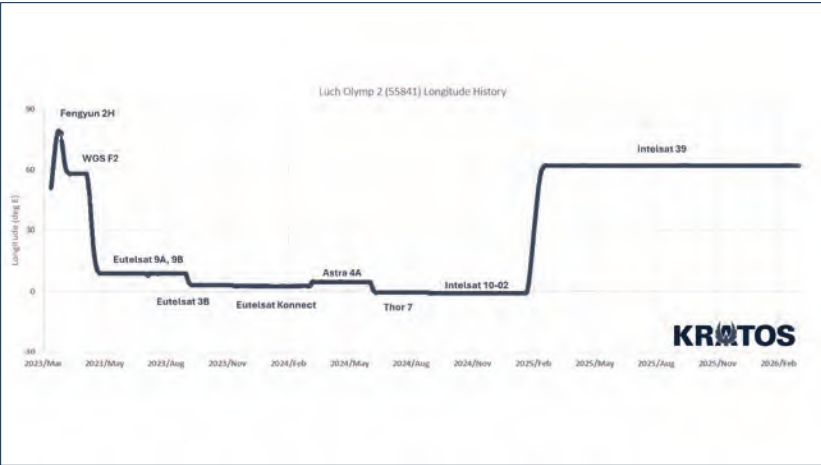
109 Sandra Erwin, "Russian spy satellite reportedly continues suspicious maneuvers," *SpaceNews*, June 27, 2024 <https://spacenews.com/russian-spy-satellite-reportedly-continues-suspicious-maneuvers/>.

110 Marco Langbroek, "The Russian eavesdropping satellite LUCH (OLYMP-K) 2 has moved significantly," *SatTrackCam Leiden (b)log*, March 14, 2025, <https://sattrackcam.blogspot.com/2025/03/the-russian-eavesdropping-satellite.html>.

On March 12, 2023, a Russian Proton-M rocket from Baikonur Cosmodrome placed another satellite in GEO that has since behaved very similar to Luch.¹⁰⁴ This new satellite, catalogued as Luch Olymp 2 (2023-031A, 55841), and designated Luch 5X in registration filings with the United Nations, appears to have resumed the RPO activities of the original Luch. It was briefly near the Russian military satellite Cosmos 2533 (2018-107A, 43867) near 70 degrees east longitude on March 18 and the US Space Force's WGS F2 (2009-17A, 34713) military communications satellite near 60 degrees east longitude from April 7 to May 5. It has since spent much longer periods of time next to Eutelsat 9B (2016-005A, 41310) and Eutelsat KA-SAT 9A (2010-069A, 37258) at 9 degrees east longitude from May 20 until September 23, Eutelsat 3B (2014-030A, 39773) from October 7 to December 5, and by Eutelsat Konnect VHTS (2022-110A, 53765) at 2.7 degrees east on December 6, 2023.¹⁰⁵ Luch 2 moved from March 26-April 2, 2024, to get to longitude 4.75 E, near satellite ASTRA 4A (2007-057A, 32299).¹⁰⁶ It then relocated in July 2024 to longitude 0.54 W to be near THOR 7 (2015-022A, 40613).¹⁰⁷ Two months later, it then moved to be in between THOR 6 (2009-058B, 36033) and INTELSAT 1002 (2004-022A, 28358).¹⁰⁸ US commercial SSA company Slingshot Aerospace has been tracking Luch 2 and noted in June 2024 the following satellites with which it had made the closest approaches: "EUTE KA SAT 9A (KA SAT [2010-069A, 37258]) (~20 km), EUTELSAT 9B [2016-005A, 41310] (~43 km), EUTE 3B [2014-030A, 39773] (~38 km), RASCOM QAF 1R [2010-037B, 36831] (~163 km), EUTE 3C (HB 10) [2009-008B, 33750] (~220 km), EUTE KONNECT VHTS [2022-110A, 53765] (~30 km), RASCOM QAF 1R (~137 km), ASTRA 4A (SIRIUS 4) [2007-057A, 32299] (~45 km), SES 5 [2012-036A, 38652] (~154 km), INTELSAT 3-F7 [1970-032A, 4376] (~228 km)."¹⁰⁹ It continued to move along the GEO belt roughly every two to four months, always positioning itself so it could conduct RPOs with commercial satellites.¹¹⁰ From September 2024 to February 2025 it was in the rough proximity of INTELSAT 1002, at which point it drifted eastward for about a month until stopping at 62 E- INTELSAT 39 (2019-049B, 44476).

The orbital history of Luch 2 is documented in Figure 2-3.

FIGURE 2-3 – LUCH 2 ORBITAL HISTORY



A compilation of Luch's orbital history and satellites visited. Credit: Kratos.

All the recent Russian RPO activities in LEO and GEO are summarized in Table 2-3.

TABLE 2-3 – RECENT RUSSIAN RPO

DATE(S)	SYSTEM(S)	ORBITAL PARAMETERS	NOTES
Jun. 2014 – Mar. 2016	Cosmos 2499, Briz-KM R/B	1501 x 1480 km; 82.4°	Cosmos 2499 did a series of maneuvers to bring it close to, and then away from, the Briz-KM upper stage.
Apr. 2015 – Apr. 2017	Cosmos 2504, Briz-KM R/B,	1507 x 1172 km; 82.5°	Cosmos 2504 maneuvers to approach the Briz-KM upper stage and may have had a slight impact before separating again.
Mar. – Apr. 2017	Cosmos 2504, FY-1C Debris	1507 x 848 km; 82.6°	After a year of dormancy, Cosmos 2504 did a close approach with a piece of Chinese space debris from the 2007 ASAT test.
Oct. 2014 – Oct. 2025	Luch, (Olymp), Multiple	35,600 km, 0°	Luch parked near more than two dozen communications satellites, including those owned by Russia, China, the United States, Pakistan, Turkey, the United Arab Emirates, France, and Italy.
Aug. – Oct. 2017	Cosmos 2521, Cosmos 2519, Cosmos 2523	670 x 650 km; 97.9°	Cosmos 2521 separated from Cosmos 2519 and performed a series of small maneuvers to do inspections before redocking with Cosmos 2519. Cosmos 2523 separated from Cosmos 2521 but did not maneuver on its own.
Mar. – Apr. 2018	Cosmos 2521, Cosmos 2519		Cosmos 2521 conducted close approaches of Cosmos 2519.
Aug. – Dec. 2019	Cosmos 2535, Cosmos 2536	623 x 621 km; 97.88°	Cosmos 2535 and Cosmos 2536 conducted at least 25 individual RPO operations to within 2 km and as far apart as 380 km.
Dec. 2019 – Mar. 2020	Cosmos 2542, Cosmos 2543, USA 245	859 x 590 km; 97.9°	Cosmos 2542 released Cosmos 2543. Cosmos 2542 did station keeping with Cosmos 2542, then raised its orbit to come within 30 km of USA 245 and establish repeated close approaches within 150 km, likely for the purpose of surveillance. Cosmos 2542 also made close approaches to USA 245.
Jun. – Oct. 2020	Cosmos 2543, Cosmos 2535		Cosmos 2543 rendezvoused with Cosmos 2535 and released a small object at high relative velocity. In Sept., Cosmos 2536 joined in the RPO with the other two and may have docked with Cosmos 2535.
Feb. 2022 - May 2024?	Cosmos 2558, USA 326		Cosmos 2558 has matched the orbital plane of USA 326 and conducted repeat close approaches, getting within 50 km of USA 326 once a week.
Nov. 2022	Cosmos 2562, Resurs-P3	400 x 385 km; 97.2°	A formerly inactive Russian Earth observation satellite, Resurs-P3, performed a large maneuver to drop its orbit by 20 km, and on November 22, Cosmos 2562 maneuvered to conduct an RPO of Resurs-P3.
Mar. 2023 – present	Luch (Olymp) 2, Multiple	35,600 km, 0°	Luch 2 has parked next to multiple American and European communications satellites.
Feb. 2025 – present	Cosmos 2581, Cosmos 2582, Cosmos 2583	82 ° inclined orbit: Cosmos 2581 was initially placed in a 595 x 578 km orbit; Cosmos 2582 in a 597 x 576 km orbit; and Cosmos 2583 in a 597 x 580 km orbit.	The three satellites have been conducting RPOs since their launch, alternating pairing off and switching which one is the target and which one is the chaser.
Jun. 2025 – present?	Cosmos 2558, Object C, USA 326	~450 km	Cosmos 2558 released Object C in June 2025; Object C conducted RPOs around it (Cosmos 2558 had not maneuvered since April 2025). By July 2025, Object C was conducting close approaches to USA 326.
Jun. 2025 – Nov. 2025	Cosmos 2589, Cosmos 2590	HEO with an apogee of 51,200 km and a perigee of 20,374 km; in November 2025, Cosmos 2589 started to circularize its orbit to get to GEO	Cosmos 2589 released an object- Object C -that later was catalogued as Cosmos 2590. Cosmos 2590 conducted RPOs around Cosmos 2589.

- 111 Bart Hendrickx, "Project Numizmat," *NASASpaceflightForums.com*, April 9, 2020, <https://forum.nasaspaceflight.com/index.php?topic=47851.new#new>.
- 112 T. Thayaparan and C. Wernik, "Noise Radar Technology Basics," *Defence Research and Development Canada*, December 2006, <https://cradpdf.drdc-rddc.gc.ca/PDFS/unc55/p526766.pdf>.
- 113 Bart Hendrickx, "Re: Soyuz-2.1v/Volga - Kosmos 2561/2562 - Plesetsk 43/4 - 21 Oct 2022 19:20 UTC," *NASASpaceflightForums.com*, January 9, 2023, <https://forum.nasaspaceflight.com/index.php?topic=57374.msg2447737#msg2447737>.
- 114 Sandra Erwin "LeoLabs data shows on-orbit maneuvers by Russian satellites," *SpaceNews*, November 6, 2023, <https://spacenews.com/leolabs-data-shows-on-orbit-maneuvers-by-russian-satellites/>.
- 115 Jeff Foust, "US claims recently launched Russian satellite is an ASAT," *SpaceNews*, May 21, 2024, <https://spacenews.com/u-s-claims-recently-launched-russian-satellite-is-an-asat/>.
- 116 Guy Faulconbridge, "Russia denies US charge that it put anti-satellite weapon in space," *Reuters*, May 22, 2024, <https://www.reuters.com/world/russia-dismisses-us-claim-that-moscow-put-an-anti-satellite-weapon-space-2024-05-22/>.
- 117 Marco Langbroek, "The Russian KOSMOS 2576 launch of May 16, and USA 314: another 'inspector satellite'? [UPDATED]," *SatTrackCam Leiden (b)log*, May 20, 2024, <https://sattrackcam.blogspot.com/2024/05/the-russian-kosmos-2576-launch-of-may.html>; "Topic: Soyuz-2.1a - Kosmos-2579 (Bars-M №6) - Plesetsk, 43/4 - 31 October 2024 (07:51:31 UTC)," *Nasa Spaceflight News Forum*, October 25, 2024, <https://forum.nasaspaceflight.com/index.php?topic=61767.0>.
- 118 Marco Langbroek, "Kosmos 2588 has been placed in the same orbital plane as the US spy satellite USA 338: another RPO?," *SatTrackCam Leiden (b)log*, May 23, 2025, <https://sattrackcam.blogspot.com/2025/05/kosmos-2588-has-been-placed-in-same.html>.
- 119 Langbroek, "Kosmos 2588," *ibid*; Bart Hendrickx, posting on *NASA Spaceflight News Forum*, May 23, 2025, <https://forum.nasaspaceflight.com/index.php?topic=62904.msg2688245#msg2688245>; Theresa Hitchens, "Russia's new Cosmos satellite orbiting near US sat, piques ASAT fears," *Breaking Defense*, May 30, 2025, <https://breakingdefense.com/2025/05/russias-new-cosmos-satellite-orbiting-near-us-sat-piques-asat-fears/>.
- 120 Langbroek, "Kosmos 2588," *ibid*.
- 121 Hitchens, "Russia's new Cosmos satellite," *ibid*.

Russia appears to have started a new initiative to develop more advanced sensor technologies for RPO. Project Numizmat was started in 2014 and appears to involve the development of a space-based ultra-wideband (UWB) radar payload.¹¹¹ UWB radar broadcasts relatively low power signals over a very wide swath of spectrum, often more than 500 megahertz. A specific type called UWB noise radar has inherent immunity from jamming, detection, and external interference.¹¹² Such a payload could have significant benefits for RPO and co-orbital ASAT weapons. On October 21, 2022, Russia launched two satellites, Cosmos 2561 (2022-137A, 54109) and Cosmos 2562 (2022-137B, 54110), into LEO on a Soyuz-2.1v rocket. Initial analysis suggests they are two new types of satellites (designated 14F164 and 14F172) and may be part of the Numizmat program.¹¹³ On November 15, 2022, a formerly inactive Russian Earth observation satellite, Resurs-P3 (2016-016A, 41386), performed a large maneuver to drop its orbit by 20 km, and on November 22, Cosmos 2562 maneuvered to conduct an RPO of Resurs-P3. US commercial SSA company LeoLabs assessed Cosmos 2562 as highly likely to have an electro-optical payload [that] collected high-resolution imagery of Resurs-P3.¹¹⁴ This suggests Cosmos 2562 was attempting to inspect Resurs-P3 to diagnose the anomaly that led to its initial failure. Cosmos 2562 subsequently re-entered the atmosphere on November 8, 2023.

During UN Security Council (UNSC) debates about nuclear weapons placed in space (discussed in Section 2.4, Russian Directed Energy Weapons), in May 2024, the US representative in the UNSC, Amb. Robert Wood, claimed that Russia had launched on May 16 a satellite (Cosmos 2576, 2024-092A, 59773) that "the United States assesses is likely a counterspace weapon, presumably capable of attacking other satellites in low Earth orbit," and that "Russia deployed this new counterspace weapon into the same orbit as a US government satellite."¹¹⁵ While Russian officials denied this as "fake news,"¹¹⁶ outside experts noted that Cosmos 2576 was co-planar with USA-314, a US intelligence satellite, and that it was likely that Cosmos 2576 is a Nivelir inspection satellite.¹¹⁷ Another Russian satellite that was recently put in a very similar orbit with a US optical reconnaissance satellite was Cosmos 2588 (2025-109A, 64095).¹¹⁸ Launched in May 2025 from Plesetsk Cosmodrome, it was placed in a 464 x 481 km, 73 degree-inclined orbit; observers noted that it was in an orbit very similar to that of USA 338 (2022-117A, 53883), a satellite thought to be one of the NRO's Crystal constellation, KH-series electro-optical satellites.¹¹⁹ Because it did not move on - that is to say, inspect and then go to another satellite - some analysts think that it and Cosmos 2576 (which also had not moved out of its orbital plane) might be demonstrating a "sleeping co-orbital ASAT capacity."¹²⁰ US SSA company Slingshot Aerospace posted, "According to Slingshot Seradata open-source information, COSMOS 2588 is thought to be a NIVELIR military inspection satellite with a suspected kinetic weapon onboard;" it is unclear how they came to the conclusion that it may have a kinetic weapon.¹²¹

Cosmos 2589 (2025-131A, 64467) was launched in June 2025 from Plesetsk Cosmodrome via an Angara A5 rocket - the first flight of the rocket with real payloads; this was after over 30 years of development - and put into a HEO orbit around the equator with a perigee of about 20,000 km and an apogee of about 50,000 km.¹²² A few days later, an object was seen separating from Cosmos 2589;¹²³ it was later called Object C and then eventually catalogued as Cosmos 2590 (2025-131C, 64527).¹²⁴ Cosmos 2589 and Cosmos 2590 conducted RPOs through July 2025, at one point getting less than 1 km from each other.¹²⁵ US commercial SSA company COMSPOC released a video of the two conducting RPOs in July 2025.¹²⁶ In early August 2025, Cosmos 2590 maneuvered and the two satellites pulled away from each other over the first part of the month and stopped conducting RPOs; by the end of the month, Cosmos 2590 had maneuvered enough so that the two could conduct RPOs.¹²⁷ Cosmos 2589 and Cosmos 2590 conducted RPOs in the first half of November staying within two kilometers of each other for nearly two weeks; Cosmos 2590 was the chaser and Cosmos 2589 was the target, as had been their norm.¹²⁸ In mid-November 2025, Cosmos 2589 had started conducting maneuvers to circularize its orbit, which would eventually allow it to join the GEO belt; Cosmos 2590 stopped maneuvering in early December 2025.¹²⁹

In December 2025, news emerged that two NATO intelligence services believed Russia to be working on a “zone effect” weapon that would distribute hundreds of thousands of pellets to Starlink orbits with the goal of degrading or even destroying multiple Starlink satellites.¹³⁰ The thinking is that the pellets would be too small to detect - maybe millimeter-sized - and thus Russia would have plausible deniability that it was responsible for the weapon. The Russian government has not commented on the reports. Analysts are unclear how effective this would be and point out that this would be an uncontrollable weapon: once the pellets have been released, they cannot be controlled and thus can threaten any satellite in orbit, including those of Russia and its allies.

Potential Military Utility /

The most likely military utility for the Cosmos 2499, Cosmos 2504, Cosmos 2519, Cosmos 2535, Cosmos 2542, Cosmos 2543, and Luch satellites is for on-orbit inspection, surveillance, and intelligence collection. Given that Cosmos 2542 and then Cosmos 2543 were co-planar with USA 245, Cosmos 2558 is co-planar with USA 326, Cosmos 2576 is co-planar with USA 314, and Cosmos 2588 is co-planar with USA 338, those satellites are suspected to possibly be part of the Nivelir program; Cosmos 2519 and Cosmos 2535 are also thought to be so.¹³¹ Although the program appears to share some heritage with the Naryad program, their actual behavior on orbit has been different than that of the IS kinetic co-orbital interceptor. The operational pattern of the Cosmos 2499 and Cosmos 2504 satellites is consistent with slow, methodical, and careful approaches to rendezvous with other space objects in similar orbits. The other space objects they approached were in largely similar orbits to their own, and only involved changes in altitude or phasing and not significant changes in inclination. This behavior is similar to several US RPO missions to test and demonstrate satellite inspection and servicing capabilities, in particular, XSS-11 and Orbital Express (see US Co-Orbital ASAT, Section 1.1). Such inspection or surveillance could be used to support target identification and tracking for attacks by other counterspace capabilities.

The on-orbit behavior of both Luch satellites strongly suggest a signals intelligence collection mission to intercept broadcasts aimed at other GEO satellites and possibly also to inspect other GEO satellites. Luch’s approach to

122 Stephen Clark, “It’s hunting season in orbit as Russia’s killer satellites mystify skywatchers,” *Ars Technica*, July 11, 2025, <https://arstechnica.com/space/2025/07/its-hunting-season-in-orbit-as-russias-killer-satellites-mystify-sky-watchers/>.

123 s2a Systems, “A few images of COSMOS 2589 and the UNID that is moving away from it, which we noticed for the first time in the night from June 21 to 22,” *Bluesky*, June 26, 2025, <https://web-cdn.bsky.app/profile/s2a-systems.bsky.social/post/3lsk37tqr22d>.

124 Greg Gillinger, “Updates!” *The Integrity Flash issue 126*, August 3, 2025, <https://isruniversity.com/2025/08/04/issue-126/>; s2a Systems, “A few images of COSMOS 2589 and the UNID that is moving away from it, which we noticed for the first time in the night from June 21 to 22,” *Bluesky*, June 26, 2025, <https://web-cdn.bsky.app/profile/s2a-systems.bsky.social/post/3lsk37tqr22d>.

125 Gillinger, “Updates!” *ibid*.

126 “Video: Cosmos 2589 and Cosmos 2590,” COMSPOC, September 15, 2025, <https://www.comspoc.com/videos/cosmos-2589-cosmos-2590#content-detail>.

127 Greg Gillinger, “Russia update: Cosmos 2589 and Object C,” *The Integrity Flash issue 127*, August 18, 2025, <https://isruniversity.com/2025/08/18/issue-127/#section-6>; Greg Gillinger, “Russia: Object C Renews RPO with Cosmos 2589,” *The Integrity Flash issue 128*, August 30, 2025, <https://isruniversity.com/2025/09/02/issue-128/>.

128 Greg Gillinger, “Cosmos 2589 Moving to GEO,” *The Integrity Flash issue 135*, December 8, 2025, <https://isruniversity.com/2025/12/08/the-integrity-flash-issue-135/#section1>.

129 Greg Gillinger, “Update: Cosmos 2589 Inching Toward GEO,” *The Integrity Flash issue 137*, January 19, 2026, <https://isruniversity.com/2026/01/19/issue-137/#tb12>.

130 John Leceister, “Starlink in the crosshairs: How Russia could attack Elon Musk’s conquering of space,” *Associated Press*, December 22, 2025, <https://apnews.com/article/russia-starlink-musk-ukraine-space-china-canada-c69c1f-da5ffc93828712ab723e606a2c>.

131 Theresa Hitchens, “Russia’s new Cosmos satellite orbiting near US sat, piques ASAT fears,” *Breaking Defense*, May 30, 2025, <https://breakingdefense.com/2025/05/russias-new-cosmos-satellite-orbiting-near-us-sat-peqies-asat-fears/>; Bart Hendrickx, “Project Nivelir: Russia’s inspection satellites (part 1),” *The Space Review*, April 28, 2025, <https://thespacereview.com/article/4979/1>.

the other satellites in GEO was consistent with the way other active satellites in the GEO belt relocate to different orbital slots. It is also not unusual for satellites to be co-located within several tens of kilometers to share a GEO slot, although it is rare for them to approach within the 10 km that both Luchs have done. Documents from Russian industry further indicate links to a military satellite communications program, heritage to the Luch series of relay satellites, and an intelligence mission. Likely examples of the former are the activities of the US PAN satellite (35815, 2009-047A) between 2009 and 2014 (see US Co-Orbital ASAT, Section 1.1) and the Chinese SJ-17 satellite (40258, 2014-058A) in 2017 (see Chinese Co-Orbital ASAT, Section 3.1).

While the known on-orbit activities of Cosmos 2499, Luch, Luch 2, Cosmos 2504, Cosmos 2519, or Cosmos 2542 did not include explicit testing of offensive capabilities or aggressive maneuvers, it is possible that the technologies they tested could be used offensively in the future. One potential offensive use would be to get a radio frequency jammer close to a satellite, thereby greatly amplifying its ability to interfere with the satellite's communications.

The RPO activities of Cosmos 2535 and Cosmos 2536 are more troubling, given the research papers linking them to the deployment of aerosols or particulate clouds and the unexplained orbital debris generated by their RPO activities. Furthermore, the high-speed deployment of Cosmos 2523 from Cosmos 2521 and another object from Cosmos 2543 suggests they may be part of an ASAT interceptor deployment test, potentially linked to the Burevestnik program.

The most recent activities of Cosmos 2566 and Cosmos 2570, including their deployment of multiple nested subsatellites, appear to be substantially different from the nested subsatellite deployed by Cosmos 2519. They occurred at much lower relative velocities, suggesting they were not weapons tests and are more likely small science or possibly inspection payloads.

It may be possible to use any of these RPO satellites as a potential weapon. The onboard tracking and guidance systems used for rendezvous could be used to try and physically collide with another satellite to damage or destroy it. However, the approach would have to involve much higher relative velocities than Russian RPO satellites have demonstrated to date, and potentially involve higher velocities and distances than what these satellites are capable of. Furthermore, the deliberate maneuvering to create a conjunction with the target satellite would be detectable with existing processes already in place to detect accidental close approaches. Warning time of such a close approach would likely be at least hours (for LEO) or days (for GEO), unless the attacking satellite was already in a very similar orbit.

2.2 – RUSSIAN DIRECT-ASCENT ASAT

Assessment /

Russia has long had the potential for a DA-ASAT capability through its historical ballistic missile defense capabilities and had DA-ASAT development programs in the past that never fully became operational. In November 2021, after more than a decade of development and testing, Russia successfully demonstrated a DA-ASAT capability against a LEO satellite. It is unclear whether this system, the Nudol, will become operational soon, and it does not appear to have the capability to threaten targets beyond LEO.

Specifics /

The Russian DA-ASAT capabilities currently consist of three primary programs which have direct or indirect counterspace capabilities:

1. **Nudol:** a current ground-launched ballistic missile that has demonstrated the ability to destroy a LEO satellite;
2. **78M6 Kontakt:** a Cold War-era air-launched ballistic missile that was designed to be launched from a fighter plane and was rumored to be in active development again; and
3. **S-500:** a next-generation exoatmospheric ballistic missile defense system, still several years from deployment, that may have capabilities against targets in low LEO orbits.

All three have their roots in Soviet-era programs but have been revived or reconstituted in recent years.

14A042 Nudol

The Soviet missile defense system A-135, first released in June 1978, was developed by the Vypmel division of the Tactical Missile Corporation, which oversees Russia's multilayered missile defense architecture.¹³² The A-135 system included two missile interceptors, the exoatmospheric 51T6 (NATO designation "SH-11 Gorgon") and the endoatmospheric 53T6 (NATO designation "Gazelle"). While the system at the time possessed some dual-use potential for use as an ASAT, it was sharply limited and has likely since been eliminated by the retirement of the 51T6.¹³³

Designs for the would-be replacement, the A-235 missile defense system, under the Russian codename Samolyot-M, first surfaced in 1985–1986, though little came of it at the time.¹³⁴ The system includes the 53T6M, an upgraded version of the Gazelle, as its short-range interceptor but does not appear to have a DA-ASAT capability at this time.

In August 2009, the PVO (Russian space defense company) Almaz-Antey signed a contract with the Russian Ministry of Defense, followed by subcontracts with OKB Novator and KB Tochmash (also known as the Nudelman Design Bureau) to work on a separate program called Nudol (US designation PL-19).¹³⁵ KB Tochmash had previously developed a cannon for the Almaz military space station and worked on several other Soviet-era counterspace programs and OKB Novator has a long history developing long-range anti-aircraft missiles. In 2010, Almaz-Antey began technical design work based on those initial blueprints and entered prototyping and initial production of various software and hardware components over the next several years.¹³⁶ Individual components were tested in 2012¹³⁷ and initial non-flight testing of the system as a whole was successfully conducted in 2013.¹³⁸ In 2013, a second contract was signed between the Ministry of Defense and Almaz-Antey that also includes the Moscow Institute of Thermal Technology, which specializes in long-range solid fuel ballistic missiles, as a subcontractor instead of OKB Novator.¹³⁹ The second contract was for a system called Aerostat, which appears to be the longer-range interceptor for the A-235 system, which is a separate program from the Nudol but still may have some DA-ASAT capability.¹⁴⁰

¹³² "Комплекс 14C033 Нудоль, ракета 14A042 [Complex 14TS033 Nudol rocket 14A042]", *MilitaryRussia.ru*, February 2, 2017, <http://militaryrussia.ru/blog/topic-806.html>.

¹³³ For an in-depth discussion of the A-135 program as well as its limitations, see: Pavel Podvig, "Did Star Wars Help End the Cold War? Soviet Response to the SDI Program," *Russian Forces*, March 17, 2013, http://russianforces.org/podvig/2013/03/did_star_wars_help_end_the_col.shtml. For a discussion of the current state of Russian BMD, including the implications of retiring Gorgon, see Aleksandr Stukalin, "'Samolet M' and the Future of Moscow Missile Defense," *Moscow Defense Brief*, p. 26 (2011).

¹³⁴ Keir Giles, "Russian Ballistic Missile Defense: Rhetoric and Reality," *US Army War College*, June 2015, <https://www.jstor.org/stable/res-rep11662>.

¹³⁵ Bart Hendrickx, "Re: Russia Tests Nudol ASAT System," posting on the *NASASpaceflight.com* forum, January 18, 2020, <https://forum.nasaspaceflight.com/index.php?topic=38943.msg2036403#msg2036403>.

¹³⁶ See "Комплекс 14C033 Нудоль, ракета 14A042 [Complex 14TS033 Nudol rocket 14A042]", *MilitaryRussia.ru*, February 2, 2017, <http://militaryrussia.ru/blog/topic-806.html>.

¹³⁷ "Годовой отчет Концерна ПВО 'Алмаз-Антей' за 2012 год [Annual Report of the Almaz-Antei Air Defense Concern for 2012]," *Livejournal*, July 18, 2013, <https://saidpvo.livejournal.com/190982.html?page=1>.

¹³⁸ GSKB Annual Report 2013.

¹³⁹ Bart Hendrickx, "Re: Russia Tests Nudol ASAT System," posting on the *NASASpaceflight.com* forum, January 18, 2020, <https://forum.nasaspaceflight.com/index.php?topic=38943.msg2036403#msg2036403>.

¹⁴⁰ Bart Hendrickx, "Aerostat: a Russian long-range anti-ballistic missile system with possible counterspace capabilities," *The Space Review*, October 11, 2021, <https://www.thespacereview.com/article/4262/1>.

141 "Противоракеты [Anti-Missile Systems]," *LiveJournal.com*, January 17, 2015, <http://bmpd.livejournal.com/1137442.html>.

142 "Система ПРО А-235 (ОКР «Нудоль») [PRO-235 System A (OCD "Nudol")]," *Военное Мировое Обзор*, May 14, 2015, <https://topwar.ru/74866-sistema-pro-a-235-okr-nudol.html>; Bill Gertz, "Russia Flight Tests Anti-Satellite Missile," *Washington Free Beacon*, December 2, 2015, <http://freebeacon.com/national-security/russia-conducts-successful-flight-test-of-anti-satellite-missile/>.

143 Bill Gertz, "Russia Just Successfully Tested an Anti-satellite Missile," December 2, 2015, *Business Insider*, <http://www.businessinsider.com/russia-just-successfully-tested-an-anti-satellite-missile-2015-12?amp;IR=T&r=UK&IR=T>.

144 Pavel Podvig, "Russia Tests Nudol Anti-Satellite System," *Russian Strategic Nuclear Forces*, April 1, 2016, http://russianforces.org/blog/2016/04/russia_tests_nudol_anti-satell.shtml; Pavel Podvig, "Construction at the Chekhov Radar Site," *Russian Strategic Nuclear Forces*, June 24, 2016, http://russianforces.org/blog/2016/06/construction_at_the_chekhov_radar_site.shtml.

145 Pavel Podvig, "Russia Tests Nudol Anti-Satellite System," *Russian Strategic Nuclear Forces*, April 1, 2016, http://russianforces.org/blog/2016/04/russia_tests_nudol_anti-satell.shtml.

146 Ankit Panda, "Russia Conducts New Test of 'Nudol' Anti-Satellite System," *The Diplomat*, April 2, 2018, <https://thediplomat.com/2018/04/russia-conducts-new-test-of-nudol-anti-satellite-system/>.

147 Pavel Podvig, "Nudol ASAT system tested from Plesetsk," *Russian Strategic Nuclear Forces*, December 16, 2020, http://russianforces.org/blog/2020/12/nudol_asat_system_tested_from.shtml.

148 USSPACECOM Public Affairs, "Russia tests direct-ascent anti-satellite missile," *US Space Command*, April 15, 2020, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2151611/russia-tests-direct-ascent-anti-satellite-missile/>.

149 USSPACECOM Public Affairs, "Russia tests direct-ascent anti-satellite missile," *US Space Command*, December 16, 2020, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2448334/russia-tests-direct-ascent-anti-satellite-missile/>.

FIGURE 2-4 — TEL-MOUNTED NUDOL



Artist's depiction from company calendar. Image credit: Almaz-Antey.¹⁴¹

The evidence suggests Nudol is being developed for the direct purpose of DA-ASAT operations. Throughout the development process, Almaz-Antey (whose role within the Russian defense complex is the development of technologies for "active space defense") has pitched the system as valuable for holding US LEO assets at risk.¹⁴² What little is known publicly about the Nudol flight tests are more suggestive of an orbital ballistic trajectory intercept than a midcourse missile intercept. Most significantly, the system itself is described by Russian state-run press reports as a mobile, TEL-based "new Russian long-range missile defense and space defense intercept complex...within the scope of the Nudol OKR [experimental development project]."¹⁴³ The system appears to be designated the 14Ts033 (14LQ033), comprised of the 14A042 Nudol rocket, 14P078 command and control system, and 14TS031 radar.¹⁴⁴

There have been eleven potential flight tests of Nudol, two of which were unsuccessful, eight likely successful, and one additional unconfirmed test. Sources suggest that at least the November 2015 test was of just a rocket and did not include a kill vehicle.¹⁴⁵ A report in April 2018, citing unnamed US intelligence officials, stated that the Nudol test in March 2018 was the first time it was fired from the transporter-erector-launcher it will be deployed with.¹⁴⁶ Russia issued safety notices for airspace closures in June and November 2019 that are consistent with additional Nudol tests, but it appears the June test did not happen.¹⁴⁷ Two additional successful tests occurred on April 15, 2020, and December 16, 2020, with the USSPACECOM issuing statements confirming both test and calling them "further proof of Russia's hypocritical advocacy of outer space arms control proposals designed to restrict the capabilities of the United States while clearly having no intention of halting their counterspace weapons programs."^{148, 149} Table 2-4 lists the known and suspected tests of the Nudol.

TABLE 2-4 – NUDOL FLIGHT TESTS TO DATE

DATE	SYSTEM	LAUNCH SITE	PAYLOAD	APOGEE	NOTES
Aug. 12, 2014	Nudol	?	?	X	Failed shortly after launch.
Apr. 22, 2015	Nudol	?	?	X	Failed at launch.
Nov. 18, 2015	Nudol	Plesetsk	KKV	200 km?	First successful test of missile.
May 25, 2016	Nudol	Plesetsk	??	100 km?	Appears to be likely rocket test (successful).
Dec. 16, 2016	Nudol	"Central Russia" (Plesetsk? Kapustin Yar?)	Likely KKV	100 km?	Appears to be likely rocket test (successful).
Mar. 26, 2018	Nudol	Plesetsk	Likely KKV	?	First test from a mobile launcher.
Dec. 23, 2018	Nudol	Plesetsk	Likely KKV	?	Successful PL-19 Nudol test, mobile launcher.
Nov. 15, 2019	Nudol	Plesetsk	Likely KKV	?	–
Apr. 15, 2020	Nudol	Plesetsk	Likely KKV	?	Successful, nothing hit.
Dec. 16, 2020	Nudol	Plesetsk	Likely KKV	?	Successful, nothing hit.
Nov. 15, 2021	Nudol	Plesetsk	KKV	470 km	Intercepted and destroyed Cosmos 1408.

On November 15, 2021, Russia conducted the first known intercept test of the Nudol, which intercepted and destroyed Cosmos 1408 (1982-092A, 13552), a defunct Russian military satellite, at an altitude of approximately 470 km. The test was preceded by a NOTAM issued on November 13 for November 15–17 that corresponded to the usual reentry zones for a Nudol launch.¹⁵⁰ Cosmos 1408 passed over the launch site headed northeast and the NOTAM suggests that the Nudol was launched in the same direction, meaning that it was generally traveling in the same direction as the satellite and the intercept velocity was likely lower than other DA-ASAT tests.¹⁵¹ The intercept destroyed Cosmos 1408, a 1,750 kg (3,860 lb) defunct Soviet Tselina-D signals intelligence satellite,¹⁵² and created a large amount of orbital debris. As of February 2026, more than 1,800 pieces of orbital debris larger than 10 cm (4 inches) have been catalogued from this test with 5 still in orbit.¹⁵³

Immediately following the intercept, the Russian Foreign Ministry publicly claimed that the debris from the test “posed no threat to space activity.”¹⁵⁴ However, due to the proximity of the test to the orbit of the International Space Station (ISS), NASA flight directors ordered the crew onboard the ISS to take emergency shelter in the Dragon and Soyuz lifeboats.¹⁵⁵ The US military condemned the test, stating that it demonstrated a “deliberate disregard for the security, safety, stability, and long-term sustainability of the space domain for all nations.”¹⁵⁶

Little is known for sure about the operational capabilities of the Nudol, and available estimates for maximum altitude vary widely out to nearly 1,000 km.¹⁵⁷ The designation 14A is usually reserved for “space rockets” and intended for intercepting space objects, either satellites or nuclear warheads.¹⁵⁸

The imagery of the Nudol appears to show a mobile launch capability but stationary radar, in keeping with the missile defense application for which it was initially conceived and reports that it relies on the 14TS031 radar system.¹⁵⁹ This has led some experts to note that while the system is movable, without mobile radar, it could be limited to hitting satellites passing over Russian

- 150 Telegram posting from Warbolts, “Еще один пуск из этой серии. Что за изделие испытывается достоверно не известно до сих пор, но эксперты связывают его с “Нудоль”. Закрытия в целом повторяют ранее объявляемые, период действия 15/11/2021 02:00 (UTC) - 17/11/2021 05:00 (UTC). Из интересного, в данных NOTAM на Плесецк и Чёскую губу указан номер телефона некоего Чирикова.” November 13, 2021, <https://t.me/warbolts/707>.
- 151 Tweet from Jonathan McDowell, “Here is the pass of Kosmos-1408 (red line) northbound over Plesetsk at about 0245 UTC Nov 15. Well aligned with the NOTAM areas (indicated) for the suspected Nudol antisatellite test,” November 15, 2021, <https://twitter.com/planet4589/status/1460305735317868545?s=20&t=Sl7upa788x-Mw7JECDSi3oq>.
- 152 “Kosmos 1408,” Wikipedia, https://en.wikipedia.org/wiki/Kosmos_1408, accessed February 16, 2022.
- 153 Data compiled from the public satellite catalog maintained by the US military at <https://space-track.org>.
- 154 “New Russian system being tested hit old satellite with “goldsmith’s” precision – Shoigu,” TASS, November 16, 2021, <https://tass.com/science/1362219>.
- 155 W.J. Hennigan, “Astronauts Take Shelter Aboard ISS After Russian Anti-satellite Test, US Says,” *Time*, November 15, 2021, <https://time.com/6117840/astronauts-shelter-iss-russia-test/>.
- 156 US Space Command Public Affairs Office, “Russian direct-ascent anti-satellite missile test creates significant, long-lasting space debris,” *US Space Command*, November 15, 2021, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2842957/russian-direct-ascent-anti-satellite-missile-test-creates-significant-long-last/>.
- 157 See Jonathan McDowell, “Launch Vehicles,” accessed March 21, 2018, <http://planet4589.org/space/lvdb/sdb/LV>. The suspected apogees were 350 km and 500–1,000 km. These estimates are notably highly consistent with estimates derived by Russian military open source blogger Dimmi from analysis of suspected components and launch observations, which are summarized in a table: “Complex 14TS033,” *MilitaryRussia.ru*.
- 158 McDowell, “Launch Vehicles,” *ibid*.
- 159 “Противоракеты [Anti-Missile Systems],” *LiveJournal.com*, January 17, 2015, <http://bmpd.livejournal.com/1137442.html>.

- 160 Bill Gertz, "Russia Flight Tests Anti-Satellite Missile," *Washington Free Beacon*, May 27, 2016, <http://freebeacon.com/national-security/russia-flight-tests-anti-satellite-missile>.
- 161 A number of on-board and ground complex systems being developed and upgraded for use with the Nudol in particular, including a new final-stage interceptor guidance and control system, a dedicated next-generation radar beginning with the 14TS031 radar with digital adaptive phased array, new hardware and software specially developed by A/A for ground command of the Nudol, planned integration with a more comprehensive space- and ground-based early warning system, and a specially-upgraded version of the "Don-2N"/5N20 and "Don-2NP"/5N20P radar systems in the interim. See: "Complex 14TS033," *MilitaryRussia.ru*.
- 162 Note that this, while a decent indicator, is not definitive: an alternative possibility is that the ECS components are present to protect the seeker/kill vehicle, or that the image was manipulated by the employees at Almaz-Antey responsible for producing it prior to publication.
- 163 Sean O'Connor, "Russian/Soviet Anti-Ballistic Missile Systems," *Air Power Australia*, January 27, 2014, <http://www.ausairpower.net/APA-Rus-ABM-Systems.html#mozTocId371125>; Pavel Podvig, (ed.), 2001, *Russian strategic nuclear forces*, Cambridge, MA: MIT Press, p. 416; Laura Grego, "A History of Anti-Satellite Programs," *Union of Concerned Scientists*, January 2012, https://www.ucsusa.org/sites/default/files/2019-09/a-history-of-ASAT-programs_lo-res.pdf.
- 164 Pavel Podvig, "Did Star Wars Help End the Cold War? Soviet Response to the SDI Program," *Russian Forces*, March 17, 2013, http://russian-forces.org/podvig/2013/03/did_star_wars_help_end_the_col.shtml.
- 165 Olga Oliker and Andrey Baklitskiy, "The Nuclear Posture Review and Russian 'De-Descalation': A Dangerous Solution to a Nonexistent Problem," *War on the Rocks*, February 20, 2018, <https://warontherocks.com/2018/02/nuclear-posture-review-russian-de-escalation-dangerous-solution-nonexistent-problem>.
- 166 Nikolay Surkov and Alexey Ramm, "Москва получит новую противоракетную защиту [Moscow will receive a new anti-missile defense]," *Izvestia*, February 21, 2018, <https://iz.ru/710845/nikolai-surkov-aleksei-ramm/moskva-poluchit-novuiu-protivoraketnuiu-zashchitu>.

territory.¹⁶⁰ However, several factors reduce the salience of this fact. First, in the event of a conflict in Russia's near abroad, many of the most relevant US assets would indeed be passing overhead. More importantly, Russia is rapidly maturing multiple technologies for advanced targeting, tracking, and measurement. These include, among others: ground-based lasers which, while stationary, are a more flexible means of target-acquisition than radar; mobile radar; space-based targeting, tracking, and measurement (TT&M) and SSA capabilities; expansion and modernization of ground-based space monitoring sites throughout Russia; and on-board guidance systems akin to those employed for late-stage course-correction of conventional and nuclear cruise and ballistic missiles.¹⁶¹

It is possible that the nuclear armament of the Nudol under at least some circumstances is being considered, but the evidence is not conclusive. Available depictions of the Nudol TEL have features that appear to be environmental control systems (ECS) on the missile tubes—a feature typically associated with nuclear-armed missiles.¹⁶² And there is precedent for such a decision: the 51T6 Gorgon was nuclear-tipped due to persistent skepticism regarding the efficacy and reliability of non-nuclear missile defense.¹⁶³ Some Soviet and Russian military strategists have discussed the desirability of nuclear ASATs for reliable, rapid, and wide-area kinetic and EMP effect, but there is no conclusive public evidence that the Soviet Union or Russia planned on nuclear-tipped ASAT weapons, even as part of their response to Reagan's Strategic Defense Initiative (SDI).¹⁶⁴ There are also some who argue that Russia has shifted its nuclear doctrine towards the use of tactical nuclear weapons for warfighting, but most Russian experts conclude that this has not yet happened.¹⁶⁵ Moreover, Russian-language media reported in early 2018 that the system would not be equipped with nuclear warheads.¹⁶⁶

78M6 Kontakt

The second category of direct-ascent ASAT system explored by the Soviet Union, and potentially resurrected in recent years, is an air-launched missile system known as Kontakt. The launch platform was originally intended to be a variant of the MiG-31 "Foxhound," designated the MiG-31D.¹⁶⁷ At least six such aircraft were completed in the 1980s, with intent to be fitted with a Vympel-developed ASAT missile dubbed the 79M6 "Kontakt."¹⁶⁸ Two waves of interceptor development were planned in the 1980s: the first was to be a three-stage interceptor capable of hitting targets at orbits of 120–600 km; the second was to reach altitudes of up to 1,500 km.¹⁶⁹ The system was also intended to be capable of deploying with little or no warning, in contrast to the USSR's co-orbital interceptors,¹⁷⁰ and of attacking large numbers of satellites quickly: Soviet documents speak of an operational target of at least 24 satellites within 36 hours, or as many as 20–40 satellites within 24 hours.¹⁷¹

The program was based out of Sary Shagan (see Imagery Appendix, pg. 17-09) with support to be provided by the Krona optical space surveillance complex, and allegedly became ready for flight-testing around 1991.¹⁷² Whether such testing ever actually occurred is an open question, with the program remaining shrouded in secrecy, but reports from a former MiG test pilot describe several tests in which the missile was successfully launched from a MiG-31D in flight, homed in on a Soviet target, and then did a deliberate near-miss before self-detonating to prevent the United States from discovering the program.¹⁷³ If true, this would demonstrate the maturity of the rocket (likely retained to the present day as other such assets were), but also of the aircraft's special upward-facing radar array, ground-based targeting and command-and-control complexes, and ability to stably and accurately launch at-speed. Put on hold due to budget cuts in the 1990s, there are reports that the program may have been resumed by the Russian Air Force in 2009.¹⁷⁴ Little public evidence exists that would confirm the existence, much less operational nature, of a viable air-launched ASAT at present, but both the launch platform and ground-based support systems are undergoing intensive modernization efforts.

Meanwhile, the integrated detection, targeting, tracking, and communications networks on which an airborne DA-ASAT system would depend are expanding and new facilities constructed: a new Krona ground radar-optical complex was recently constructed at Nakhodka (see Imagery Appendix; page 17-49), a total of three others have been built over time (one each at Stavropolye, Сары-Шаган, and near Moscow), and all have undergone significant and ongoing technological upgrades in recent years.¹⁷⁵ These upgrades have been followed by testing which, according to Russian military officials, has featured a particular emphasis on "interaction of various components, especially the impact means, with a ground-radar optical complex search and identification of artificial satellites" in order to "deal with the satellites."¹⁷⁶

167 "MiG-31 Foxhound Interceptor Aircraft," Air-Force-Technology.com, accessed March 15, 2018, <http://www.airforce-technology.com/projects/mig-31/>; "Russians Alter MiG-31 for ASAT Carrier Roles," Aviation Week and Space Technology, 17 August 1992, p.63. For a fully comprehensive treatment of the aircraft and its variants, see: Yefim Gordon, *MiG-25 Foxbat, MiG-31 Foxhound: Russia's Defensive Front Line*, Midland Publishing Ltd. (England), 1997. For a concise but detailed description of the MiG-31D, including its design specifications, differences from the standard MiG-31, and method of ASAT operation, refer to John Pike, "USSR/CIS Miniature ASAT," *GlobalSecurity.org*, updated October 4, 2016, <http://www.globalsecurity.org/space/world/russia/mini.htm>.

168 "MiG-31 Foxhound Interceptor Aircraft," *ibid*.

169 Pavel Podvig, "Another Old Anti-satellite System Resurfaces," *Russian Strategic Nuclear Forces*, January 25, 2013, http://russianforces.org/blog/2013/01/another_old_anti-satellite_sys.shtml.

170 John Pike, "USSR/CIS Miniature ASAT," *Global Security*, updated October 4, 2016, <http://www.globalsecurity.org/space/world/russia/mini.htm>.

171 Pavel Podvig, "Another Old Anti-satellite System Resurfaces," *Russian Strategic Nuclear Forces*, January 25, 2013, http://russianforces.org/blog/2013/01/another_old_anti-satellite_sys.shtml.

172 Anatoly Zak, "Anti-Satellite Weapons: History and Definitions," presentation given at a United Nations Institute for Disarmament Research conference, March 2014, <http://www.unidir.ch/files/conferences/pdfs/anti-satellite-weapons-asats-history-and-definitions-en-1-968.pdf>.

173 Audio of the interview with MiG test pilot Valery Menitsky is available here, accessed July 12, 2017: http://www.buran.ru/sound/men_31d.mp3.

174 John Pike, "USSR/CIS Miniature ASAT," *GlobalSecurity.org*, updated October 4, 2016, <http://www.globalsecurity.org/space/world/russia/mini.htm>.

175 "СМИ: Минобороны готовится испытать противоспутниковый комплекс [Media: the Ministry of Defense is preparing to test the anti-complex]," *Vzryad*, 24 January 2013, <https://vz.ru/news/2013/1/24/617307.html>; Dmitry Balburov, and Aleksei Mikhailov, "Tests of Antisatellite Complex Will Begin at the End of the Year: Revived Soviet Krona Will Down Satellites With Ground-Based or Air-Launched Missiles," *Izvestia*, January 24, 2013.

176 "СМИ: Минобороны готовится испытать противоспутниковый комплекс [Media: the Ministry of Defense is preparing to test the anti-complex]," *Vzryad*, 24 January 2013, <https://vz.ru/news/2013/1/24/617307.html>.

- 177 Tyler Rogoway and Ivan Voukadinov, "Exclusive: Russian MiG-31 Foxhound carrying huge mystery missile emerges near Moscow," *TheDrive.com*, September 29, 2018, <http://thedrive.com/the-war-zone/23936/exclusive-russian-mig-31-foxhound-carrying-huge-mystery-missile-emerges-near-moscow>.
- 178 Amanda Macias, "A never-before-seen Russian missile is identified as an anti-satellite weapon and will be ready for warfare by 2022," *CNBC.com*, October 25, 2018, <https://www.cnbc.com/2018/10/25/russian-missile-identified-as-anti-satellite-weapon-ready-by-2022.html>.
- 179 Bart Hendrickx, "Burevestnik: a Russian air-launched anti-satellite system," *The Space Review*, April 27, 2020, <https://www.thespaceview.com/article/3931/1>.
- 180 Bart Hendrickx, posting on *NASASpaceflight-forum.com*, July 28, 2020, <https://forum.nasaspaceflight.com/index.php?topic=45734.msg2112384#msg2112384>.
- 181 Sebastien Roblin, "Russia's S-500: The Ultimate Weapon Against American Missiles or a Paper Tiger?," *The National Interest*, November 4, 2016, <http://nationalinterest.org/blog/the-buzz/russias-s-500-the-ultimate-weapons-against-american-missiles-18294>.
- 182 Christopher F. Foss, "S-500," *Jane's Land Warfare Platforms: Artillery and Air Defense* (London: IHS Global, 2016), 580-1; Bill Gertz, "Pentagon: China, Russia Soon Capable of Destroying US Satellites," *Washington Free Beacon*, January 30, 2018, <http://freebeacon.com/national-security/pentagon-china-russia-soon-capable-destroying-u-s-satellites/>.
- 183 Anatoly Zak, "Russian Anti-Satellite Systems," *Russian Space Web*, updated November 30, 2017, <http://www.russianspaceweb.com/naryad.html>.
- 184 Brendan McGarry, "Graphic Details Russian Surface to Air Missile Coverage in Europe," *Military.com*, August 30, 2016, <https://www.military.com/defensetech/2016/08/30/detailing-russian-surface-to-air-missile-coverage-in-europe>; "S-500 Prometheus," *Missile Threat*, updated May 4, 2017, <https://missilethreat.csis.org/defsys/s-500-prometheus/>.
- 185 McGarry, "Graphic Details Russian Surface to Air Missile Coverage in Europe," *ibid*.
- 186 Vladimir Karnozov, "Russia's Next-generation S-500 SAM Enters Production," *AINonline*, March 14, 2018, <https://www.ainonline.com/aviation-news/defense/2018-03-14/russias-next-generation-s-500-sam-enters-production>.
- 187 Karnozov, "Russia's Next-generation S-500 SAM Enters Production," *ibid*.
- 188 Andrius Genys, "S-500," *Military Today*, April 5, 2017, <http://www.military-today.com/missiles/s500.htm>.

Images of a MiG-31 carrying what was reportedly a mock-up of a new ASAT missile to replace the Kontakt appeared online in mid-September 2018.¹⁷⁷ Three anonymous US government sources stated in 2018 that the system was being actively tested with the goal of reaching operational readiness in 2022; but as of February 2026, it most likely is not operational.¹⁷⁸ Information uncovered in spring 2020 suggests that the recent MiG-31B activity is linked to the Burevestnik co-orbital ASAT system, as opposed to a renewed version of the Kontakt DA-ASAT. Researcher Bart Hendrickx uncovered significant documentation for a three-stage solid rocket carried by a MiG-31BM that would likely be used as a quick-response launch system to place one or more co-orbital ASATs into orbit (see Russian Co-Orbital ASAT, Section 2.1).¹⁷⁹ Construction work is ongoing at Plesetsk airport to build infrastructure for future Burevestnik launches from an aircraft-carried booster and it is unclear what further role Sary Shagan will have in this program.¹⁸⁰

S-500 ABM

Moscow is also developing next-generation missile defense capabilities, the most advanced of which is the S-500 anti-ballistic missile (ABM) system.¹⁸¹ Relatively little information about the S-500 exists in the public domain, but it appears to include an exoatmospheric interceptor, capable of destroying not only ballistic missiles before re-entry but also objects in orbit.¹⁸² Russian officials, in the years following the Chinese and US ASAT and missile defense tests of the late 2000s, began to explicitly discuss the S-500 as serving a dual missile defense-ASAT purpose.¹⁸³ The development of dedicated ASATs since then, however, makes this less likely. The system was originally intended to begin production and deployment in 2016 or 2017,¹⁸⁴ but had not yet completed testing.¹⁸⁵ Russian media reported that the S-500 entered production in March 2018, with the system being manufactured at the Almaz-Antey plant in Nizhny Novgorod and missiles in Kirov.¹⁸⁶ Russian defense minister Sergei Shoigu announced that he expected deliveries to begin as soon as 2020, and funding was guaranteed as part of the State Armament Program 2018–2027;¹⁸⁷ Russia reportedly planned to field 10 battalions of the new system.¹⁸⁸

In June 2020, General Sergei Surovikin, Commander of the Russian Aerospace Forces, gave a lengthy interview in which he called the S-500 a “first generation space defense system” and noted that it will be capable of defeating low-orbit satellites and space strike systems in the future.¹⁸⁹ In July 2021, Russia showed the first video footage of a containerized missile of the S-500 system being test fired from a TEL.¹⁹⁰ While it was reported that the first S-500 unit had been delivered to Russian forces in September 2021, Russian Deputy Prime Minister Yuri Borisov stated that it was not a mature system and still needed “configurations.”¹⁹¹ Even so, the S-500’s manufacturer announced in April 2022 that mass production had begun and that serial delivery was intended to begin in 2025; however, it does not appear to have started, as India (which had considered buying the system) in the fall of 2025 seemed to have shifted its interest over to Russia’s S-400, as the S-500 does not have proven combat experience.¹⁹²

In December 2021, TASS reported that the S-550 system had entered service and that it was capable of “hitting spacecraft, ballistic missile reentry vehicles and hypersonic targets at altitudes of tens of thousands of kilometers.”¹⁹³ However, this report was immediately called into question as other reports indicated that development of the system had not yet started or that it had been confused with the S-500.¹⁹⁴ Reportedly, it is intended to have “anti-missile and anti-space defense tasks.”¹⁹⁵

Potential Military Utility /

Given the known testing, it is likely that Russia has some existing capability to field an operational DA-ASAT capability against most LEO satellites within the next few years. This would include satellites performing military weather and ISR functions. Russia would have to wait for such satellites to overfly an area where one of the systems is deployed, but most LEO satellites would do so daily to every few days. However, once launched, the target would only have an estimated 8-15 minutes of warning time before impact and the potential for an air-launched DA-ASAT capability could dramatically expand the potential launch opportunities.

To date, there is no public evidence suggesting Russia is experimenting with or developing DA-ASAT capabilities against satellites in higher orbits such as MEO or GEO, although it is possible given their advanced rocket and guidance technology.

At the same time, there are also constraints on the military utility of such systems, particularly as Russia replenishes its own space capabilities. The use of a kinetic-kill DA-ASAT against an orbital target will invariably create large amounts of orbital space debris, as was seen in the 2021 Nudol test. The aggressive use of such a capability would invariably lead to widespread condemnation, as happened after the 2007 Chinese ASAT test. The debris will pose just as much a threat to Russia’s space capabilities, including its human spaceflight program, as it does to other countries. Thus, the military utility of DA-ASATs would have to be weighed against the potential costs, particularly relative to less destructive capabilities such as jamming or blinding. The use of a DA-ASAT would also be relatively easy to attribute to Russia.

2.3 – RUSSIAN ELECTRONIC WARFARE

Assessment /

Russia places a high priority on integrating electronic warfare (EW) into military operations and has been investing heavily in modernizing this capability.

189 “Чтобы господство в воздухе оставалось за нами,” *Redstar.ru*, July 2, 2020, <http://redstar.ru/chtoby-gospodstvo-v-vozdue-os-tavalos-za-nami/>.

190 Thomas Newdick, “This is Our First View of Russia’s New S-500 Air Defense System in Action,” *The Drive*, July 20, 2021, <https://www.thedrive.com/the-war-zone/41627/this-is-our-first-view-of-russias-new-s-500-air-defense-system-in-action>.

191 Inder Singh Bisht, “Russia Begins Mass Production of S-500 Air Defense System,” *TheDefencePost*, April 28, 2022, <https://www.thedefensepost.com/2022/04/28/russia-mass-producing-s-500/>.

193 “First S-550 air defence systems enter service in Russia – source,” *TASS*, December 28, 2021, <https://tass.com/defense/1382133>.

194 Joseph Trevithick, “No, Russia’s S-550 Missile

195 Joseph Trevithick, “No, Russia’s S-550 Missile Defense System Hasn’t Been Fielded,” *The Drive*, December 29, 2021, <https://www.thedrive.com/the-war-zone/43675/no-russias-s-550-missile-defense-system-hasnt-been-fielded>.

- 196 Olga R. Chiriac, "Russian Electronic Warfare: From History to Modern Battlefield," *Irregular Warfare Initiative*, March 21, 2024, <https://irregularwarfare.org/articles/russian-electronic-warfare-from-history-to-modern-battlefield/>.
- 197 Chiriac, "Russian Electronic Warfare: From History to Modern Battlefield," *ibid*.
- 198 Roger N. McDermott, "Russia's Electronic Warfare Capabilities to 2025," *International Centre for Defence and Security*, September 2017, https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf.
- 199 Brian Wang, "Russia Will Place GPS Jammers on 250,000 Cellphone Towers to Reduce Enemy Cruise Missile and Drone Accuracy in the Event of Large Scale Conventional War," *The Next Big Future*, October 18, 2016, <https://www.nextbigfuture.com/2016/10/russia-will-place-gps-jammers-on-250000.html>.
- 200 "Silent Protector: Russia Develops Hi-Tech Jammer to Block Enemy Electronics," *Sputnik International*, August 25, 2016, <https://sputniknews.com/russia/201608251044633778-russia-jammer-electronics/>.
- 201 "Electronic Warfare Chief Interviewed," *Russian Defense Policy*, May 30 2017, <https://russiandefpolicy.blog/tag/electronic-warfare/>.
- 202 "R330ZH," *Rosobornexport*, accessed March 15, 2018, <http://roe.ru/eng/catalog/air-defence-systems/elint-and-ew-equipment/r-330zh/>; "Sky's the Limit: Russia's Unique Jamming System Getting Upgrade," *Sputnik News*, May 12, 2016, <https://sputniknews.com/russia/201612051048187517-russia-electronic-warfare-system/>.
- 203 David Stupples, "How Syria is Becoming a Test Bed for High-tech Weapons of Electronic Warfare," *The Conversation*, October 8, 2015, <https://theconversation.com/how-syria-is-becoming-a-test-bed-for-high-tech-weapons-of-electronic-warfare-48779>; "It is Official, Russian Army Deployed R-330Zh Jammer in the Battle of Debal'tseve," *Inform Napalm*, April 23, 2016, <https://informnapalm.org/en/r-330zh-jammer-battle-debaltseve/>; Sergey Sukhankin, "Russian Electronic Warfare in Ukraine: Between Real and Imaginable," *Real Clear Defense*, May 26, 2017, https://www.realcleardefense.com/articles/2017/05/26/russian_electronic_warfare_in_ukraine_111460.html.
- 204 "Russian GPS Jamming Systems Return to Ukraine," *DFRLab*, May 23, 2019, <https://medium.com/dfrlab/russian-gps-jamming-systems-return-to-ukraine-8c4ff7d8dcb8>.
- 205 Dana Goward, "Russia ramps up GPS jamming along with troops at Ukraine border," *GPS World*, April 21, 2021, <https://www.gpsworld.com/russia-ramps-up-gps-jamming-along-with-troops-at-ukraine-border/>.
- 206 Sergey Sukhankin, "Blind, Confuse, and Demoralize: Russian Electronic Warfare Operations in Donbas," *Jamestown Foundation*, August 27, 2021, <https://jamestown.org/program/blind-confuse-and-demoralize-russian-electronic-warfare-operations-in-donbas/>.

Most of the upgrades have focused on multifunction tactical systems whose counterspace capability is limited to jamming of user terminals within tactical ranges. Russia has a multitude of systems that can jam GPS receivers within a local area, potentially interfering with the guidance systems of unmanned aerial vehicles (UAVs), guided missiles, and precision-guided munitions (PGMs), but has no publicly known capability to interfere with the GPS satellites themselves using radio frequency interference. The Russian Army fields several types of mobile EW systems, some of which can jam specific satellite communications user terminals within tactical ranges. Russia can likely jam communications satellites uplinks over a wide area from fixed ground stations facilities. Russia has operational experience in the use of counterspace EW capabilities from current military campaigns, as well as using it within Russia for protecting strategic locations and VIPs. Russia may be developing high-powered space-based EW platforms to augment its existing ground-based platforms.

Specifics /

Russia has a long history of using EW during conflicts, dating back to its first use in 1904 during the Russo-Japanese War.¹⁹⁶ EW is wrapped into all of its military units and is a key part of its information warfare doctrine.¹⁹⁷ Additional information on Russian EW doctrine, organization, and capabilities can be found in the report, "Russia's Electronic Warfare Capabilities to 2025," published by the International Centre for Defence and Security in Estonia.¹⁹⁸

GNSS Jamming

GNSS jamming, particularly of the US GPS network, is a well-known technology, and jammers are widely proliferated throughout the globe. Russia is assessed to be proficient in GPS jamming capabilities, having developed both fixed and mobile systems. The known systems are downlink jammers, which affect GPS receivers within a local area. There is no known system that targets uplink jamming of the GPS satellites themselves.

The first category of Russian GPS jammers is used to protect fixed facilities. For example, Russian state media announced in 2016 that Russia was deploying 250,000 GPS jammers on cell phone towers throughout the country.¹⁹⁹ The objective of these Pole-21 jammers, developed by the JSC Scientific and Technical Center of Electronic Warfare, is to reduce the accuracy of foreign UAVs and cruise missiles over much of the Russian landmass, thereby protecting fixed installations. The Pole-21 systems are reported to be effective to a range of 80 km.²⁰⁰

The second category of Russian GPS jammers are mobile systems that are integrated within military EW units and form a critical component of Russian military capabilities.²⁰¹ These units are equipped with multifunction EW equipment, a number of which have GPS jamming capability. Two of these are the R-330Zh "Zhitel" and the "Borisoglebsk-2."²⁰² The role of these systems is to protect Russian units by jamming an adversary's tactical signals. The local jamming of GPS seeks to negate the effectiveness of UAVs, cruise missiles, and PGMs. There have been multiple reports of Russia deploying some of these EW systems in support of Russian deployments in Syria and Ukraine.²⁰³ In May 2019, the Ukrainian military released maps showing the deployment of Russian EW systems throughout the Donbas region of Ukraine.²⁰⁴ Reports of GPS interference along the Ukrainian border intensified in March and April 2021.²⁰⁵ In August 2021, the Jamestown Foundation released a detailed report on Russian EW activities in the Donbas region of Ukraine.²⁰⁶

In February 2022, reports of GPS interference in Ukraine spiked alongside

Russia's forces entering Ukraine. Hawkeye360, a US-based commercial geospatial analytics company, said they noted increased GPS interference in and around Ukraine in the months leading up to the February attack as well as since. However, the first few months of the conflict did not include the degree of GPS interference and other kinds of electronic warfare that some analysts expected, with several different potential explanations as to why. But by July 2022, at least three of Russia's five EW brigades were reported to be involved in the fighting in Ukraine and reports of electronic warfare began to increase. GPS jamming around Russian Engles-2 and Marinikova air bases also increased following Ukrainian long-range drone attacks on those facilities. Ukraine's electric grid was also reported to have been affected by GPS jamming as it interfered with the grid's time synchronization and hampered efforts to balance loads within the system, leading to outages and failures.²⁰⁷

FIGURE 2-5 – RUSSIAN COUNTERSPACE EW SYSTEMS



Russian mobile counterspace EW systems deployed in Eastern Ukraine. Image credit: OSCE²⁰⁸

From 2023 to 2024, reports of GPS jamming in Eastern Ukraine intensified. Reports indicated that the GPS jamming was affecting weapons systems that use GPS, such as the Excalibur GPS-guided artillery shells,²⁰⁹ the High Mobility Artillery Rocket System (HIMARS),²¹⁰ and the Joint Direct Attack Munition (JDAM) smart targeting upgrade kit for bombs.²¹¹ The Ukrainian military found that the Excalibur shells went from a 50 percent accuracy rate to less than 10 percent, and eventually phased them out, also spurred on by the fact that the regular howitzer shells were easier to work with.²¹² The JDAMs received a patch from their manufacturer to counter the jamming, which helped, but the system's hit rate stayed at about 60 percent for most of 2023.²¹³ And the HIMARS was missing its target at times by 50 feet.²¹⁴ Russian GPS spoofing also reportedly limited the effectiveness of Guided Multiple Launch Rocket System (GMLRS) missiles and their follow-on, the Ground-Launched Small Diameter Bomb (GLSDB).²¹⁵ It is unknown whether the impacted systems are using the Selective Availability Anti-Spoofing Module (SAASM) anti-jam features introduced in the early 2000s or the newest M-Code encrypted military signals, or whether they are limited to only civil GPS signals.

207 Joe Marshall, "Project PowerUp – Helping to keep the lights on in Ukraine in the face of electronic warfare," *CISCO TALOS*, December 4, 2023, <https://blog.talosintelligence.com/project-powerup-ukraine-grid/>.

208 Ukrainian Mission to OSCE & UN in Vienna (@UKRinOSCE), "Російські новітні системи озброєння - автоматизована станція перехоплення Р-330Ж 'Житель' та комплекс радіоелектронної боротьби 'Тірада-2', зафіксовані Спеціальною моніторинговою місією ОБСЄ неподалік від н.п. Южна Ломуватка, на окупованій Росією частині Донбасу," Twitter.com, April 3, 2019, <https://twitter.com/UKRinOSCE/status/1113385017185640448?s=20>. Further analysis suggests that the system identified in the photo as a Tirada-2 was another EW system, the R-934BMV counter-UAV system. See Michael Sheldon, "Tirada-2 Likely Not Spotted in Ukraine," *Digital Forensic Research Lab*, July 17, 2019, <https://medium.com/dfrlab/tirada-2-likely-not-spotted-in-ukraine-a4b86956adc>.

209 "Russia is starting to make its superiority in electronic warfare count," *The Economist*, November 23, 2023, <https://www.economist.com/europe/2023/11/23/russia-is-starting-to-make-its-superiority-in-electronic-warfare-count>.

210 Alex Marquardt, Natasha Bertrand, and Zachary Cohen, "Russia's jamming of US-provided rocket systems complicates Ukraine's war effort," *CNN*, May 6, 2023, <https://www.cnn.com/2023/05/05/politics/russia-jamming-himars-rockets-ukraine/index.html>.

211 Thomas Whittington, "Jamming JDAM: The threat to US munitions from Russian electronic warfare," *Royal United Services Institute*, June 6, 2023, <https://rusi.org/explore-our-research/publications/commentary/jamming-jdam-threat-us-munitions-russian-electronic-warfare>.

212 Isabelle Khurshudyan, "Russian jamming leaves some high-tech US weapons ineffective in Ukraine," *Washington Post*, May 24, 2024, <https://www.washingtonpost.com/world/2024/05/24/russia-jamming-us-weapons-ukraine/>.

213 Khurshudyan, "Russian jamming leaves some high-tech US weapons ineffective in Ukraine," *ibid.*

214 Khurshudyan, "Russian jamming leaves some high-tech US weapons ineffective in Ukraine," *ibid.*

215 Sam Skove, "Another US precision-guided weapon falls prey to Russian electronic warfare, US says," *Defense One*, April 28, 2024, <https://www.defenseone.com/threats/2024/04/another-us-precision-guided-weapon-falls-prey-russian-electronic-warfare-us-says/396141/>.

- 216 Matt Burgess, "When a Tanker Vanishes, All the Evidence Points to Russia," *Wired*, September 21, 2017, <https://www.wired.co.uk/article/black-sea-ship-hacking-russia>.
- 217 "Norway, Finland suspect Russia of jamming GPS," *GPS World*, November 12, 2018, <https://www.gpsworld.com/norway-finland-suspect-russia-of-jamming-gps/>.
- 218 Nerijus Adomaitis, "Norway says it proved Russian GPS interference during NATO exercises," *Reuters*, March 18, 2019, <https://www.reuters.com/article/us-norway-defence-russia/norway-says-it-proved-russian-gps-interference-during-nato-exercises-idUSKCN1Q21WN>.
- 219 "Intensified GPS jamming is side effect of Russia's self-protection of Kola bases," *ArcticToday*, May 31, 2024, <https://www.arctictoday.com/intensified-gps-jamming-is-side-effect-of-russias-self-protection-of-kola-bases/>; Thomas Nilsen, "Russian jamming is now messing up GPS signals for Norwegian aviation practically every day," *Arctic Today*, February 26, 2024, <https://www.arctictoday.com/russian-jamming-is-now-messing-up-gps-signals-for-norwegian-aviation-practically-every-day/>.
- 220 "Above Us, Only Stars," *C4ADS*, March 2019, <https://static1.squarespace.com/static/566ef8b4d8af107232d5358a/t/5c99488beb39314c45e782da/1553549492554/Above+Us+Only+Stars.pdf>.
- 221 "Head of the Russian General Staff's Office for UAV Development Major General Alexander Novikov holds briefing for domestic and foreign reporters," Ministry of Defence of the Russian Federation, January 11, 2018, https://twitter.com/mod_russia/status/951469288220774401.
- 222 "Loss of GPS Signal at Ben Gurion Airport, Tel Aviv, Israel, (LLBG)," *The International Federation of Airline Pilots' Associations*, 19SAB05, June 25, 2019, <https://www.ifalpa.org/media/3388/19sab05-loss-of-gps-signal-at-ben-gurion.pdf>.
- 223 "Ben Gurion Airport GPS Disruption Blamed on Russian Electronic Warfare," *DefenseWorld.net*, June 28, 2019, https://www.defenseworld.net/news/25041/Ben_Gurion_Airport_GPS_Disruption_Blamed_on_Russian_Electronic_Warfare.
- 224 Thomas Newdick, "Russia is Jamming Royal Air Force Transport Aircraft Flying Out of Cyprus: Reports," *The Drive*, March 19, 2021, <https://www.thedrive.com/the-war-zone/39872/russia-is-jamming-royal-air-force-transport-aircraft-flying-out-of-cyprus-reports>.
- 225 Thomas Newdick, "US Destroyer Shows Up Right Off Crimea On Vessel Tracking Sites But It Ever Left Port (Updated)," *The Drive*, June 29, 2021, <https://www.thedrive.com/the-war-zone/41349/u-s-destroyer-shows-up-right-off-crimea-on-vessel-tracking-sites-but-it-never-left-port>.

There have also been reports of GPS interference occurring outside of conflict zones. In June 2017, the captain of a tanker approaching the Russian Black Sea port of Novorossiysk noticed a sudden anomaly in the ship's GPS system, placing its location approximately 30 miles away on land near the local airport. Additionally, the Automated Identification System (AIS), a navigation safety communication system carried by all large commercial ships, reported that several other ships were also located near the airport. The AIS system relies on GPS to identify a ship's location. This anomaly could have been caused by GPS spoofing exercises or tests conducted by the Russian military, likely within the parameters of a test program or exercise in the local area and the ships were unintentionally affected.²¹⁶ In November 2018, there were media reports of widespread jamming of civil GPS signals in Norway and Finland at the same time as a major North Atlantic Treaty Organization (NATO) exercise.²¹⁷ The jamming reportedly affected military systems as well as civilian airliners, cars, trucks, ships, and smartphones. In March 2019, the Norwegian government claimed they had proof that the disruption was caused by Russian interference and demanded an explanation.²¹⁸ A Russian EW unit in the Kola peninsula is thought to be responsible for near-daily GPS interruptions for Norwegian pilots flying in that region.²¹⁹

In March 2019, the nonprofit C4ADS published an in-depth report on Russian GNSS jamming and spoofing in Russia, Crimea, and Syria.²²⁰ The report details nearly 10,000 suspected incidents across the entire Russian Federation, its occupied territories (including Crimea), and overseas military facilities (primarily in Syria). In particular, the report tracks the use of GNSS spoofing as part of very important person (VIP) protection, protection of important strategic facilities, and airspace denial in active combat zones. The report was based on data from maritime AIS, ridesharing services such as Uber, and GPS-enabled fitness tracker applications. The spoofing often manifested in devices reporting they were located at one or more nearby airports, which may be an attempt to use the mandatory geofencing in commercial drones to deny their use. At Russian air bases in Syria, where weaponized drone attacks have occurred, military EW systems have reportedly been used to spoof GNSS and force attacking drones to land in designated spots.²²¹ The spoofing began in 2016, peaked in 2017, and appears to have lessened since being publicly reported.

In June 2019, Ben Gurion International Airport in Tel Aviv, Israel, experienced GPS disruptions that Israel attributed to Russian military activities. The International Federation of Airline Pilots' Associations noted that it had received multiple reports from pilots about the loss of GPS signals near the airport.²²² The disruptions affected only airborne systems and not terrestrial navigation systems and only occurred during the daytime. Israeli security officials stated that the disruptions were caused by defensive electronic warfare measures being taken at the Khmeimim Air Base in Syria, 390 km north, where Russian aircraft were based.²²³

In March 2021, the UK Royal Air Force reported GPS jamming affecting its military flight operations out of Cyprus in the Eastern Mediterranean, with suspicion falling on Russian military operations in Syria.²²⁴ In June 2021, the AIS position of a US Navy warship was spoofed to make it appear that it was sailing with a Ukrainian patrol within the territorial waters of Russian-occupied Crimea, when in fact the ship was tied up in port in Odessa.²²⁵

In March 2022, several aircraft flying near Kaliningrad and also along Finland's eastern border reported interference with their GPS signals. Although the Finnish government did not make any public attributions to the interference, some of it was significant enough to halt flights from Helsinki to Savonlinna in

eastern Finland.²²⁶ Additional reports of GPS interference in eastern Finland spiked later in 2022 to more than 81 days, four times as many as in early years, and likely a result of the renewed conflict in Ukraine.²²⁷ Finnair announced a temporary pause in their flights to Tartu, Estonia, in April 2024 due to GPS interference; they wanted the Tartu airport to find an approach that would not require GPS.²²⁸ While they did not say that this specifically was because of Russian jamming, Finnair pilots had reported incidents of GPS interference while near Kaliningrad. Ships sailing in the Gulf of Finland also began to report incidents of GPS interference in the summer of 2024.²²⁹

The jamming and spoofing of GPS signals in the Eastern Baltic picked up in late 2023 and early 2024, with multiple reports of impacts across broad areas of Finland, Sweden, Poland, Estonia, and Latvia.²³⁰ The spoofing also included the first known cases of “circle spoofing” impacting aviation, where a device’s location is altered to make it look like they are circling a fixed point on the ground, usually an international airport. Open source analysis suggests that at least one of the jammers affecting flights in the region is based in Kaliningrad Oblast.²³¹ In April 2024, the German defense ministry stated, “The persistent disruptions to the global navigation satellite system are very likely of Russian origin and are based on disruptions in the electromagnetic spectrum, including those originating in the Kaliningrad Oblast.”²³² In May 2024, a report from a Romanian think tank associated with its Ministry of Foreign Affairs noted that it was undergoing GPS jamming, particularly in areas that abutted Moldova; Romanian officials warned of, “advanced electronic warfare capabilities developed by the Russian Armed Forces, including the use of R-330Zh, Borisoglebsk-2 and Zhitel systems for jamming GPS signals and protecting their own strategic infrastructure.”²³³ Several research groups believe that this is not the result of Russia targeting these countries directly but rather is an unintended consequence from Russia sending out electronic interference to protect itself from drone attacks.²³⁴

²²⁶ “Finland reports GPS disturbances in aircraft flying over Russia’s Kaliningrad,” *The Guardian*, March 9, 2022, <https://www.theguardian.com/world/2022/mar/09/finland-gps-disturbances-aircrafts-russia>.

²²⁷ Tor Kjetil Kristoffersen, “Russerne jammer Widerøes GPS-er: – Skaper store problemer for oss,” *Nettavisen*, December 22, 2022, <https://www.nettavisen.no/nyheter/russerne-jammer-wideroes-gps-er-skaper-store-problemer-for-oss/s/5-95-819901>.

²²⁸ “Finnair pauses some Estonia flights due to GPS interference,” *Reuters*, April 29, 2024, <https://www.reuters.com/world/europe/finnair-pauses-flights-tartu-estonia-amid-gps-interference-2024-04-29/>.

²²⁹ Tereza Pultarova, “Disrupted Signals: How Estonia Found Itself on the Front Lines of GNSS Interference in Europe,” *Via Satellite*, January 14, 2025, <https://interactive.satellitetoday.com/via/january-february-2025/disrupted-signals-how-estonia-found-itself-on-the-front-lines-of-gnss-interference-in-europe>.

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²³¹ Markus Jonsson, posting on *Twitter*, January 3, 2024, <https://x.com/auonsson/status/174265903123422420?s=20>.

²³² “Germany says Russia very likely responsible for Baltic GPS disruptions,” *Reuters*, April 5, 2024, <https://www.reuters.com/world/europe/germany-says-russia-very-likely-responsible-baltic-gps-disruptions-2024-04-04/>.

²³³ “Russia’s hybrid warfare in space of GPS waves along the Prut River,” *IPN Press Agency*, May 21, 2024, https://www.ipn.md/en/russia-hybrid-warfare-in-space-of-gps-waves-along-7978_1104640.html.

²³⁴ Shaun Waterman, “Russian Jamming Is Wreaking Havoc on GPS in Eastern Europe. But Is It Hybrid Warfare?,” *Air & Space Forces Magazine*, July 10, 2024, <https://www.airandspaceforces.com/russian-gps-jamming-nato-ukraine/>.

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- 237 Tracy Cozzens, "Russian jamming creates 'Bermuda Triangle' in Baltic," *GPS World*, June 5, 2025, <https://www.gpsworld.com/russian-jamming-creates-bermuda-triangle-in-baltic/>.
- 238 "Minister Sabutis Builds Regional Coalition and Calls for EU Response to GNSS Interference," Lithuanian Ministry for Transport and Communications, June 6, 2025, <https://sumin.lrv.lt/en/news/minister-sabutis-builds-regional-coalition-and-calls-for-eu-response-to-gnss-interference/>.
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As the war in Ukraine continues into 2026, so do concerns about Russia being behind GPS interference, with experts seeing a shift towards more spoofing; as well, this interference over the Baltic frequently comes from two regions within Russia: Kaliningrad and St. Petersburg.²³⁵ Romania's Chief of Defense Staff Gheorghiță Vlad said in May 2025, "We are facing problems with electromagnetic interference, and here I am referring to spoofing and GPS system movements. It is not always daily, but mostly we have weekly challenges."²³⁶ Maritime monitoring services have "seen" ships traveling in circles on land east of the Baltic Sea.²³⁷ Lithuanian Minister of Transport and Communications Eugenijus Sabutis coordinated a letter with 16 other European Union (EU) ministers for transport and digital affairs in June 2025 to the European Commission, calling for a coordinated response to GNSS interference originating from Russia and Belarus.²³⁸ Driving this was an increase in GNSS spoofing and jamming starting in August 2024; the European Council's response to that letter included the following statistics for GNSS interference with aircraft: "In Lithuania: starting from 556 cases in March 2024 to 890 in October 2024 and 1185 in January 2025; in Latvia: from 790 cases in October 2024 to 1288 cases in January 2025; in Estonia: 1150 cases in October 2024 and 1085 cases in January 2025; in Poland: 1908 cases in October 2024 to 2732 cases in January 2025."²³⁹ Estonia announced in July 2025 that it had detected Russia moving jamming equipment to a site (Kingsiepp) 20 km from its border with Estonia.²⁴⁰ That same month, Estonian officials said that Russian GNSS jamming had caused damage worth over €500,000 in the three months prior alone.²⁴¹ Sweden's Department of Transport said in September 2025 that GNSS interference originating in Russian territory was affecting aircraft over the Baltic almost daily and that it has "spread both geographically and in scope... occurring over a larger area over both land and sea in Sweden."²⁴²

In October 2025, the ICAO passed a resolution determining that the GNSS interference originating in Russia was indeed an infraction of the 1944 Convention on International Civil Aviation, condemned it for doing so, and called for it to fulfill its obligations under the Convention.²⁴³

Russia's submission to the ITU's Radio Regulations Board (RRB) in June 2025 indicated that it believed Western satellites being used by the Ukrainian military to be "legitimate targets," and that countries did not have the right to protest if those satellites were jammed.²⁴⁴ This subject came up again in November 2025 at the 100th meeting of the RRB, which discussed harmful interference to radio navigation satellite service (RNSS) for receivers in Estonia, Finland, Latvia, and Lithuania coming from Russian territory; it said that it "again urge[d] the Administration of the Russian Federation to take all possible actions to immediately cease any source of harmful interference to safety services in the RNSS."²⁴⁵

The GPS jamming over Ukraine is reported to have affected at least one space actor's satellites. Aerospace Corporation, a federally funded research and development center, said in July 2025 that in tracking its 10-cubic cm satellites in LEO (which have GPS receivers on them for PNT purposes), there is "a giant hole above the Ukraine region."²⁴⁶

What has been described as a “mass AIS interference event” occurred in the Baltic in November 2025.²⁴⁷ For about 30 minutes, hundreds to possibly thousands of fake AIS messages showed up on tracking platforms, with many pretending to be military ships in the Finnish Gulf. It is thought that this might have occurred via a Finnish terrestrial AIS base due to hacking or spoofing.

In 2021, new research emerged about a Russian program called Tobol that appears to be aimed at protecting Russian satellites from uplink jamming.²⁴⁸ The head of the project is linked to several academic papers and patents related to monitoring authentic satellite signals, detecting any focused interference, and transmitting additional signals to counter the interference. Additional sources suggest that there are at least seven Tobol complexes spread across Russian territory, all of which are co-located with satellite tracking facilities.²⁴⁹ Four are stationary, two are mobile, and the seventh is undetermined as of yet (see Imagery Appendix, pg. 17-28). There is also some evidence to suggest that Russia may be planning a new version or modification to the Tobol system that can attack foreign satellite transmissions, including potentially acting as an uplink jammer for GPS, in addition to (or instead of) protecting Russian satellite transmission.²⁵⁰ Leaked US military documents suggest that Russia has used at least three Tobol installations to try and disrupt Starlink commercial satellite signals over Eastern Ukraine.²⁵¹ Other reports suggest that the GPS jamming and spoofing in the eastern Baltic might be from another Tobol installation in Kaliningrad Oblast (specifically, Pioniersk).²⁵²

Jamming of Communications Satellites

Russia has dedicated capabilities for both downlink and uplink jamming of signals from communications satellites. The R-330Zh “Zhitel” mobile jammer is reportedly able to jam commercial INMARSAT and Iridium receivers within a tactical local area and has been deployed throughout recent Russian military campaigns.²⁵³

Russia has also committed to developing more advanced EW and communications jamming capabilities over the next decade. In November 2017, Oleg Ochasov, the Deputy Head of 46th TsNII research institute of the Ministry of Defense, disclosed to the Russian parliament in connection with the 2018–2027 defense procurement program that the “Tirada-2S electronic warfare complex...specialized in jamming communications satellites” was under development, and “expected to be available in ‘ground’ and ‘mobile’ architectures.”²⁵⁴ The Tirada-2 reportedly can be used to conduct uplink jamming of communications satellites, potentially even capable of causing permanent damage.²⁵⁵ The Russian Ministry of Defense has publicly stated that the Tirada-2 would enter service in 2019 and three additional versions were in development.²⁵⁶ Another system reportedly in development is the Bylina-MM, which is designed to “suppress the on-board transponders of the millimeter band communications satellites Milstar, GBS, Skynet, Sicral, Italsat and Sakura” and may be linked to a much larger EW program also under the name Bylina.²⁵⁷

In September 2018, the Sputnik News service published a report claiming that Russia was developing a new EW aircraft that could be used to target satellite services.²⁵⁸ The project is aimed at replacing the IL-22PP Porubshchik EW aircraft, which has become difficult to support due to its underlying airframe. The new project is reported to add the ability to interfere with space systems as well as air, ground, and maritime systems, but this has not yet been confirmed, nor has the specific capability of the system.

In March 2022, SpaceX CEO Elon Musk also warned Ukrainian users of his

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company's Starlink satellite broadband communication system about potential attacks against end user terminals by Russian forces.²⁵⁹ Musk further claimed that Russia had jammed a Starlink terminal in Ukraine for "hours at a time" before SpaceX was able to ship a software update to mitigate much of the jamming.²⁶⁰ However, there has not been independent or public validation of the type and magnitude of the jamming and the specific mitigation measures taken. In May 2024, Ukrainian military units started to see outages in their Starlink connections, something a Ukrainian government official said was the result of Russia "testing different mechanisms" for its EW systems.²⁶¹

Interestingly, reports emerged in February 2024 that Russian troops had been using Starlink via thousands of its terminals, even though Starlink is not authorized to operate in Russia; it is possible that these were either captured terminals or purchased off the black market.²⁶² A tweet in July 2024 purported to show Starlink terminals that were bought in support of the Russian military by the KatyaValya volunteer group.²⁶³ Russian attack drones were reported in January 2026 to be using Starlink to guide them during strikes.²⁶⁴ To counter this, the Ukrainian government and SpaceX worked to create a verification system where legitimate Ukrainian users would register their terminals and unregistered terminals would be disabled.²⁶⁵ As well, SpaceX enacted an update that would cut connectivity if the user is moving more than 75 kilometers per hour to attempt to keep Russian drones from using Starlink.²⁶⁶

In any case, Russia is also reported to be working on a system, Kalinka, intended to detect and disrupt signals to and from Starlink satellites, with the goal of interfering with drones and Ukrainian military communications; its proponents claim Kalinka can even detect terminals connected to Starshield, the military version of Starlink that is supposed to have stronger security features.²⁶⁷

Another EW system is the Murmansk-BN, which is designed to interfere with High Frequency communications with an estimated range of 5000 - 8000 km; it also can interfere with radio signals, satellite communications, and GPS.²⁶⁸ It is based on six trucks, four of which carry antennas that are 32 meters high.²⁶⁹

Additional reports have surfaced of Russian jamming of communications satellites as part of the armed conflict in Ukraine.²⁷⁰ One known example was jamming that impacted AMOS-3 (2008-022A, 32794), a commercial communications satellite providing direct-to-home television broadcasts in Ukraine. Signal analysis suggests the jamming stemmed from a building owned by the Russian Ministry of Defense northeast of Moscow. A Ukrainian media conglomerate underwent an attack in March 2024 that temporarily broadcast Russian videos over Ukrainian news and other TV shows.²⁷¹ Several European countries also complained in spring 2024 that their broadcasting satellites were being targeted, including interrupting programming to show images of the war in Ukraine. The International Telecommunication Union (ITU)'s Radio Regulations Board expressed in July 2024, "its grave concern regarding the use of signals to cause intentional harmful interference," noting that the interference to Swedish and French satellites "seemed to originate from earth station(s) located in the areas of Moscow, Kaliningrad and Pavlovka" and said that they were "extremely worrisome and unacceptable."²⁷² In fall 2024, French and Luxembourgish TV broadcasting satellites also experienced disruptions in their broadcasts.²⁷³

Jamming of SAR Satellites

The Krasukha-4 mobile electronic warfare system, manufactured by Russia's Radio-Electronic Technologies Group (KRET), is designed to counter airborne early warning and control systems (AWACS) and other airborne radar, ground radars, and radar-guided ordnance and has a reported effective range of 300 km.²⁷⁴ It is comprised of two vehicles, one of which has three parabolic antennae that can rotate and tilt at any angle, and one that has one antennae on its roof, most likely for communications.²⁷⁵ Due to its range and power, it is also reported to be effective against LEO synthetic aperture radar imaging satellites.²⁷⁶ News reports have discussed delivery of a new EW system called Divnomorye that is meant to replace the Krasukha and serve as an integrated EW system against air, space, and ground systems; however, it is unclear what state of development it is in or if it has been fielded.²⁷⁷

In July 2021, several public reports emerged claiming the European Space Agency's Sentinel-1 radar imaging satellite was jammed while imaging locations near the Russian-Ukrainian border.²⁷⁸ The exact source of the jamming, and whether it was deliberate or not, is uncertain as the Sentinel-1 radar operates in C-Band (around 5 GHz), which is also used by various ground-based radar systems. Sentinel-1 is used for civil applications, with a relatively low resolution and all of its data publicly accessible, making it unlikely that it was being used for national security purposes. In March 2022, Ukrainian forces captured a containerized command post for the Krasukha-4 system intact near Kyiv.²⁷⁹

There is some evidence that Russia is planning a follow-on to its Tobol EW system that might be aimed at preventing optical and radar reconnaissance satellites from imaging Russian territory by blocking the signals they send to data relay satellites.²⁸⁰ Russia also has a passive system called Moskva-1, which is reported to be able to detect radar emission sources, including those from SAR satellites.²⁸¹

FIGURE 2-6 — KRASUKHA-4



A Russian mobile electronic warfare system used to jam radar. Image credit: Sputnik News.²⁸²

Space-based Jamming

In October 2019, new research emerged that suggests Russia might be developing a new generation of nuclear reactors to power on-orbit jammers. Research done by Bart Hendrickx uncovered evidence of a project called Ekipazh that involves a Russian company, KB Arsenal, with a long history of

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275 Vladislav V., "Hackers Leak Detailed Photos of Russian EW System 1RL257 Krasukha-4," *Militarnyi*, October 9, 2025, <https://militarnyi.com/en/news/hackers-leak-detailed-photos-of-russian-ew-system-1rl257-krasukha-4/>.

276 "Jamming the Enemy: Russia Ramps Up Production of Electronic Warfare Systems," *Sputnik News*, May 13, 2017, <https://sputniknews.com/military/201705131053579633-russia-electronic-warfare-systems-production/>.

277 Roger McDermott, "Russia's Electronic Warfare Capability: Training and Procurement," *Eurasia Daily Monitor*, May 17, 2018, <https://jamestown.org/program/russias-electronic-warfare-capability-training-and-procurement/>.

278 Dylan Malyasaov, "Russia is jamming European Space Agency's Sentinel satellite," *Defence Blog*, July 25, 2021, <https://defence-blog.com/russia-is-jamming-european-space-agencys-sentinel-satellite/>.

279 Joseph Trevithick, "Ukraine Just Captured Part of One of Russia's Most Capable Electronic Warfare Systems," *The War Zone*, March 22, 2022, <https://www.thedrive.com/the-war-zone/44879/ukraine-just-captured-part-of-one-of-russias-most-capable-electronic-warfare-systems>.

280 Bart Hendrickx, "Re: Russian space-related electronic warfare projects," posting to NASA Spaceflight Forums, February 15, 2022, <https://forum.nasaspaceflight.com/index.php?topic=52194.msg2342023#msg2342023>.

281 Oleksandr Matvienko and Zoriana Semenovich, "Electronic warfare moves to space in Russia-Ukraine war," *Counteroffensive Pro*, January 7, 2025, <https://newsletter.counteroffensive.pro/p/electronic-warfare-moves-to-space-in-russia-ukraine-war>.

282 "Invisible Shield, Invisible Sword: Russia's Electronic Warfare 'Second to None,'" *Sputnik News*, August 31, 2017, <https://sputniknews.com/20170831/russia-electronic-warfare-system-krasukha-1056962045.html>.

- 283 Bart Hendrickx, "Ekipazh: Russia's Top-Secret Nuclear-Powered Satellite," *The Space Review*, October 7, 2019, <https://www.thespacereview.com/article/3809/1>.
- 284 Hendrickx, "Ekipazh: Russia's Top-Secret Nuclear-Powered Satellite," *ibid*.
- 285 Bart Hendrickx, "Re: KB Arsenal's project Ekipazh," posting to the NASA Spaceflight Forum message boards, November 10, 2021, <https://forum.nasaspaceflight.com/index.php?topic=48342.msg2309060#msg2309060>.
- 286 "Countering constellations: Jamming," *SatelliteObservation.net*, March 13, 2024, <https://satelliteobservation.net/2024/03/13/countering-constellations-jamming/>.
- 287 "Countering constellations: Jamming," *ibid*.
- 288 Brandon Davenport and Rich Ganske, "Recalculating Route: A Realistic Risk Assessment for GPS," *War on the Rocks*, March 11, 2019, <https://warontherocks.com/2019/03/recalculating-route-a-realistic-risk-assessment-for-gps/>.

developing nuclear reactors for satellites.²⁸³ The Ekipazh project began on August 13, 2014, under the project code 14F350 and uses language that implies a connection to a "transport and energy module" (TEM) that had been previously proposed as part of the Plazma-2010 nuclear-powered space tug, a project that was apparently never funded.

While the exact payload for the Ekipazh program is unknown, KB Arsenal had previously suggested that the Plazma-2010 could be used to power space-based EW payloads.²⁸⁴ KB Arsenal has argued that the nuclear reactor would be powerful enough to support jammers operating on a wide range of frequencies and interfering with electronic systems over a wide area from highly elliptical or geostationary orbits. Additional documentation emerged in 2021 that suggests the purpose of Ekipazh is indeed to develop a nuclear-powered satellite for electronic warfare.²⁸⁵ Developing and deploying such a system would be consistent with Russia's stated military doctrine for space, but there is currently no public evidence of plans for operational deployment.

One researcher argued that a nuclear-powered satellite is not needed to have the ability to jam target satellites in GEO, noting that any GEO communication satellite could do so by changing its frequency so it is emitting on the frequency used by the target.²⁸⁶ He does posit that perhaps the additional power of nuclear-powered satellites would be helpful in jamming military communication satellites, whose frequency-hopping characteristics may require more power to keep up with, or in jamming multiple frequency bands to affect users of multiple satellites.²⁸⁷

Potential Military Utility /

RF jamming is an effective means of negating certain space capabilities. The most significant and prevalent, thus far, is using EW to degrade the accuracy of GPS-guided systems in tactical scenarios. Given this high reliance of modern militaries on GNSS, and GPS in particular, Russia is likely to yield significant military utility from being able to actively prevent, or even undermine confidence in, the ability of adversaries to use GNSS in a future conflict.

EW can be used to suppress or degrade space capabilities by the uplink jamming of communications satellites. It is an attractive option for counterspace because of its flexibility: it can be temporarily applied, its effects on a satellite are completely reversible, it generates no on-orbit debris, and it may be narrowly targeted, which could affect only one of a satellite's many capabilities (e.g., specific frequencies or transponders). EW is an extremely useful military counterspace capability and is expected to gain even more prominence in the future, in step with increasing autonomy of military systems and increasing reliance on satellite systems.

However, conducting operationally useful, dependable, and reliable jamming of highly-used military space capabilities, such as GNSS, is more difficult than most commentators suggest. Military GNSS signals are much more resilient to jamming than civil GNSS signals, and a wide variety of tactics, techniques, and procedures exist to mitigate attacks.²⁸⁸ It is much more likely that an EW counterspace weapon would degrade military space capabilities rather than completely deny them.

2.4 – RUSSIAN DIRECTED ENERGY WEAPONS

Assessment /

Russia has a strong technological knowledge base in directed energy physics

and is developing a number of military applications for laser systems in a variety of environments. Russia has revived, and continues to evolve, a legacy program whose goal is to develop an aircraft-borne laser system for targeting the optical sensors of imagery reconnaissance satellites, although there is no indication that an operational capability has been yet achieved. Although not their intended purpose, Russian ground-based satellite laser ranging (SLR) facilities could be used to dazzle the sensors of optical imagery or ISR satellites. There is no indication that Russia is developing, or intending to develop, high-power space-based laser weapons.

Specifics /

Russia has a long history of research in high-energy laser physics science and is considered to have advanced technical knowledge and capability in this field. During the 1980s, the USSR reportedly researched several potential anti-satellite laser weapon systems, although there is no evidence that any reached the stage of realistic testing or deployment.²⁸⁹ The most well-known of these was the suspected laser weapons research facility Terra-3 located on the Sary Shagan testing range where the Reagan administration claimed the Soviets were developing advanced anti-satellite laser weapons.²⁹⁰ There was even a rumor that Terra-3 had been used to lase the Space Shuttle Challenger on October 10, 1984.²⁹¹ However, an official US Congressional visit in 1989 found it was more of a "Potemkin village" than an operational weapons site, with lasers that were much less powerful than what the US military already had deployed.²⁹² With the economic turmoil created by the dissolution of the USSR, these programs appear to have been abandoned. However, the scientific knowledge base remained.

Russia has increased funding for some types of military research, which in turn allowed continued Russian research into advanced laser technologies and applications. For example, it was reported that the Institute of Atmospheric Optics at Tomsk developed a laser system with the capability to shoot down drones, using fiber laser technology.²⁹³ This system would, however, have no capability against spacecraft in orbit.

Airborne Laser (ABL) ASAT System

During the 1980s, the USSR began a development program to mount a high-power laser on a modified IL-76 transport aircraft, known as the Beriev A-60. The laser was installed in the cargo bay, with a turret opening on the top of the aircraft. The aircraft was used to test the laser system that was later used in the Skif-DM spacecraft, lost in a failed launch in 1987. The test aircraft was reportedly lost in a fire during the late 1980s. A second aircraft was modified for continued testing. It held ten flights in the early 2000s, and in 2009, the aircraft laser reportedly conducted a successful test of illuminating a Japanese satellite in orbit - Ajisai (1986-061A, 16908).²⁹⁴ Work on the project was halted in 2011, due to lack of funding.²⁹⁵

In 2012, the Ministry of Defense announced the revival of the program.²⁹⁶ In April 2017, Almaz-Antey general designer Pavel Sozinov announced that the company had been ordered by Russian leadership to, "develop weapons that could interfere electronically with or achieve 'direct functional destruction of those elements deployed in orbit.'"²⁹⁷ The new system, called Sokol-Echelon ("Falcon Echelon"), would be equipped with the 1LK222 laser system, apparently a different system than the original Carbon Dioxide laser type from the 1980s; this new laser was supposed to have a range of 300-600 km.²⁹⁸ It reportedly was to be fitted aboard a "brand-new, as-yet-unnamed" aircraft, according to Russian media reports,²⁹⁹ which turned out to be a modified IL-76MD-90A transport.³⁰⁰ The program was again cancelled in 2020.³⁰¹ This decision became moot when

289 John Pike, "Lasers," *GlobalSecurity.org*, updated October 4, 2016, <https://www.globalsecurity.org/space/world/russia/lasers.htm>.

290 "Soviets could have laser able to blind US satellites," *Gadsden Times*, April 10, 1984, <https://news.google.com/newspapers?nid=1891&dat=19840410&id=fqkfAAAIAIAJ&sjid=etYEAIAIAJ&pg=2785,2451827>.

291 Boris Kononenko, "Silent Space is Being Monitored," *Armeyskiy Sbornik*, June 1996, https://web.archive.org/web/20131224105115/http://www.fas.org/news/russia/1996/dru-ma189_s96005.htm.

292 Bill Keller, "American Team Gets Closer Look at Soviet Laser," *New York Times*, July 9, 1989, <https://www.nytimes.com/1989/07/09/world/american-team-gets-close-look-at-soviet-laser.html>.

293 "Russian Scientists Invent Technology to Wirelessly Recharge and 'Kill' Drones," *Russian Aviation*, June 21, 2017, <https://www.ruaviation.com/news/2017/6/21/90427h>.

294 Dwayne A. Day, "Burning Falcon: the death of a Russian laser ASAT plane," *The Space Review*, December 1, 2025, <https://www.thespacereview.com/article/5112/1>.

295 John Pike, "A-60 1A Airborne Laser," *GlobalSecurity.org*, August 3, 2018, <https://www.globalsecurity.org/military/world/russia/a-60.htm>.

296 Pavel Podvig, "Russia to Resume Work on Airborne Laser ASAT," *Russian Strategic Nuclear Forces*, November 13, 2012, http://russianforces.org/blog/2012/11/russia_to_resume_work_on_airbo.shtml.

297 Patrick Tucker, "Russia Claims It Now Has Lasers to Shoot Satellites," *Defense One*, February 26, 2018, <http://www.defenseone.com/technology/2018/02/russia-claims-it-now-has-lasers-shoot-satellites/146243/>; "В РФ разрабатывается противоспутниковая система РЭБ," *Ria Novosti*, April 25, 2017, <https://topwar.ru/114285-v-rf-razrabatyvaetsya-protivosputnikovaya-sistema-reb.html>.

298 Day, "Burning Falcon," *ibid*.

299 Patrick Tucker, "Russia Claims It Now Has Lasers to Shoot Satellites," *Defense One*, February 26, 2018, <http://www.defenseone.com/technology/2018/02/russia-claims-it-now-has-lasers-shoot-satellites/146243/>.

300 Bart Hendrickx, posting on the *NASASpaceflight.com* forums, February 6, 2020, <https://forum.nasaspaceflight.com/index.php?topic=50072.msg2042842#msg2042842>.

301 Bart Hendrickx, "Peresvet: a Russian mobile laser system to dazzle enemy satellites," *The Space Review*, June 15, 2020, <https://www.thespacereview.com/article/3967/1>.

- 302 "Ukrainian Forces Destroyed Russian A-60 Aircraft Equipped with a Laser Capable of Shooting Down Satellites," *Defense Express*, November 25, 2025, https://en.defence-ua.com/news/ukrainian_forces_destroyed_russian_a_60_aircraft_equipped_with_a_laser_capable_of_shooting_down_satellites-16603.html.
- 303 Dimmi, "A-60/78T6/1LK222," *Military Russia*, forum contribution created July 3, 2012, and modified November 26, 2025, <http://militaryrussia.ru/blog/topic-680.html>.
- 304 Bart Hendrickx, "Peresvet: a Russian mobile laser system to dazzle enemy satellites," *The Space Review*, June 15, 2020, <https://www.thespacereview.com/article/3967/1>.
- 305 Bart Hendrickx, "Peresvet: a Russian mobile laser system to dazzle enemy satellites," *The Space Review*, June 15, 2020, <https://www.thespacereview.com/article/3967/1>.
- 306 Hendrickx, "Peresvet: a Russian mobile laser system to dazzle enemy satellites," *ibid*.
- 307 Hendrickx, "Peresvet: a Russian mobile laser system to dazzle enemy satellites," *ibid*.

Ukrainian drones attacked an airbase in Taganrog, Russia in November 2025, where the A-60 had been for a decade, and according to stills from videos of the attack, where the A-60 was destroyed.³⁰²

It is unclear whether its mission was to dazzle or damage satellite sensors; a Russian website with a tremendous amount of information on the program says that it was intended to "blind" space surveillance assets, but that may be a matter of translation.³⁰³ The program's chief designer, Aleksandr Ignatyev, stated in interviews in 2010 and 2014 that the program was initiated in response to the US withdrawal from the Anti-Ballistic Missile Treaty in 2002 and was designed to "counter air-based and space-based reconnaissance assets in the infrared part of the spectrum."³⁰⁴ If the 1LK222 was a solid-state laser, it could be operated at different power levels, thereby making it possible to operate in both laser dazzling and optical sensor damage roles. Due to the technical challenges of operation on an aircraft, it is unlikely that the laser was sufficiently high powered to cause damage to a satellite's structure. Therefore, it was likely intended to target only optical imaging satellites. An airborne system provides a few advantages for laser ASAT systems. The high flight altitude reduces the amount of atmosphere that the laser beam has to traverse, thereby reducing attenuation and beam spreading. However, this advantage comes at the cost of more difficult pointing due to the instability of the aircraft in flight.

Peresvet Mobile Laser Dazzler

Russia is also developing an advanced mobile laser dazzling system known as Peresvet that appears to be designed to protect mobile ICBMs from being imaged.³⁰⁵ The system was formally named in part of a speech by Russian President Vladimir Putin on March 1, 2018, where he boasted about Russia's progress in arming its troops with laser weapons. Putin called for a public contest to name the system, resulting in "Peresvet," which translates to "over-exposure."³⁰⁶ In July 2018, the Russian Ministry of Defense released a second video showing the shelters for the Peresvet vehicles and the training facility for the operators. The shelters are located alongside garrisons near Teykovo, Yoshkar-Ola, and Novosibirsk for the new Topol-MR ICBM currently being deployed (see Imagery Appendix, pg. 17-26).

FIGURE 2-7 — THE PERESVET LASER SYSTEM



A Russian mobile laser system used to dazzle aerial and space reconnaissance assets. Image credit: Russian Ministry of Defense³⁰⁷

The Peresvet system consists of a laser connected to a gimbaled mirror, all of which is mounted inside a truck-towed trailer. A statement by the Russian Ministry of Defense in December 2018 said that the system had entered

“experimental combat duty” and could “efficiently counter any aerial attack and even fight satellites in orbit.”³⁰⁸ Russian officials have claimed that it could blind satellites to an orbit of 1,500 km.³⁰⁹ While the system is unlikely powerful enough to destroy space objects, it is likely capable of temporarily dazzling visible optics used by satellites. Additionally, the system is linked to two patents for a “mobile optical telescope” designed to monitor and clean up space debris. The Chief of the General Staff of Russia’s Armed Forces Valeriy Gerasimov confirmed that Peresvet’s task is to “conceal the movements” of mobile missile systems, suggesting that its job is to dazzle aerial and space reconnaissance systems trying to detect, image, or track Topol-MR deployments.

In June 2020, General Sergei Surovikin, Commander of the Russian Aerospace Forces, gave a lengthy interview in which he stated the Peresvet system was operational.³¹⁰ In May 2022, Russian officials claimed that Peresvet, or potentially an even more advanced version referred to as “Zadira,” was being deployed to the conflict in Ukraine.³¹¹ However, there is no evidence to support that claim, and some social media reports of lasers being fired in the sky are likely due to meteorological phenomena rather than laser weapons.³¹²

Kalina Upgrade to Krona Ground-based Electro-Optical System

There are indications that Russia may be upgrading its Krona optical space surveillance system in the North Caucasus with laser dazzling or blinding capabilities (see Imagery Appendix, pg. 17-49). The Krona complex has historically included ground-based radars and optical telescopes for tracking, identifying, and characterizing space objects. Lasers have long been used to support optical tracking of space objects by providing range-finding for precision tracking and creating artificial guide stars used in adaptive optics. Research by Bart Hendrickx discovered bank guarantees and reports suggesting a project code-named Kalina to upgrade the facilities at Krona to include “functional suppression of electro-optical systems of satellites,” which is likely a euphemism for dazzling or partially blinding optical sensors of satellite systems.³¹³ The project appears to be led by the Scientific and Industrial Corporation “Precision Instrument Systems” (NPK SPP). Public documents suggest the contracts were awarded in 2015 and 2018 and satellite imagery suggests that construction work on the project began in August 2019.³¹⁴

In May 2018, NPK SPP presented a proposal to the Russian Academy of Sciences to install a laser at the Titov Optical Laser Centre (AOLTs) in the Altai mountain range that would be able to deorbit small pieces of space debris through laser ablation.³¹⁵ The idea is similar to historical US proposals such as Project Orion in the 1990s.³¹⁶ More recently, NASA Ames proposed a “LightForce” concept for a less powerful laser to deorbit small space debris through radiation pressure.³¹⁷ Although NASA ultimately passed on the proposal, it has been picked up by a private Australian company, Electro Optic Systems.³¹⁸ It is unclear if the NPK SPP proposal for AOLTs will go forward, or if it is linked to the Kalina proposal.

Satellite Laser Ranging (SLR): Potential for Laser Dazzling

Russia has nine stations that are part of the International Laser Ranging Service Satellite (ILRS) network.³¹⁹ The ILRS network supports laser ranging measurements to cooperative satellites with retro-reflector arrays for scientific purposes. Although it is not their purpose, the stations could be used to dazzle optical imaging satellites (but is harmless to other types of satellites).³²⁰ Additionally, Russia could establish a network of laser dazzling stations near sensitive sites using SLR technology. However, there is no public indication of this occurring, and SLR technology capable of this is not unique to Russia.

308 Hendrickx, “Peresvet: a Russian mobile laser system to dazzle enemy satellites,” *ibid*.

309 Guy Faulconbridge, “Russia uses new laser weapons in Ukraine, Zelenskiy mocks ‘wonder weapon,’” *Reuters*, May 18, 2022, <https://www.reuters.com/world/europe/russia-touts-new-generation-blinding-laser-weapons-2022-05-18/>.

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311 Amy Chang, “Russian touts new laser weapons, but Ukraine and the US are skeptical,” *Washington Post*, May 19, 2022, <https://www.washingtonpost.com/world/2022/05/19/russia-laser-weapon-zadira-peresvet-ukraine/>.

312 Ed Browne, “Fact Check: Did Russia Use Lasers to Target Satellites Over Ukraine Border?” *Newsweek*, October 5, 2022, <https://www.newsweek.com/russia-ukraine-laser-weapon-peresvet-light-1749202>.

313 Bart Hendrickx, “Russia develops co-orbital anti-satellite capability,” *Jane’s Intelligence Review*, September 27, 2018, https://www.janes.com/images/assets/463/83463/Russia_develops_co-orbital_anti-satellite_capability.pdf.

314 Bart Hendrickx, “Kalina: A Russian ground-based laser to dazzle imaging satellites,” *The Space Review*, July 5, 2022, <https://www.thespacereview.com/article/4416/1>.

315 Bart Hendrickx, “Kalina: A ground-based laser ASAT system?,” *NASASpaceflight.com*, October 2, 2018, <https://forum.nasaspaceflight.com/index.php?topic=46485>.

316 J.W. Campbell, “Project ORION: Orbital debris removal using ground-based sensors and lasers,” National Aeronautics and Space Administration, Technical Memorandum 108522, October 1996, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960054373.pdf>.

317 Jahn Stupl et al, Conference paper for AMOS: Advanced Maui Optical and Space Surveillance Conference, September 9, 2014, “LightForce Photon-pressure collision avoidance: Updated efficiency analysis utilizing a highly parallel simulation approach,” <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150000244.pdf>.

318 Nick Grimm, “Scientists plan to use high powered lasers to track and shoot away space junk,” *Australian Broadcasting Corporation*, March 21, 2018, <https://www.abc.net.au/news/2018-03-21/scientists-plan-to-shoot-down-space-junk-with-a-laser/9573066>.

319 International Laser Ranging Service web page, List of Stations; online <https://ilrs.cddis.eosdis.nasa.gov/network/stations/index.html>.

320 Yousaf Butt, “Effects of Chinese Laser Ranging on Imaging Satellites,” *Science and Global Security*, 17:20-35, 2009, <http://scienceandglobalsecurity.org/archive/sgs17butt.pdf>.

- 321 Dwayne A. Day, and Robert G. Kennedy III, "Soviet Star Wars," *Air and Space Magazine*, January 2010, <https://www.airspacemag.com/space/soviet-star-wars-8758185/?all>.
- 322 Day and Kennedy, "Soviet Star Wars," *ibid*.
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- 324 This is a fascinating look into some of the Soviet thinking about how to respond to the United States' Strategic Defense Initiative, as well as the build-up to the Skif-DM: Dwayne A. Day and Robert Kennedy, "Barbarian in space: the secret space-laser battle station of the Cold War," *The Space Review*, June 5, 2023, <https://www.thespacereview.com/article/4598/1>.
- 325 Pavel Podvig, "Did Star Wars Help End the Cold War? Soviet Response to the SDI Program," *Science and Global Security*, 2017, Vol 25 No 1, 3—27, p. 11, <https://scienceandglobalsecurity.org/archive/sgs25podvig.pdf>.
- 326 Dwayne A. Day, and Robert G. Kennedy III, "Soviet Star Wars," *Air and Space Magazine*, January 2010, <https://www.airspacemag.com/space/soviet-star-wars-8758185/?all>.
- 327 House Intelligence Committee, "Statement from Chairman @RepMikeTurner," *Twitter*, February 15, 2024, <https://x.com/HouseIntel/status/1757805804885823775?s=20>.
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- 329 Dustin Volz and Gordon Lubold, "White House confirms Russia is developing antisatellite weapons," *Wall Street Journal*, February 15, 2024, <https://www.wsj.com/politics/national-security/russia-space-weapon-classified-confirmed-b5beacf>.
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- 331 "Security Council Fails to Adopt First-Ever Resolution on Arms Race in Outer Space, Due to Negative Vote by Russian Federation," *United Nations Security Council*, April 24, 2024, <https://press.un.org/en/2024/sc15678.doc.htm>.
- 332 "Statement from National Security Advisor Jake Sullivan on Russia's Veto of the UN Security Council Resolution on the Outer Space Treaty," *White House*, April 24, 2024, <https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2024/04/24/statement-from-national-security-advisor-jake-sullivan-on-russias-veto-of-the-un-security-council-resolution-on-the-outer-space-treaty/>.

Space-Based Laser ASAT

During the 1970s, the USSR researched the development of a space-based high-power laser for anti-satellite missions.³²¹ The program resulted in the production of a concept known as Skif-DM (or Polyus). The Skif-DM vehicle was to be a very large spacecraft (approximately 80 metric tons) that was placed in orbit by the very large Energia space launch vehicle used to launch the Buran space shuttle.³²² On May 11, 1987, an attempted launch of an unarmed Skif-DM mock-up was a failure due to an attitude control problem.³²³ During the flight, the bus (or "functional block") was supposed to turn the spacecraft 180 degrees so that the engines were pointed down; however, there was an issue with the software and the Skif-DM ended up flipping over several times until it was pointed down, at which point its engines fired it into the Pacific Ocean.³²⁴ The mock-up was reportedly a test vehicle for a one-megawatt carbon dioxide laser.³²⁵ No other launches of similar test spacecraft were attempted - there had been plans for follow-on efforts called Skif-D1 and Skif-D2 - and the program was likely abandoned in the turmoil of the dissolution of the USSR in 1991. This was also the first flight of the Energia SLV, which was eventually abandoned together with the Buran space shuttle program.³²⁶

Operating a high-power space-based laser would be a very demanding technological challenge. Achieving high enough power to damage or destroy satellites would require either a large chemical laser or a large solid-state laser. The chemical laser would require a large store of feed chemicals in order to operate for more than a few seconds. Also, venting of the exhaust gasses during operation would pose stability challenges for the spacecraft. A solid-state laser would require a large electrical generation capacity. If achieved with solar panels, a very large array would be required. It would not be possible to surreptitiously deploy either of these concepts in orbit.

There is no evidence that Russia has either the technological capacity or the intent to pursue a space-based laser ASAT capability at this time.

Potential Nuclear Directed Energy Weapon

In February 2024, rumors emerged about the existence of a new kind of Russian DEW threat. It began on February 15 with a cryptic public announcement from Representative Mike Turner, Chairman of the House Select Permanent Committee on Intelligence, that his committee was making classified intelligence on a new Russian threat available to all members of Congress.³²⁷ The following day, anonymous government sources clarified that the threat in question had to do with a new Russian program to develop a "space-based capability to attack satellites using a nuclear weapon."³²⁸ The Biden administration also clarified that this capability is still in development and not yet deployed in orbit, but if done so it would constitute a breach of the *Outer Space Treaty*, which aligns with a nuclear weapon placed into orbit.³²⁹ Russian President Vladimir Putin responded that, "We have always been categorically against the deployment of nuclear weapons in space and we are still against it," and Russian Defense Minister Sergei Shoigu stated, "[W]e don't have this."³³⁰ The United States and Japan co-sponsored a United Nations Security Council resolution in April 2024 that reminded countries of their OST obligations not to put WMD in orbit and urged countries not to develop nuclear weapons with the intention of being placed in orbit; Russia vetoed the resolution (while China abstained), so the resolution did not pass.³³¹ A White House official, in criticizing Russia for its veto, said, "As we have noted previously, the United States assesses that Russia is developing a new satellite carrying a nuclear device."³³²

In May 2024, Mallory Stewart of the US State Department explained that the satellite thought to be related to this program, "is in a region not used by any

other spacecraft, — that which in itself was somewhat unusual. And the orbit is in a region of higher radiation than normal lower Earth orbits, but not high enough of a radiation environment to allow accelerated testing of electronics as Russia has described the purpose to be.”³³³ The satellite in question was almost immediately identified by outside experts as Cosmos-2553, launched in February 2022 and at an altitude of 2100 km, a place of high radiation inside the Van Allen belts.³³⁴ Though based on its orbit to possibly be doing interferometric SAR imaging, outside experts have not ruled out that Cosmos-2553 might have a secondary mission to undertake radiation tests, perhaps to determine whether the orbit is stable enough that a nuclear device could reside in a satellite there without issue.³³⁵ It appears the capability in question would utilize a nuclear weapon to generate an electromagnetic pulse (EMP) that could damage or disable large swaths of satellites. In December 2024, the United States, Japan, and Argentina co-sponsored a resolution, this time at the UN General Assembly, again reminding countries of their OST obligations and calling on countries to not develop nuclear weapons designed to be placed in outer space; it passed.³³⁶

In November 2024, US commercial SSA company LeoLabs, which had been monitoring Cosmos-2553 since its launch, noted that it appeared to be tumbling.³³⁷ LeoLabs reached out to Maxar, a US commercial imagery company, which had taken pictures of Cosmos-2553 in January 2024 and had it take images of the satellite in December 2024 in order to compare; this allowed LeoLabs to confirm “with confidence” that the satellite was unstable and tumbling.³³⁸ When the news of this emerged in April 2025, outside experts were able to conduct photometric analyses of Cosmos-2553 and determine that there were regular changes in its brightness levels.³³⁹ Another commercial SSA company, Slingshot, noticed changes in its brightness starting in May 2024; by the time the news had become public in April 2025, company officials said that it seemed to have stabilized.³⁴⁰ In any case, it is unclear if the tumbling - whether it has stopped or is still on-going - has affected the operability of the satellite.

Based on nuclear testing the United States and the then-Soviet Union did in the early 1960s, there is some understanding in terms of what would happen to satellites exposed to a nuclear detonation. Much depends on the size of the warhead and the altitude at which the warhead is set off. Satellites in the direct line of sight would be exposed to X-ray, gamma, and ultraviolet photons and would be severely damaged or disabled.³⁴¹ The EMP would release a large amount of charged particles into space, which can be trapped by the Earth’s magnetic field and significantly amplify the normal Van Allen radiation belts for an extended period of time. Eventually the trapped particles will diffuse, taking roughly 30 days for GEO and nearly 300 days for LEO; in the meantime, satellites not hardened against extended radiation would likely undergo failures of their circuitry and/or power boards, leaving them unable to maneuver or function.³⁴²

Potential Military Utility /

DEWs, primarily lasers, offer significant potential for military counterspace applications. They offer the possibility of interfering with or disabling a satellite without generating significant debris. The technologies required for ground-based lasers systems are well developed. Ground-based systems can dazzle or blind EO satellites, or even inflict thermal damage on most LEO satellites.

In contrast, the technical and financial challenges to space-based DEW for counterspace remain substantial. These include the mass of the weapon,

333 “The Nuclear Option: Deciphering Russia’s New Space Threat,” CSIS Aerospace Security Project, May 3, 2024, <https://www.csis.org/events/nuclear-option-deciphering-russias-new-space-threat>.

334 Theresa Hitchens, “Is Russia’s Cosmos 2553 satellite a test for a future orbital nuclear weapon?” *Breaking Defense*, May 22, 2024, <https://breakingdefense.com/2024/05/is-russias-cosmos-2553-satellite-a-test-for-a-future-orbital-nuclear-weapon/>.

335 Bart Hendrickx, “Russian research on space nukes and alternative counterspace weapons (part 1),” *The Space Review*, May 13, 2024, <https://thespacereview.com/article/4793/1>.

336 “The Adoption of the Weapons of Mass Destruction in Outer Space Resolution, submitted by Japan, US, and Argentina, at the United Nations General Assembly,” Ministry of Foreign Affairs Japan, December 3, 2024, https://www.mofa.go.jp/press/release/pressite_000001_00771.html.

337 Greg Gillinger, “Tumbled: Cosmos 2553 Update,” *Integrity Flash* vol. 120, May 5, 2025, <https://isr.university.com/2025/05/05/is-sue-120/>.

338 Gillinger, “Tumbled: Cosmos 2553 Update,” *ibid*.

339 Marco Langbroek, “The tumbling behaviour of the mysterious Kosmos 2553 satellite,” *SatTrackCam Leiden (blog)*, May 23, 2025, <https://sattrackcam.blogspot.com/2025/05/the-tumbling-behaviour-of-mysterious.html>.

340 Joey Roulette, “Russian satellite linked to nuclear weapon program appears out of control, US analysts say,” *Reuters*, April 25, 2025, <https://www.reuters.com/business/media-telecom/russian-satellite-linked-nuclear-weapon-program-appears-out-control-us-analysts-2025-04-25/>.

341 “Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack,” Critical National Infrastructures, April 2008, https://permanent.fdlp.gov/LPS101707/A2473-EMP_Commission-7MB.pdf.

342 “Collateral Damage to Satellites from an EMP Attack,” Defense Threat Reduction Agency, August 2010, <https://apps.dtic.mil/sti/pdfs/ADA531197.pdf>.

343 For more information about the effects on satellites from a nuclear explosion in space, see: *Collateral Damage to Satellites from an EMP Attack*, Defense Threat Reduction Agency, DTRA-IR-10-22, August 2010, <https://apps.dtic.mil/sti/pdfs/ADA531197.pdf>; Don Snyder, Angela Putney, Erin N. Leidy, Gavin S. Hartnett, James Bonomo; "The Effects of High-Altitude Nuclear Explosions on Non-Military Satellites," RAND, March 3, 2025, https://www.rand.org/pubs/research_reports/RRA3028-3.html; and Victoria Samson, Seth Walton, Kathleen Brett, "FAQ: What We Know About Russia's Alleged Nuclear Anti-Satellite Weapon," Secure World Foundation, published April 17 2024, updated June 26, 2024, and September 26, 2025, <https://www.swfound.org/publications-and-reports/faq-what-we-know-about-russias-alleged-nuclear-anti-satellite-weapon>.

consumables and disturbance torques (chemical lasers), electrical power generation (solid-state and fiber lasers, particle beams), target acquisition and tracking, and the potentially large constellation of satellites required. The acquisition and tracking challenges are greatly simplified in a co-orbital GEO or LEO scenario.

However, both ground- and space-based DEW counterspace capabilities do have significant drawbacks in assessing their effectiveness. It can be very difficult to determine the threshold between temporary dazzling or blinding and causing long-term damage, particularly since it may depend on the internal design and protective mechanisms of the target satellite that are not externally visible. Moreover, it can be difficult for an attacker to determine whether a non-destructive DEW attack actually worked.

The military utility of a nuclear weapon used as an EMP device against satellites on-orbit is both devastating and limited. In a purely destructive sense, such a weapon could destroy large numbers of satellites. This would be done in two waves: the first would be those satellites in the line of sight of the nuclear explosion; the second would be satellites affected by the increased amount of radiation trapped in the Van Allen belts.³⁴³ However, it would be indiscriminate and destroy Russian satellites as much as any adversary's. Some of the effects would not be felt for days, weeks, or even months as the higher radiation levels slowly degraded unhardened satellites and could persist for years afterwards, endangering the use of space by all countries. Deployment of such a weapon would also be an egregious breach of the *Outer Space Treaty* and likely engender swift political and diplomatic censure from a large number of countries, which would further undermine any benefit that could be derived from its use.

2.5 – RUSSIAN SPACE SITUATIONAL AWARENESS CAPABILITIES

Assessment /

Russia has sophisticated SSA capabilities that are likely second only to the United States. Russian SSA capabilities date to the Cold War and leverage significant infrastructure originally developed for missile warning and missile defense. Although some of these capabilities atrophied after the fall of the Soviet Union, Russia has engaged in several modernization efforts since the early 2000s to reinvigorate them. While the government owned and operated SSA capabilities are limited to the geographic boundaries of the former Soviet Union, Russia is engaging in international civil and scientific cooperative efforts that likely give it access to data from SSA sensors around the globe. Today, Russia maintains a catalog of Earth-orbiting space objects in LEO that is somewhat smaller than that of the United States but a slightly more robust catalog of HEO and GEO objects.

Specifics /

Like the United States, Russia developed its original SSA capabilities as part of the Cold War space and nuclear rivalry. The Russian Space Surveillance System (SKKP) consists of multiple phased array radars that are primarily used for missile warning along with dedicated ground-based electro-optical telescopes. Several of the SKKP sensors are located in former Soviet republics and are operated by Russia under a series of bilateral agreements with the host countries.

Russian ground-based radar tracking of space objects began as part of its ABM and ASAT efforts. The original Russian SSA radars were the 5N15 Dnestr

(NATO codename HEN HOUSE) installations built in the 1960s near Irkutsk and Sary Shagan.³⁴⁴ Each site had four complexes, with each complex containing a pair of Dnestr radars that could track LEO objects linked to a command and control building, and was intended to be the targeting system for the Soviet IV ASAT system (see Russian Co-Orbital ASAT, Section 2.1).³⁴⁵ Beginning in the 1970s, the radars were incrementally upgraded to Dnestr-M and integrated into the national ballistic missile early warning network, and most were later upgraded to the Dnepr variant (see Imagery Appendix, pg. 17-44). The Dnepr upgrades included new installations at Balkhash (modern-day Kazakhstan); Mischelevka, Siberia; Skrunda (modern-day Latvia), Olenegorsk, Kola Peninsula; Sevastopol, and Mukachevo (both in modern-day Ukraine). The dissolution of the Soviet Union eventually led to the radars in Skrunda, Sevastopol, and Mukachevo being shut down by the early 2000s.

In 2009, Russia began construction of the Voronezh phased array radar to replace the Dnestr-M and Dnepr radars for both ballistic missile early warning and SSA missions (see Imagery Appendix, pg. 17-42). The Voronezh-M uses very-high frequency (VHF) radio waves, Voronezh-DM uses UHF, and Voronezh-VP works in L-Band. The DM version is claimed to be able to detect objects the size of a soccer ball at 8,000 kilometers and track up to 500 objects simultaneously. The first Voronezh was built at a new location in Lekhtusi near St. Petersburg and was operational in 2012.³⁴⁶ The remaining Dnepr radar sites were planned to be converted over to Voronezh by 2022, with several new sites also being developed.³⁴⁷ There are seven radar sites with three more under construction. It is unclear if all of these sites are actively involved in providing SSA data. Two of the radars were attacked by Ukrainian drones in May 2024: a Voronezh-DM in Armavir on May 22 and then a Voronezh-M in Orsk on May 26.³⁴⁸

In recent years, Russia has also developed newer radars that are specifically designed for SSA. Razvyazka, also known as 14Ts031, is described as a digital active phased-array antenna operating in the P-band and designed to track space objects as small as 10 cm.³⁴⁹ The Razvyazka project began in 2009 and is located near the town of Chekhov southwest of Moscow, on the site of a legacy Dunai-3U missile warning radar. In June 2023, the Russian Ministry of Defence reported that the Razvyazka site was finally operational (see Imagery Appendix, pg. 17-47).³⁵⁰

Russia's primary optical SSA facility is the Okno ("Window") complex located near the city of Nurek in northern Tajikistan (see Imagery Appendix, pg. 17-51). The Okno facility consists of a cluster of 10 electro-optical telescopes, laid out in 2 clusters of 4 and 6 telescopes each, that are designed to detect space objects at altitudes from 2,000 to 40,000 kilometers, although some reports suggest an additional capability to track space objects down to 120 km and up to 50,000 kilometers, as well as conduct TT&C with Russian civilian satellites.³⁵¹ Each telescope is covered by a 25-meter metal dome to protect it during the daytime. Although construction began in the 1980s, it was not commissioned until 2004 and underwent significant modernization that was completed in 2018. Originally, Western analysts suspected Okno was being built as a laser weapons site, but those speculations were proven wrong.³⁵² Originally, a total of four Okno sites were planned throughout the Soviet Union, but ultimately work was only started on one, Okno-S, in Primorsky Krai in the Russian Far East. However, open source analysts have yet to identify the site nor determine its status.

Russia also operates the Krona radio-optical complex near Storozhevaya in southwestern Russia (see Imagery Appendix, pg. 17-48). Krona uses a combination of radar and optical sensors to track, image, and characterize

344 Sean O'Connor, "Soviet and Russian Space Surveillance Facilities," *IMINT and Analysis*, June 23, 2008, <https://geimint.blogspot.com/2008/06/soviet-russian-space-surveillance.html>.

345 O'Connor, "Soviet and Russian Space Surveillance Facilities," *ibid*.

346 Pavel Podvig, "Radar in Lekhtusi Begins Combat Duty," *Russian Strategic Nuclear Forces*, February 11, 2012, http://russianforces.org/blog/2012/02/radar_in_lekhtusi_begins_combat.shtml.

347 "Three Advanced Early Warning Radars Enter Service in Russia," TASS, December 19, 2017, <https://tass.com/defense/981965>.

348 David Brennan, "Map Shows Ukraine's Record-Breaking Hits on Russian Nuclear Warning Sites," *Newsweek*, May 28, 2024, <https://www.newsweek.com/map-ukraine-record-breaking-hits-russian-nuclear-warning-radar-1905221>.

349 Bart Hendrickx, "Re: Russia's space surveillance network," posting on *NASASpaceFlight.com* forums, June 16, 2023, <https://forum.nasaspaceflight.com/index.php?PHPSESSID=g-1s1u6hvcf7n3fqklnqoifnqei&topic=55993.msg2497800#msg2497800>.

350 "Bart Hendrickx, "Re: Russia's space surveillance network," posting on *NASASpaceFlight.com* forums, June 10, 2022, <https://forum.nasaspaceflight.com/index.php?PHPSESSID=g-1s1u6hvcf7n3fqklnqoifnqei&topic=55993.msg2376324#msg2376324>.

351 Allen Thompson, "Sourcebook on the Okno, Okno-S, Krona, and Krona-N Space Surveillance Sites," *Federation of American Scientists*, Version 2014-11-19, pg 6 and pg 15, <https://fas.org/spp/military/program/track/okno.pdf>.

352 William Broad, "Private Satellite Photos Offer Clues About Soviet Laser Site," *New York Times*, October 23, 1987, <https://www.nytimes.com/1987/10/23/us/private-satellite-photos-of-fer-clues-about-soviet-laser-site.html>.

- 353 Allen Thompson, "Sourcebook on the Okno, Okno-S, Krona, and Krona-N Space Surveillance Sites," *Federation of American Scientists*, Version 2014-11-19, <https://fas.org/spp/military/program/track/okno.pdf/>.
- 354 Thompson, "Sourcebook on the Okno, Okno-S, Krona, and Krona-N Space Surveillance Sites," *ibid*.
- 355 Allen Thompson, "The Altay Optical-Laser Center Sourcebook," *Federation of American Scientists*, updated March 29, 2011, <https://fas.org/spp/military/program/track/altay.pdf>.
- 356 Thompson, "The Altay Optical-Laser Center Sourcebook," *ibid*, p. 3.
- 357 Steven Aftergood, "Russia Images the LACROSSE Spysat," *Secrecy News*, April 23, 2015, <https://fas.org/blogs/secrecy/2015/04/lacrosse-altay/>.
- 358 "Russia to Deploy New Space Surveillance System Element to Four Regions," *Sputnik*, November 30, 2016, <https://www.defencetalk.com/russia-to-deploy-new-space-surveillance-system-elements-in-four-regions-68624/>.
- 359 Bart Hendrickx, "Russia's space surveillance network," *NASASpaceflight.com* forums, March 29, 2022, <https://forum.nasaspaceflight.com/index.php?topic=55993.msg2355021#msg2355021>.
- 360 Tereza Pultarova, "Ukraine destroys giant radio telescope used by Russian military," *Space.com*, September 18, 2025, <https://www.space.com/astronomy/drone-destroys-rt-70-radio-telescope-crimea>.
- 361 Hendrickx, "Russia's space surveillance network," *ibid*; Pultarova, "Ukraine destroys giant radio telescope," *ibid*.
- 362 "Russia to Set Up SSA Observatories Along Arctic Ocean Coast," *SpaceWatchGlobal*, November 2018, <https://spacewatch.global/2018/11/russia-to-set-up-ssa-observatories-along-arctic-ocean-coast/>.
- 363 I. Molotov, V. Voropaev, G. Borovin, and A. Romanov, "International Scientific Optical Network (ISON) for the Near-Earth Space Monitoring: the Latest Achievements and Prospects," *ISON*, presentation to the fifty-fourth session of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, January 30 – February 10, 2017, <https://www.unoosa.org/documents/pdf/copuos/stsc/2017/tech-05E.pdf>.
- 364 Molotov, Voropaev, Borovin, and Romanov, "International Scientific Optical Network (ISON) for the Near-Earth Space Monitoring: the Latest Achievements and Prospects," *ibid*.
- 365 The public catalog can be accessed at <http://spacedata.vimpel.ru/>.
- 366 United Nations Office for Outer Space Affairs, "UNOOSA and the Keldysh Institute of Applied Mathematics are Working on an Announcement of Opportunity to Provide Telescopes to Institutions in Developing Countries," *SpaceRef*, December 24, 2019, <http://www.spaceref.com/news/viewpr.html?pid=55062>.
- 367 Bart Hendricks, "Russia's Space Surveillance Network," *NASASpaceflight forums*, March 9, 2022, <https://forum.nasaspaceflight.com/index.php?topic=55993.msg2348815#msg2348815>.

space objects. The radar, located at 43.826155°N, 41.343355°E, includes both ultra-high frequency (UHF) and super-high frequency (SHF) transmitters. The optical sensor complex (30J6, see Imagery Appendix, pg. 17-49) is located 30 km away at 43.7169171°N, 41.2316883°E and includes a laser locator and electro-optical imager.³⁵³ The dual radar bands allow for both broad area search and detection and precise tracking. The precise tracking data is used to aim the laser, which then generates a precise lidar image of the object. Another complex, Krona-N, is located at 42.9353°N, 132.5770°E, near Nakodka in the Russian Far East.³⁵⁴

The Altay Optical Laser Center, located near the small Siberian town of Savvushka, is a specialized facility for providing high resolution images of space objects.³⁵⁵ The facility uses a laser rangefinder and a 60-cm telescope equipped with adaptive optics to enable high resolution images of satellites in LEO. A second 3.12-meter telescope is under construction that would allow an imaging resolution of 25 cm or better out to 1,000 km.³⁵⁶ In 2015, the site was reportedly used to image a US LACROSSE radar reconnaissance satellite.³⁵⁷ Russia is currently engaged in programs to upgrade many of its SKKP sensors, although its current status is difficult to judge from open sources.

In 2016, Russian state media reported that upgrades were planned for four radio-electronic sensor complexes in the Altai Republic, the Far East, Crimea, and the Republic of Buryatia,³⁵⁸ which appears to be a new program called Pritsel ("Target") under the code 14Sh33.³⁵⁹ The project officially started in 2007 and includes optical telescopes in multiple locations co-located with other types of sensors. In August 2025, Ukrainian drones destroyed the RT-70 radio telescope located near Yevpatoria, Crimea.³⁶⁰ This telescope was part of a space tracking station and had been used to communicate with interplanetary missions; it also was reported to have been upgraded to be used as an antenna for the GLONASS system, making it thought to be 30 percent more accurate, and to be used by Russia for military communications.³⁶¹

Russia has also announced plans to set up new ground-based observatories in the Nenets Autonomous Region to monitor space objects in polar orbits.³⁶² In addition to the government owned and operated facilities, Russia also has a program to develop a network of scientific instruments for SSA purposes. The International Scientific Optical Network (ISON) is a collection of more than 38 observation facilities of various affiliation with 90 telescopes in 16 countries that are coordinated by the Keldysh Institute of Applied Mathematics (KIAM) of the Russian Academy of Sciences.³⁶³ The telescopes are used to track space objects and orbital debris in Earth orbit as well as Near-Earth Objects (asteroids and comets) in orbit around the Sun. The ISON network includes four different types of partners: 26 telescopes used by KIAM for scientific research, 24 telescopes used by KIAM Ballistics Service for commercial purposes, 22 telescopes used by Roscosmos/TsNIIMash for conjunction analysis, and 18 telescopes used by the Vypel Corporation for SSA.³⁶⁴ The network collects more than 2 million observations annually and maintains a catalog of more than 6,000 space objects in HEO or GEO orbits. In 2014, Vypel launched a public portal to access the catalog maintained by ISON.³⁶⁵ In December 2019, KIAM announced a partnership with the United Nations Office of Outer Space Affairs to launch a project to provide small telescopes and training to select developing countries free of charge beginning in 2020.³⁶⁶

Russia has also been working on a mobile optical sensor complex known as Zorkiy ("sharp-sighted," "vigilant").³⁶⁷ The project appears to have been proposed as early as 2009 but more recent contracts suggest an actual starting date of 2015. Zorkiy appears to consist of a vehicle-mounted 1.5 m optical telescope

along with a second control vehicle and was intended to be used for observing small objects in HEO or GEO orbits from prepared observation sites.

Russian SSA data is processed by two different centers, one military and one civil. The military center is the 821st Main Centre for Reconnaissance of Situation in Space (Главный центр разведки космической обстановки, tr. GTsRKO), located in the village of Dubrovo about 35 kilometers outside of Moscow.³⁶⁸ The Centre controls the SKKP and uses its data products for both offensive and defensive counterspace applications. In 2016, a new civil SSA monitoring center called Automated Warning System on Hazardous Situations in Outer Space (ASPOS OKP) began operations under contract to Roscosmos.³⁶⁹ ASPOS OKP utilizes data from ISON and other Russian SSA assets to detect and track objects in Earth orbit above 2000 kilometers and provide a range of SSA services, including conjunctions, fragmentations, reentries, and post-mission disposal.

In May 2020, Roscosmos outlined plans for several upgrades to its SSA capabilities under a program called Milky Way.³⁷⁰ In remarks to the TASS news agency, Alexander Bloshenko, Roscosmos Executive Director for Long-Term Programmes and Science, said that Russia would develop at least one space surveillance satellite and space surveillance hosted payloads on future Sfera-class Earth observation satellites, and a hosted payload on the ISS, to complement its existing ground-based telescope network.³⁷¹ Bloshenko stated that these upgrades, along with machine learning, would allow Russia to better identify orbital debris and reduce uncertainty in calculating collision hazards in LEO. Another presentation outlined plans to add radiofrequency and radar tracking capabilities to complement optical tracking capabilities.³⁷²

Evidence suggests that the first of these “Milky Way” complimentary upgrades is complete and is part of the Integrated Observation Complex (OKN) located in Russia’s Far East.³⁷³ OKN is a military facility that was primarily designed to monitor telemetry from rocket launches and the upgrades combine optical tracking telescopes with radiofrequency monitoring antennas and a computer control system. Plans announced to have additional OKN sites in Mexico or Cuba appear to be on hold.

Russia also has several institutions involved in space weather research. Russia operates a network of ground stations that cover 170 degrees of longitude and 60 degrees of latitude to measure various geomagnetic and space weather effects.³⁷⁴ Russia also operates multiple satellites with on-orbit space weather sensors, including the Meteor series of polar-orbiting meteorological satellites. Space weather predictions and warnings are provided by the Federal Service for Hydrometeorology and Environmental Monitoring.³⁷⁵ The Institute for Applied Geophysics contributes to the ISES.

Military Utility /

Russia possesses sophisticated SSA capabilities that allow it to track, identify, and characterize nearly all objects bigger than 10 cm in Earth orbit. While the Russian SKKP possesses many of the same shortcomings of the US SSN in geographic coverage of LEO due to its northern location, the addition of the ISON network eliminates those shortcomings for GEOs. Russian SSA capabilities were originally developed as part of their ASAT capabilities and likely maintain the ability to effectively detect, track, characterize, and target many adversaries’ national security satellites. The ongoing modernization of Russia’s SSA capabilities, combined with the modernization of their offensive counterspace capabilities, suggests a focus on developing an integrated operational system for future conflicts that extend into space.

368 “Главный центр разведки космической обстановки отметил свое 25-летие,” *Topwar.ru*, July 11, 2013, <https://topwar.ru/30674-glavnyy-centr-razvedki-kosmicheskoy-obstanovki-otmetil-svoe-25-letie.html>.

369 V. Agapov, “The use of ASPOS OKP System in the Interests of Ensuring the Safety of Space Operations and Increasing Awareness About the Situation in High Orbits,” presentation to the sixty-first session of the United Nations Committee on the Peaceful Uses of Outer Space, June 25, 2018, <http://unoosa.org/documents/pdf/copuos/2018/copuos2018tech05E.pdf>.

370 “Russia to develop space surveillance satellite to monitor space debris as part of Milky Way SSA network,” *SpaceWatch Global*, June 2020, <https://spacewatch.global/2020/06/russia-to-develop-space-surveillance-satellite-to-monitor-space-debris-as-part-of-milky-way-ssa-network/>.

371 “Russia to launch first satellite to monitor space junk in 2027,” *TASS*, May 28, 2020, <https://tass.com/science/1161437>.

372 Vladimir Agapov, “Неопределённости при оценивании и прогнозировании параметров движения центра масс космических объектов в ОКП, связанные с невозможностью прямого учёта ряда возмущающих факторов негравитационной природы,” 2022, <http://bsfp.iszf.irk.ru/sites/default/files/school/2022/materials/AgapovVM.pdf>.

373 Bart Hendrickx, “Re: Russia’s space surveillance network,” posting on *NASASpaceFlight.com* forums, March 31, 2023, <https://forum.nasaspaceflight.com/index.php?PHPSESSID=g-1s1u6hvcf7n3fqklnqoifnqe&topic=55993.msg2471131#msg2471131>.

374 S. Avdyushin et al, “Russian Space Weather Initiatives,” *ResearchGate*, January 1999, https://www.researchgate.net/publication/237384438_RUSSIAN_SPACE_WEATHER_INITIATIVES.

375 “Space Weather Today and Possible Effects,” *Federal Service for Hydrometeorology and Environmental Monitoring*, accessed February 21, 2020, <http://space-weather.ru/index.php?page=home-en>.

- 376 S.G. Chekinov, and S.A. Bogdanov, "Evolution of the Essence and Content of the Concept of War in the 21st Century," *Voennaia mysl*, no. 1 (2017), <https://dlib.eastview.com/browse/doc/48113925>; Daniel Coats, "Worldwide Threat Assessment of the US Intelligence Community: Statement for the Record," March 6, 2018, <https://www.dni.gov/index.php/newsroom/congressional-testimonies/item/1851-state-ment-for-the-record-worldwide-threat-as-sessment-of-the-us-intelligence-community>.
- 377 Anton Petrov, "Future Warfare," *Moscow Defense Brief*, no. 3 (2016), <http://www.mdb.cast.ru/mdb/3-2016/item1/article1/>.
- 378 S.G. Chekinov, and S.A. Bogdanov, "Evolution of the Essence and Content of the Concept of War in the 21st Century," *Voennaia mysl*, no. 1 (2017), <https://dlib.eastview.com/browse/doc/48113925>.

2.6 – RUSSIAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Assessment /

Russian military thinkers see modern warfare as a struggle over information dominance and net-centric operations that can often take place in domains without clear boundaries and contiguous operating areas. To meet the challenge posed by the space aspect of modern warfare, Russia is pursuing goals of incorporating EW capabilities throughout its military to both protect its own space-enabled capabilities and degrade or deny those capabilities to its adversary. In space, Russia is seeking to mitigate the superiority of US space assets by fielding a number of ground-, air-, and space-based offensive capabilities. Russia has re-organized its military space forces into a new organization that combines space, air defense, and missile defense capabilities. Although technical challenges remain, Russian leadership has indicated that Russia will continue to seek parity with the United States in space.

Specifics /

Russian Military Thought and Initiatives on Space and Conflict

Having observed the US way of war during the past several decades, the Russian political and military leadership have come to see the military aspect of space as essential to modern warfare and winning current and future conflicts. While it is true that the Russian military sees the US reliance on space-based assets as a vulnerability to be exploited, Russian thinking about conflict in space and space in conflict is much more a reflection of the evolution of modern warfare and the struggle to achieve information dominance during military operations.³⁷⁶ To that end, the Russian military is aggressively pursuing capabilities to degrade or destroy adversary space-based assets as well as negate the advantage of space-based capabilities in theaters of conflict. At the same time, the Russian military is expanding its presence in space and its ability to use space-based capabilities to enhance the performance of its forces in conflict. Given Russian views of the nature of warfare and its perceptions of the threat environment facing the Russian Federation, Russian investment in the space domain is certain to continue.

Russian Views of Space and Modern Warfare

Russian leadership and military assessments of the security aspect of space must be understood within the larger context of Russian views of modern warfare. Russian strategists see the trajectory of modern warfare being dominated by the struggle to achieve information dominance as a prerequisite to military victory.³⁷⁷

Information-driven modern technologies ranging from long-range precision strike platforms to offensive cyber capabilities are driving a Russian view of modern conflict as evolving toward non-contact warfare (*beskontaktnaia voenna*). According to this view, technological advancements enable adversaries to target and conduct offensive operations against each other's assets and critical infrastructure without entering the physical geographic theater of conflict.³⁷⁸ This concept also appears in the Russian military at times under different rubrics such as sixth generation warfare in the 1990s and early 2000s, and perhaps more recently as "new type warfare."

Space-based, information-driven military capabilities make non-contact warfare possible, through such enabling actions as queuing and guidance of long-range strike assets. This is but one application of space-enabled information. Russian security strategists believe the struggle for information dominance begins before the conflict and, once the conflict has ensued,

is used to dominate an opponent's decision-making by either denying the adversary's ability to utilize space-enabled information or by corrupting that information to mislead an adversary into making decisions contrary to their military objectives.³⁷⁹

Space in Conflict

The role of space in conflict is to provide the information necessary to employ one's forces and weapons and to deny that ability to one's adversary. The Russian military has invested heavily in electronic warfare, in part, to mitigate US space-based capabilities.

During the late 1990s and early 2000s, Russia's GLONASS satellite system had atrophied to a mere seven satellites, not enough for effective military application. For example, in the first Chechnyan war from 1994-1996, Russian pilots and ground forces came to partially rely on western-based GPS navigation systems.³⁸⁰

Since 2011, Russia has maintained the minimum 24 GLONASS satellites necessary for its military applications.³⁸¹ The return of Russian space-based capabilities is increasing the capability and effectiveness of Russian forces and weapons platforms, a capability that some Russian writers suggest signals Russia's ability to conduct non-contact warfare.³⁸² A fully functioning GLONASS architecture benefits Russian forces in navigation, PGM employment, and command and control. For example, satellite-based course correction for some Russian PGMs decreased the impact deviation from 30 to less than 10 meters.³⁸³ In Syria, Russian forces have used satellite-enabled weapons ranging from more accurate air-launched and dropped munitions to sea-based PGM employment.³⁸⁴ Satellite navigation has also improved Russian situational awareness on the ground.³⁸⁵ The Ukrainian Ministry of Defence reported in November 2022 that GLONASS data has been used in the conflict: microchips in Russian drones and missiles receive information from GLONASS and use that for navigation and targeting.³⁸⁶

Russian capabilities to deny an adversary's use of space-based information span the military spectrum from the tactical through the operational and into the strategic levels of war. At the tactical level, GPS jamming platforms such as the Zhitel would be employed in conflict to deny western forces the use of GPS.³⁸⁷ At the operational-strategic level, other systems would challenge western military forces' use of satellite-based communications over large sections of the battlefield.³⁸⁸ The Russian military is integrating these capabilities into all of its combat units down to the lowest level with an understanding that information warfare, to include space-based capabilities, is essential to winning in modern warfare.

Conflict in Space

There is an obvious overlap between space in conflict and conflict in space. Considerations of the military aspects of the space domain drive several concerns and initiatives from the Russian political and military leadership. First, as noted earlier, the Russian military sees the US reliance on space-based capabilities as a potential vulnerability to be exploited during conflict. Space control is perceived to be important for situational awareness and enhancing warfighting capabilities in times of conflict.³⁸⁹ The Russian forces also see their space-based capabilities as enabling more effective early warning and combat operations, especially when one considers the contrast between operations against Georgia and recent operations in Syria and Ukraine; additionally, escalation options are given by space and counterspace capabilities as a conflict evolves through different phases.³⁹⁰ However, based on an understanding of the US vulnerability, the Russian military understands

379 Yu Donskov, A.L. Moraresku, and V.V. Panasyuk, "On the Issue of Disorganization of Command and Control," *Voennaia mysl*, no. 8 (2017).

380 Anton Lavrov, "Russia's GLONASS Satellite Constellation," *Moscow Defense Brief*, no. 4 (2017), <http://www.mdb.cast.ru/mdb/4-2017/item2/article3/>.

381 Lavrov, "Russia's GLONASS Satellite Constellation," *ibid*.

382 Constantine Bogdanov, "Russian Operations in Syria," *Natsionalnaia oborona*, no. 12 (2017).

383 Bogdanov, "Russian Operations in Syria," *ibid*.

384 Dmitry Kornev, "Russian High-Precision Weapons in Syria," *Moscow Defense Brief*, no. 3 (2016), <http://www.mdb.cast.ru/mdb/3-2016/item4/article1/>.

385 Anton Lavrov, "Russia's GLONASS Satellite Constellation," *Moscow Defense Brief*, no. 4 (2017), <http://www.mdb.cast.ru/mdb/4-2017/item2/article3/>.

386 "Foreign-made components help guide Russian missiles to Ukraine, says Ukraine's intelligence," *The New Voice of Ukraine*, November 25, 2022, <https://english.nv.ua/nation/foreign-made-components-help-guide-russian-missiles-to-ukraine-says-ukraine-s-intelligence-50286734.html>.

387 Roman Skomorokhov, "Станция постановки помех Р-330Ж «Житель»," accessed March 15, 2018, <https://topwar.ru/98467-stanciya-postanovki-pomeh-r-330zh-zhitel.html>.

388 Dmitry Yurov, "Мат в два хода: как «Мурманск-БН» нейтрализует силы НАТО за минуты [Mate in two moves: how 'Murmansk-BN' neutralizes NATO forces in minutes]," *Tvzvezda.ru*, October 18, 2016, <https://tvzvezda.ru/news/forces/content/201610180741-uzd8.htm>.

389 Michael Connell with contributions by Samuel Bendett and Brooke Lennox, "The Role of Space in Russia's Operations in Ukraine," Center for Naval Analyses Occasional Paper Series, November 2023, <https://www.cna.org/reports/2023/11/Role-of-Space-in-Russias-Operations-in-Ukraine.pdf>.

390 Connell, Bendett, and Lennox, "The Role of Space in Russia's Operations in Ukraine," *ibid*.

- 391 "Рогозин предупредил о необратимых последствиях размещения оружия США в космосе [Rogozin warned about the irreversible consequences of placing US weapons in space], *VPK*, March 14, 2018, <https://vpk-news.ru/news/41695>; Vladimir Kozin, "Pentagon Rushes Into Space," *Red Star*, 2017, No. 2 37, <https://dlib.eastview.com/search/pub/doc?art=64&id=48594676>; B.L. Zaretsky, "Aerospace Security of Russia - VM," *Voennaia mysl*, no. 9 (2015), <https://dlib.eastview.com/browse/doc/45346075>.
- 392 Daniel Coats, "Worldwide Threat Assessment of the US Intelligence Community: Statement for the Record," March 6, 2018, <https://www.dni.gov/index.php/newsroom/congressional-testimonies/item/1851-statement-for-the-record-worldwide-threat-assessment-of-the-us-intelligence-community>.
- 393 Cheyenne Trotter, "Exploring Factors for US-Russia Crisis Stability in Space," *RAND*, January 21, 2025, https://www.rand.org/pubs/research_reports/RRA2313-3.html.
- 394 John Klein and Clementine G. Starling-Daniels, "Countering Russian escalation in space," *The Atlantic Council*, January 21, 2026, <https://www.atlanticcouncil.org/in-depth-research-reports/report/countering-russian-escalation-in-space/>.
- 395 "Russia vows to 'respond' to any weapon deployment in space: state space corporation," *Xinhua*, November 22, 2024, <https://english.news.cn/europe/20241122/50187c69598d-46049ce03befa48c82f7c.html>.
- 396 Victor Mokhov, "Russian Satellites: Failure After Failure," *Moscow Defense Brief*, no. 6 (2015), <http://www.mdb.cast.ru/mdb/6-2015/item3/article1/>.
- 397 Ivan Cheberko, "Launch of the Satellite System Arktika is Postponed Until 2018," *Defense & Security*, 2016, No. 967, <https://dlib.eastview.com/search/pub/doc?art=11&id=47537968>.
- 398 "Путин анонсировал полет российской миссии на Марс в 2019 году," accessed March 15, 2018, <http://www.interfax.ru/russia/603683>; "Путин рассказал о новых космических проектах России," accessed March 15, 2018, <https://www.vesti.ru/doc.html?id=2876961>.
- 399 "Russian space agency head says satellite hacking would justify war - report," *Reuters*, March 2, 2022, <https://www.reuters.com/world/russia-space-agency-head-says-satellite-hacking-would-justify-war-report-2022-03-02/>.
- 400 "Russia warns West: We can target your commercial satellites," *Reuters*, October 27, 2022, <https://www.reuters.com/world/russia-says-west-commercial-satellites-could-be-targets-2022-10-27/>.

that its own space-based capabilities are a vulnerability that must be mitigated through both offensive means and retaining key capabilities and knowledge that is not reliant on space-based information. Finally, the Russian leadership is concerned about the possibility of space-based weapons that can target ground-based assets and critical infrastructure.

One could argue, based on public Russian statements and initiatives, such as promoting treaties against the weaponization of space, that the Russian concern over the militarization of space is in response to US initiatives.³⁹¹ It is more likely, however, that Russian strategists see space as a natural domain within which competition and conflict will grow. Motivations aside, Russian military leaders and the defense industry are aggressively pursuing destructive and non-destructive ground-, air-, and space-based anti-satellite capabilities.³⁹² It is argued that since 2022, Russian thinkers have become more comfortable with using offensive counterspace capabilities.³⁹³ This particularly might be in the case in early stages of a conflict where the goal would be to prevent the adversary from access to their space assets to remove that asymmetric advantage.³⁹⁴ The then-head of Roscosmos, Yuri Borisov, stated in November 2024 that Russia would "respond," should any country place weapons in space, adding that "Russia has firmly and consistently maintained its position against the deployment of any weapons into space."³⁹⁵

Russian objectives in space, however, face significant challenges over the near term primarily from industry shortcomings.³⁹⁶ The Ukraine conflict and the subsequent sanctions placed on Russia brought to light several Russian industrial and technological deficiencies in its space program such as the hardening and miniaturization of electronics.³⁹⁷ Despite these challenges, Russian President Vladimir Putin announced a series of initiatives suggesting that Russia intends to aggressively address its shortfalls in space.³⁹⁸

Russia has also made recent statements on its interpretation of attacks against satellites. In March 2022, the head of Roscosmos stated publicly that any cyber attacks on Russian satellites would be taken as a justification for war.³⁹⁹ In October 2022, a senior Russian official in the Foreign Ministry stated that commercial satellites from the United States and its allies could become legitimate targets if they were involved in the war in Ukraine.⁴⁰⁰

Space and Counterspace Organization

Russian space activities are run by Roscosmos. Created in 1992 as the Federal Space Agency, it was dissolved in 2015 and its responsibilities transferred to the Roscosmos state corporation, which was merged with the United Rocket and Space Corporation.⁴⁰¹ In its current form, Roscosmos is responsible for Russian civil space activities as well as supervising companies manufacturing civil and military space, missile, and rocket hardware. Russia's space strategy is defined by the Ministry of Defense, although some suggest Roscosmos may have a role.⁴⁰² In 2015, Russia also reorganized its military space forces. From 2001 until 2011, Russian military space forces were a separate branch of the military. In 2011, they became part of the Aerospace Defense Troops, and in 2015, the Aerospace Defense Troops were merged with the Air Force to become the Aerospace Forces. The new Aerospace Forces have authority for conducting space launches, maintaining ballistic missile early warning, the satellite control network, and the space surveillance network along with anti-air and anti-missile defense.⁴⁰³ According to Russia Defense Minister Sergei Shoigu, the move was motivated by a recognition of a, "shift in the combat 'center of gravity' toward the aerospace theater," and also a desire to counter US capabilities such as the Prompt Global Strike Program.⁴⁰⁴

A report issued in 2017 noted that company-level EW units, including a platoon dedicated to operating the R-330Zh "Zhitel" counter-GPS and satellite communications jammer, are now included organically within each Russian Motorised Rifle Brigade.⁴⁰⁵ Additionally, Russia maintains five dedicated EW brigades that can provide operational or strategic effects out to several hundred km.⁴⁰⁶

The budget for Russian military space activities was estimated at \$1.7 billion in 2020.⁴⁰⁷ In 2021, President Putin announced that he planned to cut the budget for Russian space activities across the board by 16 percent annually from 2022 to 2024, citing unhappiness with its performance.⁴⁰⁸

In 2022, more evidence emerged signaling significant budget challenges for the Russian space program. Roscosmos reportedly suffered a huge increase in net losses to \$421 million (31 billion rubles) in 2021-2022, and the ongoing war in Ukraine and associated economic sanctions have made that even worse.⁴⁰⁹ The budget shortfalls were also exacerbated by Russia's complete severing of its foreign commercial space launch sales as a result of the war in Ukraine.

401 Avaneesh Pandey, "Russia's Federal Space Agency Dissolved, Responsibilities To Be Transferred To State Corporation," *International Business Times*, December 28, 2015, <https://www.ibtimes.com/russias-federal-space-agency-dissolved-responsibilities-be-transferred-state-2240831>.

402 Forian Vidal, "Russia's Space Policy: The Path of Decline?", *Études de l'Ifri*, Ifri, p.15, January 2021, https://www.ifri.org/sites/default/files/atoms/files/vidal_russia_space_policy_2021_.pdf.

403 Matthew Bodner, "Russian military merges Air Force and Space Command," *The Moscow Times*, August 3, 2015, <https://www.themoscowtimes.com/2015/08/03/russian-military-merges-air-force-and-space-command-a48710>.

404 Bodner, "Russian military merges Air Force and Space Command," *ibid*.

405 Roger N. McDermott, "Russia's Electronic Warfare Capabilities to 2025," *International Centre for Defence and Security*, September 2017, pp. 5-6, https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf.

406 McDermott, "Russia's Electronic Warfare Capabilities to 2025," *ibid*, pp. 7

407 Павел Лузин, "Цена и перспективы военной космической программы," *Riddle*, May 22, 2020, <https://www.ridl.io/ru/ce-na-i-perspektivy-voennoj-kosmicheskoy-programmy/>.

408 Eric Berger, "Putin slashes Russia's space budget and says he expects better results," *Arstechnica*, October 8, 2021, <https://arstechnica.com/science/2021/10/putin-slashes-russias-space-budget-and-says-he-expects-better-results/>.

409 Pavel Luzin, "Russian Space Spending for 2023," *The Jamestown Foundation*, February 10, 2023, <https://jamestown.org/program/russian-space-spending-for-2023/>.

39.9042°N

03

CHINA

116.4074°E

Over the last few decades, China has embarked on a sustained national effort to develop a broad spectrum of space capabilities across the civil, national security, and commercial sectors. Space capabilities under development by China include a robust human spaceflight and robotic space exploration program; remote sensing for weather and resource management; and military applications such as positioning, navigation and timing and intelligence, surveillance, and reconnaissance.

China appears to be highly motivated to develop counterspace capabilities to bolster its national security. China is beginning to assert its regional political, economic, and military interests more strongly, and sees counterspace capabilities as a key enabler. Much has been written about how reliant the United States is on space capabilities to project global military power, and thus being able to counter US space capabilities is a key element of China's ability to assure its freedom of action and deter potential US military operations in its sphere of influence.

China has a sustained effort to develop a broad range of offensive counterspace capabilities. Over the last decade, China has engaged in multiple tests of technologies and capabilities that either are offensive counterspace weapons or could be used as such. China has also begun developing the policy, doctrine, and organizational frameworks to support the integration of counterspace capabilities into its military planning and operations. That said, it is unclear whether China intends to offensively use its counterspace capabilities in a future conflict, or whether the goal is to use them as a deterrent against aggression. There is no confirmed public evidence of China actively using counterspace capabilities in current military operations, but operational testing has occurred.

The following sections provide details on China's development of co-orbital, direct-ascent, electronic warfare, directed energy, and space situational awareness capabilities for counterspace applications and the policy, doctrine, and military organizational framework to support those capabilities.

3.1 – CHINESE CO-ORBITAL ASATs

Assessment /

China has conducted multiple tests of technologies for close approach and rendezvous in both low Earth orbit (LEO) and geostationary Earth orbit (GEO) that could lead to a co-orbital ASAT capability. However, the public evidence indicates they have not conducted an actual destructive intercept of a target, and there is no proof that these technologies are definitively being developed for counterspace use as opposed to intelligence gathering or other purposes. China has most likely demonstrated an on-orbit refuelling.

Specifics /

China has conducted a series of on-orbit demonstrations of rendezvous between different pairs of unmanned satellites. The first known incident occurred in LEO in the summer of 2010¹ and involved the Chinese satellites Shi Jian-12 (SJ-12, 2010-027A, 36596), and SJ-06F (2008-053B, 33409). SJ-06F was launched on October 25, 2008,² and SJ-12 was launched on June 15, 2010. Both satellites were reportedly built by the Shanghai Academy of Spaceflight Technology (SAST) under contract with the China Aerospace Science and Technology Corporation (CASC). The official mission for the SJ-06 series satellites is to measure the space environment and perform space experiments. Some observers believe that their true mission is collection of electronic

1 A previous incident in October 2008 involving the Chinese BX-1 microsatellite and the International Space Station was most likely an incidental conjunction, as the BX-1 was not under any active control at the time. For more details, see Brian Weeden, "China's BX-1 Microsatellite: A Litmus Test for Space Weaponization," *The Space Review*, October 20, 2008, <http://www.thespacereview.com/article/1235/1>.

2 Mark Wade, "SJ-6," *Astronautix*, accessed March 22, 2018, <http://www.astronautix.com/s/sj-6.html>.

- 3 Wade, "SJ-6," *ibid*.
- 4 Leiying Xu, "China Sends Research Satellite into Space," *Xinhua*, updated June 15, 2010, <http://english.cri.cn/6909/2010/06/15/1821s576844.htm>.
- 5 A more detailed technical analysis of this event can be found in Brian Weeden, "Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F," *The Space Review*, August 30, 2010, <http://www.thespacereview.com/article/1689/1>.
- 6 "Overview of the DART Mishap Investigation Results," NASA, accessed March 22, 2018, http://www.nasa.gov/pdf/148072main_DART_mishap_overview.pdf.
- 7 Jonathan McDowell, posting on the *NASASpaceflight.com* forums, July 20, 2013, <http://forum.nasaspaceflight.com/index.php?topic=30486.msg1076481#msg1076481>.
- 8 Posting on the 9ifly.cn Forums, August 8, 2013, <http://bbs.9ifly.cn/forum.php?mod=viewthread&tid=9551&page=1#pid261125>.
- 9 Posting on the 9ifly.cn Forums, July 26, 2013, <http://bbs.9ifly.cn/forum.php?mod=viewthread&tid=10910&page=16#pid259544>.
- 10 Gunter Krebs, "CX 1," *Gunter's Space Page*, updated November 12, 2017, http://space.skyrocket.de/doc_sdat/cx-1.htm.
- 11 Due to the uncertainty regarding which payload was which, the public Space Track catalog has not identified which satellite was which. They are still labeled Payload A, Payload B, and Payload C.

intelligence (ELINT) or signals for the Chinese military, in part because no scientific research is known to have been published based on the work of these satellites.³ The mission of SJ-12, as stated by the state media service Xinhua, is to carry out, "scientific and technological experiments, including space environment probe [sic], measurement, and communications."⁴ Both the SJ-12 and SJ-06F were in orbits between 600 kilometers (km) and 570 km sun-synchronous orbits with an inclination of 97.6 degrees.

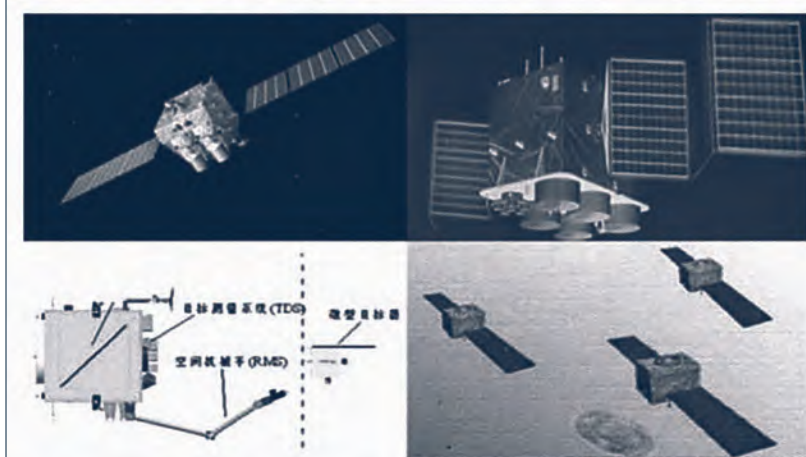
In the summer of 2010, the SJ-12 initiated a series of deliberate changes in its orbital trajectory to approach and rendezvous with the SJ-06F.⁵ The maneuvers occurred over several weeks between June 12, 2010, and August 16, 2010, and indicated a very slow and methodical approach. On August 19, the two satellites had their closest approach, which was estimated to be less than 300 meters (m). A change in the orbital trajectory for the SJ-06F around that same time indicates that the two satellites may have bumped into each other, although at a very slow relative speed of a few meters per second. There were no external indications of damage to either satellite nor any trackable debris created by the incident. The incident appears to have been similar to the bumping that occurred during the autonomous rendezvous attempt between NASA's Demonstration for Autonomous Rendezvous Technology (DART) satellite and the US Navy's Multiple Path Beyond Line of Site Communication (MUBLCOM) satellite in April 2005 (see US Co-Orbital ASAT, Section 1.1).⁶ As of February 2026, SJ-12 is in a slowly decaying orbit at roughly 525 km.

Another rendezvous between two Chinese satellites in LEO occurred in 2013. On July 19, 2013, China placed three payloads into roughly similar orbits around 670 km altitude and 98 degrees inclination from the same launch: Shiyao 7 (SY-7, 2013-037A, 39208), Chuangxin 3 (CX-3, 2013-037B, 39209), and Shijian 15 (SJ-15, 2013-037C, 39210). The mission was publicly described by the Chinese government as, "conducting scientific experiments on space maintenance technologies."⁷ Public information at the time indicated the SY-7 was built by the DFH Satellite Corporation on behalf of the Chinese Academy of Space Technology (CAST), and likely carried a robotic arm being developed to support China's space station program, perhaps similar to the Canadian robotic arm used on the International Space Station.⁸ SJ-15 was built by the SAST after eight years of development, and was reportedly an optical space tracking satellite similar to the US Air Force (USAF)'s Space-Based Surveillance System (SBSS) satellite.⁹ CX-3 was built by the Chinese Academy of Sciences and was likely a small store-and-forward communications satellite that was the most recent in a series of such satellites.¹⁰ Once on orbit, the three satellites were catalogued as Payload A, Payload B, and Payload C by the US military.¹¹

More than a year later, in October 2014, an internet code repository was discovered that supported earlier claims that the three satellites were engaged in capture and surveillance activities. Payload A was known internally to the Chinese program as Tansuo-4, corresponding to the public designation SY-7, and was designed with a teleoperated robotic arm that interacted with the separating subsatellite, as shown at the lower left of Figure 3-1 below. Payload B was known internally as Tansuo-3, corresponding to the public designation CX-3, and was designed to provide optical surveillance of space objects in geostationary and low Earth orbits. Payload C was known internally as Tansuo-5, corresponding to the SJ-15, and was designed to maneuver and conduct proximity operations with other space objects.

FIGURE 3-1 – RPO/ROBOTIC ARM DEMONSTRATOR SY-7

附图 1: 2013 年前三季度公司小卫星产品发射交付概览



资料来源: 上海证券研究所

Image of the SY-7 (lower left, with robotic arm) and its small companion satellite. Image credit: Liss¹²

In August 2013, the SJ-15 initiated a series of maneuvers to alter its orbit and bring it close to two other satellites. On August 9, the SJ-15 altered its altitude by a few tens of kilometers, which meant it passed above the CX-3 at a distance of a few kilometers before returning largely to its original orbit. On August 16, the SJ-15 altered its altitude by more than 100 km and its inclination by 0.3 degrees, which eventually led to a close approach of Shi Jian 7 (SJ-7), a Chinese satellite launched in 2005 (2005-024A, 28737), to within a few kilometers.¹³ Anonymous US officials claimed that the rendezvous was part of a “covert anti-satellite weapons development program,” and that one of the satellites “grabbed” another,¹⁴ although there is no way to confirm a physical docking from the publicly available tracking data and the satellite with the arm, SY-7, was not involved in this particular RPO.

On October 18, 2013, the SY-7 initiated a small maneuver to raise its orbit by several hundred meters, and shortly thereafter released another object, which the US military labeled Payload A Debris (2013-037J, 39357). The SY-7 and Payload A debris orbited in relatively close proximity to each other for several days, ranging between a few kilometers and several hundred meters, with some reports claiming the two objects may have physically joined with each other.¹⁵ However, the publicly available tracking is not accurate enough to confirm those claims. Both objects occasionally conducted small maneuvers throughout 2014 and 2015, although the separation distance between them never exceeded more than a few kilometers.

In April 2014, the SJ-15 began another series of small maneuvers to conduct proximity operations around the CX-3. Between April 12-14, the SJ-15 raised its orbit by several tens of kilometers, and then between May 12 and 14, Payload C lowered its orbit by several tens of kilometers. The effect of these maneuvers was to match orbital planes once again with the SJ-7, and on a trajectory that brought it above and then behind the SJ-7 at a range of around 150 km, with a vertical separation of a few kilometers.¹⁶ Throughout the rest of May, the SJ-15 slowly decreased the distance to the SJ-7 to within a kilometer.¹⁷

- 12 Posting on Novosti Kosmonavtiki forums, January 1, 2016, <https://forum.novosti-kosmonavtiki.ru/index.php?msg=1462007>.
- 13 Marcia Smith, “Surprise Chinese satellite maneuvers mystify western experts,” *Space Policy Online*, updated August 19, 2013, <http://space-policyonline.com/news/surprise-chinese-satellite-maneuvers-mystify-western-experts/>.
- 14 Bill Gertz, “China Testing New Space Weapons,” *The Washington Free Beacon*, October 2, 2013, <http://freebeacon.com/national-security/china-testing-new-space-weapons/>.
- 15 Marcia Smith, “Did China Succeed in Capturing One of its own Satellites? – Update,” *Space Policy Online*, updated October 26, 2013, <http://space-policyonline.com/news/did-china-succeed-in-capturing-one-of-its-own-satellites/>.
- 16 Posting on Novosti Kosmonavtiki forums, May 5, 2014, <http://novosti-kosmonavtiki.ru/forum/messages/forum12/topic13702/message1254275/#message1254275>.
- 17 Posting on Novosti Kosmonavtiki forums, May 29, 2014, <http://novosti-kosmonavtiki.ru/forum/messages/forum12/topic13702/message1262548/#message1262548>.

- 18 Posting on NASA's Spaceflight.com forums, June 7, 2016, <http://forum.nasaspaceflight.com/index.php?PHPSESSID=iamdpagZi-g407ooqdm18gm06k6&topic=30486.msg1545873#msg1545873>.
- 19 "China lands Prototype Crew Spacecraft after inaugural Long March 7 Launch," *Spaceflight101*, June 27, 2016, <http://spaceflight101.com/long-march-7- maiden-launch/china-lands-prototype-crew-spacecraft-after-inaugural-long-march-7-launch/>.
- 20 "Is China militarising space? Experts say new junk collector could be used as anti-satellite weapon," *South China Morning Post*, updated June 12, 2017, <http://www.scmp.com/news/china/diplomacy-defence/article/1982526/china-militarising-space-experts-say-new-junk-collector>.
- 21 During a 2011 workshop organized by the National Research Council as part of a study of NASA's space debris program, participants stated that a Department of Defense plan to remove space debris did not go forward in part due to concerns that "most of the proposals had a weapons-like character about them". See National Research Council, *Limiting Future Collision Risk to Spacecraft: An Assessment of NASA's Meteoroid and Orbital Debris Programs*, Washington, DC: National Academies Press, 2011, <https://doi.org/10.17226/13244>, pg. 143.
- 22 Jon Fingas, "China successfully refuels a satellite in orbit," *Engadget*, July 2, 2016, <https://www.engadget.com/2016/07/02/china-refuels-satellite-in-orbit/>.
- 23 Jeffrey Lin and P.W. Singer, "China's largest space launch vehicle, the Long March 7 flies, with a Technological Triple Whammy," *Popular Science*, July 8, 2016, <http://www.popsoci.com/chinas-largest-space-launch-vehicle-long-march-7-flies-with-technological-triple-whammy>.
- 24 "Re-Entry: Aolong-1 Space Debris Removal Demonstrator," *Spaceflight101*, August 28, 2016, <http://spaceflight101.com/re-entry-aolong-1-space-debris-removal-demonstrator/>.
- 25 Stephen Clark, "Chinese Long March 6 rocket delivers nine small satellites to space," *Spaceflight-Now.com*, April 30, 2021, <https://spaceflightnow.com/2021/04/30/chinese-long-march-6-rocket-delivers-nine-small-satellites-to-space/>.
- 26 Cao Siqi, "Robot prototype capable of clearing space debris shines at Airshow China," *Global Times*, November 21, 2022, <https://www.global-times.cn/page/202211/1279404.shtml>.

The SJ-15 continued to occasionally make changes to its orbit in 2015 and 2016, but the reasons for doing so were unclear. On December 3, 2015, the SJ-15 increased its inclination by 0.3 back to 98 degrees. On May 6, 2016, the SJ-15 changed its altitude by several tens of kilometers, bringing it close to the CX-3 again.¹⁸ As of February 2026, SJ-15 is in a slowly decaying orbit at approximately 660 km.

In 2016, another Chinese satellite was launched that again created concerns about on-orbit grappling. The Aolong-1 (AL-1, 2016-042F, 41629), also known as the Advanced Debris Removal Vehicle (ADRV) or "Roaming Dragon," was a small satellite developed by Harbin Institute of Technology under contract to the China Academy of Launch Vehicle Technology (CALT) to reportedly demonstrate using a robotic arm to capture a small piece of space debris for removal from orbit. Aolong-1 was placed into orbit on the first launch of China's new Long March 7 (LM-7) rocket on June 25, 2016, from Wenchang Space Launch Center (see Imagery Appendix, pg. 17-15) along with a scaled-down test version of China's next human spacecraft, a ballast mass, and a few small rideshare cubesats. The purpose of the launch was to demonstrate the ability of the LM-7 and its restartable upper stage to place the new crewed spacecraft into orbit, to deploy multiple payloads into different orbits, test the new Tianyuan-1 refueling system developed by the National University of Defense Technology, and test the atmospheric re-entry of the crewed spacecraft test vehicle.¹⁹

Although they were only small parts of the mission, the debris removal and refueling experiments generated significant press outside of China due to concerns over dual-use technology and China leaping ahead in technology. Stories included an inflammatory report that quoted a researcher from the National Astronomical Observatories in Beijing talking about the potential for Aolong-1 to be used as a weapon system.²⁰ However, it is unclear whether the researcher was truly convinced that was indeed the motive for Aolong-1, or whether he was hypothesizing about military applications for debris removal technology in general, much as US scientists and officials often do.²¹ More media stories were generated that claimed the same test had included the successful refueling of another satellite,²² and that the two events taken together demonstrated China's increasing technological prowess.²³

The reality of either the Aolong-1 or the refueling experiment was less than the media hype. By all appearances, the Tianyuan-1 refueling system was attached to the upper stage, as no separate satellite of that description was ever catalogued by the US military, nor did any of the ten objects catalogued in space rendezvous with any other satellites. According to US military tracking data, the Aolong-1 did indeed separate into a 380 km by 200 km orbit but did not rendezvous with any other objects. The debris capture experiment appears to have been simulated, and the Aolong-1 does not appear to have altered its orbit during its short two months on orbit.²⁴

In April 2021, China launched nine small payloads into LEO from Taiyuan Space Launch Center (see Imagery Appendix, pg. 17-14) that reportedly carried an orbital debris removal experiment.²⁵ The NEO-01 payload, developed by Origin Space Technology Company, reportedly carried out an experiment of using a large net to capture a tethered target simulating orbital debris.²⁶ However, it is difficult to accurately verify if this claim is true as it is unclear if any of the objects from the launch released any additional objects. None appeared to have approached any existing pieces of space debris.

SJ-6 05A (SJ-6I) (2021-122A, 49961) and SJ-6 05B (SJ-6J) (2021-122B, 49962) were launched in December 2021 via a Long March 4B from the Jiuquan Satellite

Launch Center into a SSO.²⁷ CASC is reported to have said that their mission was for space environment exploration and technology verification.²⁸ The pair was initially at an altitude of 470 km and conducted RPOs in 2022, when SJ-6 05A got within 1 km of SJ-6 05B repeatedly starting that March.²⁹ In October 2022, they completed their RPOs and raised their orbits about 100 km to join the rest of the SJ-6 series.³⁰

In December 2023, a Long March 11 (CZ-11) launched three satellites from a barge launch pad near Guangdong.³¹ The three satellites - Shiyang-24C satellites (SY-24C 01, (2023-206A, 58650); SY-24C 02 (2023-206B, 58651); SY-24C 03 (2023-206C, 58652) - were inserted into a Sun-synchronous orbit inclined at 97.3 degrees (at an altitude of 540 x 553 x 540 km). Their orbit was co-planar with SJ-6 05A (2021-122A, 49961) and SJ-6 05B (2021-122B, 49962), two satellites launched on October 12, 2021, via a Long March 4B (CZ 4B) launch vehicle from the Jiuquan Satellite Launch Center.³² According to a USSF fact sheet, the five satellites started conducting RPOs from mid-March 2024 through the end of April 2024, at times separated by less than 1 km, and undertaking “two simultaneous proximity events at the same time.” In September, SY-24C 02 and SY-24C 03 conducted three separate approaches, again under 1 km, with two being multi-day actions.³³ In December, SY-24C 03 and SJ6 5A came within “tens of meters” of each other five different times and with “associated relative velocities less than 10 cm/s,” this again was a multi-day event.³⁴ After that, the five satellites maneuvered to maintain a separation of over 100 km.³⁵ USSF officers have described this particular series of RPOs as “dogfighting in space,” which is not technically accurate and implies that these RPOs have an inherently offensive mission.³⁶

CASI’s Kristin Burke published in July 2025 an analysis of the SJ-6 series, at which point consisted of five pairs.³⁷ She identified three consistencies across the series: “The A satellite maneuvers more than the B satellite. The B satellite acts as a target for another satellite’s maneuvers, either in series or out of series. The SJ-6 pairs contribute to RPO TTPs for a satellite outside of their series. For example, SJ-12, and more recently SY-24C.”³⁸ She noted that this most recent series of RPOs had “important consistencies with past behavior and is an incremental advancement for improved payload testing and TTP [tactics, techniques, and procedures] development,” and suggested that the “A” satellites in future SJ-6 series would continue to get more maneuverable. Finally, she urged analysts to look back at the whole series to identify new capabilities versus expanded ones, because “Without identifying past similarities, one is more likely to interpret behavior as a near term threat, rather than an evolving and manageable challenge.”³⁹

27 Andrew Jones, “China sends classified Shijian satellites into orbit with milestone Long March launch,” *SpaceNews*, December 10, 2021, <https://spacenews.com/china-sends-classified-shijian-satellites-into-orbit-with-milestone-long-march-launch/>.

28 Jones, “China sends classified Shijian satellites,” *ibid.*

29 Kristin Burke, “China’s SJ-6 Satellites—Tactics, Techniques, and Procedures,” *China Aerospace Studies Institute*, July 2025, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2025-07-07%20China%27s%20SJ-6%20TTPs.pdf>.

30 Burke, “China’s SJ-6 Satellites,” *ibid.*

31 David Todd, “Two Chinese launches: Long March 11 launches Shiyang-24C trio while Long March 3B puts two Beidou navsats into orbit,” *Seradata*, December 26, 2023, <https://www.seradata.com/two-chinese-launches-long-march-11-launches-shiyang-24c-trio-while-long-march-3b-puts-two-beidou-navsats-into-orbit/>.

32 “SHIJIAN 6 05A (SJ-6 05A), 49961,” *Kayhan Space Satcat*, Accessed February 21, 2025, <https://www.satcat.com/sats/49961>; “Space Threat Fact Sheet Annex,” Headquarters Space Force Intelligence, February 21, 2025, <https://nssaspace.org/wp-content/uploads/2025/02/20250221-S2-Space-Threat-Fact-Sheet-Annex-v1-RELEASE.pdf>.

33 “Space Threat Fact Sheet Annex,” Headquarters Space Force Intelligence, February 21, 2025, <https://nssaspace.org/wp-content/uploads/2025/02/20250221-S2-Space-Threat-Fact-Sheet-Annex-v1-RELEASE.pdf>.

34 “Space Threat Fact Sheet Annex,” *ibid.*

35 “Space Threat Fact Sheet Annex,” *ibid.*

36 Chris Gordon, “China Practicing ‘Dogfighting in Space,’ US Space Force Says,” *Air & Space Forces Magazine*, March 18, 2025, <https://www.airandspaceforces.com/china-practicing-dog-fighting-space-force/>.

37 Burke, “China’s SJ-6 Satellites,” *ibid.*

38 Burke, “China’s SJ-6 Satellites,” *ibid.*

39 Burke, “China’s SJ-6 Satellites,” *ibid.*

40 The reason why the switch away from calling this “Shenlong” is that the Chinese government has never used that name for it; it comes from a photo taken nearly two decades ago of an object that had “Shenlong” painted on it. That object never went to space; its manufacturer has since moved on to different spaceplanes. There was nearly a decade between its flight and the flight of the Chinese Reusable Experimental Spacecraft, which has a different manufacturer. So while we cannot prove that the latter is not the Shenlong, we cannot prove it is either. So Chinese Reusable Experimental Spacecraft it is until we learn differently.

41 Howard Wang, Jackson Smith, Cristina L. Garafo-la, *Chinese Military Views of Low Earth Orbit: Proliferation, Starlink, and Desired Countermeasures*, RAND, March 4, 2025, p. 28, https://www.rand.org/pubs/research_reports/RRA3139-1.html.

42 Haley Wong, “Will satellite dogfights be the final frontier for the US-China space rivalry?” *South China Morning Post*, May 15, 2025, <https://www.scmp.com/news/china/military/article/3310469/will-satellite-dogfights-be-final-frontier-us-china-space-rivalry>; (translated) Li Qian, “Let’s observe the “new trend” in the space strategic competition,” China Ministry of National Defense website, October 31, 2019, http://www.81.cn/jfjbmap/content/2019-10/31/content_246539.htm.

43 Prepared by BluePath Labs, Daniel Shats with Peter Wood, “Chinese Spaceplane Programs,” China Aerospace Studies Institute, p.8, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2021-12-06%20Spaceplanes.pdf>.

44 BluePath Labs, Shats, Wood, “Chinese Spaceplane Programs,” *ibid*, p. 9.

45 BluePath Labs, Shats, Wood, “Chinese Spaceplane Programs,” *ibid*, p. 10.

46 BluePath Labs, Shats, Wood, “Chinese Spaceplane Programs,” *ibid*, p. 11.

47 Gunter D. Krebs, “Chongfu Shiyong Shiyang Hangtian Qi (CSSHQ),” *Gunter’s Space Page*, accessed February 27, 2026, https://space.skyrocket.de/doc_sdat/csshq.htm.

48 Geoff Brumfiel, “New Chinese Space Plane Landed At Mysterious Air Base, Evidence Suggests,” *National Public Radio*, September 9, 2020, <https://www.npr.org/2020/09/09/91113352/new-chinese-space-plane-landed-at-mysterious-air-base-evidence-suggests>.

49 Data compiled from the public US military satellite catalog at <https://space-track.org>.

50 Andrew Jones, “China’s mystery spaceplane releases object into orbit,” *SpaceNews*, November 2, 2022, <https://spacenews.com/chinas-mystery-spaceplane-releases-object-into-orbit/>.

51 Joseph Trevithick and Tyler Rogoway, “China’s Secret Spacecraft Looks To Have Landed At This Remote Base With A Massive Runway,” *The Warzone*, September 8, 2020, <https://www.thedrive.com/the-warzone/36270/this-remote-base-with-a-massive-runway-looks-to-be-where-chinas-secretive-spacecraft-landed>.

52 Geoff Brumfiel, “Satellite Photos Show China Expanding Its Mysterious Desert Airfield,” *National Public Radio*, July 1, 2021, <https://www.npr.org/2021/07/01/1011806020/satellite-photos-show-china-expanding-its-mysterious-desert-airfield?s=09>.

53 Andrew Jones, “China’s mystery spaceplane releases object into orbit,” *SpaceNews*, November 2, 2022, <https://spacenews.com/chinas-mystery-spaceplane-releases-object-into-orbit/>.

Chinese Reusable Experimental Spacecraft⁴⁰ /

Chinese researchers were very concerned about the US X-37B spaceplane (see Section 1.1, US Co-Orbital ASAT), arguing that it would upset strategic stability and argued for the need for technological parity; this concern is thought to be what drove China to develop its own spaceplane.⁴¹ A 2019 PLA analysis warned that the X-37B could at any point “transform into an aggressive unmanned intelligent fighter in space” as it had, they believed, the potential to “use its robotic arms to destroy other countries’ satellites, and be equipped with laser weapons.”⁴² Designs for it can be found as far back as 2000; the only photo that exists of it was leaked in 2007 and showed it suspended under a Xian H-6 bomber aircraft.⁴³ Analysis indicates that the spacecraft in the photo probably is much smaller than the United States’ X-37B: the Shenlong in the photo has a diameter of .8 m, is 6.5 m long, and has a mass of around 4500 kg.⁴⁴ Because the Shenlong in the photo did not have a rear stabilizer, it is posited that the spacecraft in the photo was a mock-up and a technology demonstrator.⁴⁵ The only confirmed flight test of the Shenlong was held in January 2011 and involved a suborbital trajectory.⁴⁶

On September 4, 2020, China launched what it called a “reusable experimental spacecraft” (Chongfu Shiyong Shiyang Hangtian Qi, or CSSHQ)⁴⁷ into orbit on a CZ-2F rocket from Jiuquan Satellite Launch Center (see Imagery Appendix pg. 17-11) under unusually heavy secrecy.⁴⁸ Few facts are known, but the US military catalogued the spaceplane (PRC Test Spacecraft, 2020-063A, 46389) and a CZ-2F upper stage (CZ-2F R/B, 2020-063B, 46390) in a 348 km by 331 km and 50.2° inclination orbit. One day later, they catalogued three pieces of debris in a similar orbit and the following day, on September 6, the US military catalogued an unknown payload in orbit (Object A, 2020-063G, 46395) while also indicating the spaceplane had re-entered the atmosphere.⁴⁹ Object A is reported to have broadcast S band transmissions for weeks.⁵⁰ Outside experts suggested that the spaceplane could have landed on a long runway constructed at China’s Lop Nor nuclear test site,⁵¹ located in the southeastern portion of the Xinjiang Autonomous Region.⁵² The mission of the small satellite it deployed is unknown, although it broadcast transmissions that were similar to a small “companion” satellite released by the Shenzhou 7 crewed spacecraft during a mission in September 2008.⁵³ As of February 2026, neither the spaceplane nor the subsatellite it released have been registered with the United Nations.

In August 2022, China launched a second CSSHQ (PRC Test Spacecraft 2, 2022-093A, 53357) from Jiuquan Satellite Launch Center (see Imagery Appendix pg. 17-11) into an orbit of 346 km by 593 km at 49.99° inclination. This launch was 697 days after the previous mission ended.⁵⁴ Six pieces of orbital debris from the launch were also catalogued shortly after launch, five of which re-entered the atmosphere by January 2023. On October 23, 2022, the spaceplane raised its perigee significantly to a nearly circular orbit of 607 km by 597 km.⁵⁵ Shortly thereafter, a new object (OBJECT J, 2022-093J, 54218), was catalogued that was apparently released from the spaceplane after its orbit-raising maneuver. Neither the spaceplane nor Object J appear to have made any significant maneuvers. Tracking data collected by commercial SSA company LeoLabs suggests that the spaceplane made RPOs with the released object in November-December 2022, January 2023, and February-March 2023; LeoLabs described the activities as “least two and possibly three capture/docking operations,” as well as “rendezvous and formation flying,” while noting that OBJECT J appeared at least five times to be able to maneuver independently of the spaceplane.⁵⁶ On May 8, 2023, China state media announced that the spaceplane had re-entered the atmosphere after 276 days in orbit, which again appeared to take place at the Lop Nor facility.⁵⁷ As of February 2026, neither object from this second test flight nor the spaceplane has been registered with the United Nations.

On December 14, 2023, China launched the CSSHQ (PRC Test Spacecraft 3, 2023-195A, 58573) for the third time, again from Jiuquan Satellite Launch Center (see Imagery Appendix, pg. 17-11), into a 333 km by 348 km at 49.99° inclination orbit along with an upper stage and four catalogued pieces of debris.⁵⁸ This launch happened 220 days after the previous mission ended.⁵⁹ The spaceplane subsequently raised its orbit to 609 km by 601 km in late January 2024, similar to previous missions.⁶⁰ Chinese state media announced that while on orbit, “it will carry out reusable technology verification and space science experiments as planned, providing technical support for the peaceful use of space.”⁶¹ The CSSHQ released an object in orbit (OBJECT G, 2023-195G, 59884) on May 24, 2024, at an altitude of about 620 km;⁶² it performed an avoidance maneuver to raise its orbit by 1 km, then did more maneuvers June 5-7 to bring it within several kilometers of Object G on June 8.⁶³ It maneuvered again June 11-12 to bring it one kilometer or less from Object G on June 12; similar maneuvers happened on June 14 and June 15/16.⁶⁴ On July 30, 2024, an amateur photographer captured pictures of it in orbit; based on his analysis of the imagery, it could have two solar panels on it, or possibly antennae.⁶⁵ As well, it appears that the CSSHQ is at most ten meters long.⁶⁶ It landed on September 6, 2024, after 268 days in orbit, likely at Lop Nor again.⁶⁷ An official statement said that the “success of the experiment demonstrates the growing maturity of China’s reusable spacecraft technologies, which will pave the way for more convenient and affordable round-trip methods for the peaceful use of space in the future.”⁶⁸ As of February 2026, neither the spaceplane nor the object released has been registered with the United Nations.

54 Andrew Jones, “China launches reusable spaceplane on fourth secretive orbital mission,” *SpaceNews*, February 7, 2026, <https://spacenews.com/china-launches-reusable-spaceplane-on-fourth-secretive-orbital-mission/>.

55 Andrew Jones, “China’s spaceplane raises orbit and national funding,” *SpaceNews*, October 25, 2022, <https://spacenews.com/chinas-spaceplane-raises-orbit-and-national-funding/>.

56 Andrew Jones, “China’s spaceplane conducted proximity and capture maneuvers with subsatellite, data suggests,” *SpaceNews*, May 11, 2023, <https://spacenews.com/chinas-spaceplane-conducted-proximity-and-capture-maneuvers-with-subsatellite-data-suggests/>.

57 Andrew Jones, “China’s mystery reusable spaceplane lands after 276 days in orbit,” *SpaceNews*, May 8, 2023, <https://spacenews.com/chinas-mystery-reusable-spaceplane-lands-after-276-days-in-orbit/>.

58 Andrew Jones, “China launches mystery reusable spaceplane for the third time,” *SpaceNews*, December 14, 2023, <https://spacenews.com/china-launches-mystery-reusable-spaceplane-for-third-time/>.

60 Andrew Jones, “China’s secretive spaceplane raises orbit, but yet to deploy satellites,” *SpaceNews*, January 31, 2024, <https://spacenews.com/chinas-secretive-spaceplane-raises-its-orbit-but-yet-to-deploy-satellites/>.

61 “My country successfully launches reusable test spacecraft (我国成功发射可重复使用试验航天器),” *Xinhua*, December 14, 2023, <https://app.xinhuanet.com/news/article.html?articleId=b9141bb29a221c45ac2ad0d44dc87fc6>.

62 Slingshot Aerospace *LinkedIn* Post, date accessed March 3, 2025, https://www.linkedin.com/posts/slingshot-aerospace_the-slingshot-global-sensor-network-is-tracking-activity-7201624236233289729-Z3rF.

63 Marco Langbroek, “The Chinese robotic Space Plane 3 and Object G: proximity operations [MULTIPLE UPDATES],” *SatTrackCam Leiden (b) log*, June 12, 2024, <https://sattrackcam.blog-spot.com/2024/06/the-chinese-robotic-spaceplane-3-and.html>.

64 Langbroek, “The Chinese robotic Space Plane 3 and Object G,” *ibid*.

65 “PRC TEST SPACECRAFT 3 (Chinese space plane),” *Astrobin*, Accessed February 11, 2025, <https://www.astrobin.com/btd0dy/>.

66 Jack Congram, “What Do We Know About China’s Reusable Spaceplane?” *China in Space*, February 2, 2026, <https://www.china-in-space.com/p/what-do-we-know-about-chinas-reusable>.

67 Andrew Jones, “China’s secretive reusable spaceplane lands after 267 days in orbit,” *SpaceNews*, September 6, 2024, <https://spacenews.com/chinas-secretive-reusable-spaceplane-lands-after-267-days-in-orbit/>.

68 “China successfully lands reusable experimental spacecraft,” *Xinhua*, September 6, 2024, <https://english.news.cn/20240906/651bb65c-0c0b4dce896882d815c293a1/c.html>.

- 69 William Zheng, "China sends fourth 'Shenlong' reusable spacecraft mission into orbit," *South China Morning Post*, February 7, 2026, <https://www.scmp.com/news/china/science/article/3342759/china-sends-fourth-shenlong-reusable-spacecraft-mission-orbit>.
- 70 "China successfully launches reusable experimental spacecraft," *Xinhua*, February 7, 2026, <https://english.news.cn/20260207/396ed-b9335a94acc94b78443c5bd7f82/c.html>.
- 71 Andrew Jones, "China launches reusable spaceplane on fourth secretive orbital mission," *SpaceNews*, February 7, 2026, <https://space-news.com/china-launches-reusable-spaceplane-on-fourth-secretive-orbital-mission/>.
- 72 Jonathan McDowell, "The Chinese spaceplane launched last night..." *Twitter*, February 7, 2026, <https://x.com/planet4589/status/2020169876250451979?>; Jonathan McDowell, "The Chinese spaceplane maneuvered..." *Twitter*, February 15, 2026, <https://x.com/planet4589/status/2023242545535283382?>.
- 73 "China's Shijian-17 Satellite settles in Geostationary Orbit for Experimental Mission," *Spaceflight101*, November 24, 2016, <http://spaceflight101.com/shijian-17-settles-in-geostationary-orbit/>.
- 74 General James Dickinson, statement before the Senate Armed Services Committee, April 21, 2021, <https://www.armed-services.senate.gov/imo/media/doc/Dickinson04.20.2021.pdf>.
- 75 The other major method of getting to GEO utilizes constant thrust ion propulsion, which can take weeks or months.
- 76 "China's Shijian-17 Satellite settles in Geostationary Orbit for Experimental Mission," *Spaceflight101*, November 24, 2016, <http://spaceflight101.com/cz-5- maiden-flight/shijian-17-settles-in-geostationary-orbit/>.
- 77 Originally, this was reported as Chinasat 6A closing in with Chinasat 5A, due to the US military mislabeling the SJ-17 as Chinasat 6A.
- 78 Gunter Krebs, "Zhongwei 1 (ChinaStar 1) ZX 5A (ChinaSat 5A) APStar 9A," *Gunter's Space Page*, updated November 12, 2017, http://space.skyrocket.de/doc_sdat/zhongwei-1.htm.
- 79 "In-Space Eavesdropping? – China's Shijian-17 completes High-Altitude Link-Up," *Spaceflight101* December 9, 2016, <http://spaceflight101.com/cz-5- maiden-flight/shijian-17-rendezvous-with-chinasat-5a/>.

A fourth flight of the CSSHQ started in February 2026 with a launch from Jiuquan Satellite Launch Center via a Long March-2F (PRC Test Spacecraft 4, 2026-024A, 67689).⁶⁹ According to state news agency Xinhua, the spaceplane "will conduct technological verification for reusable spacecraft, providing technical support for the peaceful use of space."⁷⁰ This flight occurred about 519 days after the previous mission ended.⁷¹ The Long March 2F can take eight metric tons to LEO, which may mean that the CSSHQ is roughly the same size as the X-37B. The spaceplane was first catalogued to be in an orbit of 50° of 344 km x 590 km; about five days after its launch, it maneuvered to a circular 588 km x 597 km orbit.⁷²

TABLE 3-1 – CHINESE REUSABLE EXPERIMENTAL SPACECRAFT FLIGHT HISTORY

LAUNCH DATE	LAUNCH LOCATION	LANDING DATE	LANDING LOCATION	TIME ON ORBIT	TIME BETWEEN MISSIONS
Sep. 4, 2020	Jiuquan Satellite Launch Center	Sep. 6, 2020	Lop Nur Test Site	2 days	N/A
Aug. 4, 2022	Jiuquan Satellite Launch Center	May 8, 2023	Lop Nur Test Site	276 days	697 days
Dec. 14, 2023	Jiuquan Satellite Launch Center	Sep. 5, 2024	Lop Nur Test Site	268 days	220 days
Feb. 6, 2026	Jiuquan Satellite Launch Center	–	–	–	519 days

Recent Chinese Rendezvous and Proximity Operations in GEO /

Another incident of rendezvous and proximity operations (RPO) between two Chinese satellites occurred in 2016, but this time in GEO. On November 3, 2016, China lofted the SJ-17 satellite (2016-065A, 41838) to GEO on the maiden launch of its new Long March 5 (LM-5) space launch vehicle from Wenchang Space Launch Complex on Hainan Island (see Imagery Appendix pg. 17-15). The SJ-17 was reportedly designed to test advanced technologies such as environmentally friendly chemical propellant, ion propulsion, quad-junction gallium arsenide solar panels, and an on-board optical surveillance sensor.⁷³ General James Dickinson, then Commander of US Space Command, stated in Congressional testimony that the SJ-17 also carried a robotic arm that could be used for dual use capabilities.⁷⁴ The launch was typical of the historical process of getting most satellites to GEO using chemical propulsion,⁷⁵ taking about 6 hours and 14 minutes after launch.⁷⁶ The only anomaly was with the Yuanzheng-2 (YZ-2, 2016-065C, 41840) upper stage that carried the SJ-17 to GEO. The YZ-2 failed to do a disposal maneuver to remove itself from the protected GEO zone in accordance with international debris mitigation guidelines. Instead, the YZ-2 remained in an orbit with a perigee near GEO altitude such that the YZ-2 will occasionally dip down very close to, and rotate around, the active GEO belt for decades to come.

Several days after reaching GEO and separating from the YZ-2, the SJ-17 began maneuvering to place itself into the active GEO belt close to another Chinese satellite. It began with a maneuver on November 10 to lower its orbit and reduce its westward drift, and then a pair of maneuvers on November 11 to fully stabilize within the active GEO belt at a longitude of 162.9 E. This placed the SJ-17 relatively close to another Chinese satellite, Chinasat 5A (1998-033A, 25354).⁷⁷ Chinasat 5A was originally built by Lockheed Martin under contract to the Chinese Communications Ministry, and launched in 1998 under the name Zongwei 1 to provide commercial satellite communications services for southeast Asia.⁷⁸ The SJ-17 made several small maneuvers to circumnavigate Chinasat 5A at a distance of between 100 and 50 km for several days, slowly closing in to within a few km on November 30, and then returning to a 100 to

50 km standoff distance.⁷⁹ The two satellites remained close until December 29, when Analytical Graphics, Inc., (AGI) reported that Chinasat 5A had begun drifting away.⁸⁰ On April 26, 2017, the SJ-17 began drifting again, and stopped around the end of June at 125 E. It drifted again between September 29 and October 10, 2017, settling in at 118 E. On January 11, 2018, the SJ-17 began a rapid eastward drift at two degrees per day, followed by a rapid drift westward at four degrees per day starting on February 9. On March 20, the SJ-17 lowered its orbit to reverse its drift and moved to RPO with Chinasat 20 (2003-052A, 26643), a Chinese military communications satellite that was still under longitudinal control but had slowly been increasing in inclination for years.⁸¹

Over the first half of 2018, the SJ-17 made additional unusual changes to its orbit. Beginning on January 23, 2018, the SJ-17 raised its inclination from 0.43 to roughly four degrees, before reverting to zero between July 20-22.⁸² According to the commercial SSA company AGI, this reversal in inclination was also accompanied by maneuvering to a drift orbit of four degrees per day. This appears to be linked to an unexplained anomaly in the orbital trajectory of Chinasat 1C, a Chinese communications satellite launched in December 2015, which began drifting westward at 0.5 deg/day.⁸³ The sudden, large change in inclination suggests the SJ-17 has significant Delta-v capability as plane change maneuvers are among the most energy intensive. SJ-17 slowed to rendezvous with Chinasat 1C, coming within 1.5 km on July 29. Ten days later, Chinasat 1C halted its drift and began to slowly drift back to its operational location. SJ-17 remained with Chinasat 1C through the first week of August before departing, while Chinasat 1C arrived back at its original location on September 7. This strongly suggests that SJ-17 was used to inspect Chinasat 1 to determine the source of the anomaly and then monitor the recovery attempt.

Following its rendezvous with Chinasat 1C, the SJ-17 made smaller changes to conduct RPO with Chinasat 6B in January 2020 and SJ-20 (2019-097A, 44910), a new Chinese high bandwidth communications satellite launched in December 2019, in October 2020. SJ-17 started drifting eastward in February 2023; in November 2023, SJ-17 spent a brief period next to VENESAT-1 (2008-055A, 33414), a Venezuelan communications satellite built by China and launched in 2008. SJ-17 continued to move, changing its altitude six times in the process (five times taking it below the GEO belt); it dropped its altitude by 76.2 km to move below the GEO belt on Nov. 1, 2024 and then increased its altitude by 76.2 km to rejoin the GEO belt on Nov. 14.⁸⁴ It officially entered the Western hemisphere on Nov. 20, 2024 and appears to be stable at 178 degrees West longitude, with the nearest operational satellite being Russia's YAMAL 300K (2012-061B, 38978).⁸⁵

FIGURE 3-2 – LONGITUDINAL HISTORY OF THE SJ-17⁸⁶



The longitudinal history of the SJ-17 satellite since launch in 2017, including major RPOs with other satellites. Image credit: Kratos.

80 Analytical Graphics (@AGItweets), "ComSpOC has detected that #Chinasat 5A has departed SJ-17 & is drifting 0.9 deg/day westward. SJ-17 remains @ 163 deg," *Twitter*, December 29, 2016, <https://twitter.com/AGItweets/status/814513003798364161>.

81 Posting by Liss on NASA Spaceflight.com Forum, February 6, 2021, <https://forum.nasaspaceflight.com/index.php?topic=39415.msg2189039#msg2189039>.

82 Jonathan McDowell, "Jonathan's Space Report," No. 754, October 8, 2018, <http://planet4589.org/space/jsr/back/news.754.txt>; Verified by data compiled from the public US military satellite catalog at <https://space-track.org>.

83 Bob Hall, "Ep16 – Chinasat 1C Space Activities," *Analytical Graphics, Inc.*, July 2, 2019, <https://www.youtube.com/watch?v=oTmRjca3VE>.

84 "The Integrity Flash: Analysis of Developments in the Space Domain," *Space Force Association*, November 24, 2024, <https://isruniversity.com/wp-content/uploads/2024/12/110-24-Nov-2024-Integrity-Flash.pdf>.

85 Hall, "Ep16 – Chinasat 1C Space Activities," *ibid*.

86 Data compiled by Kratos.

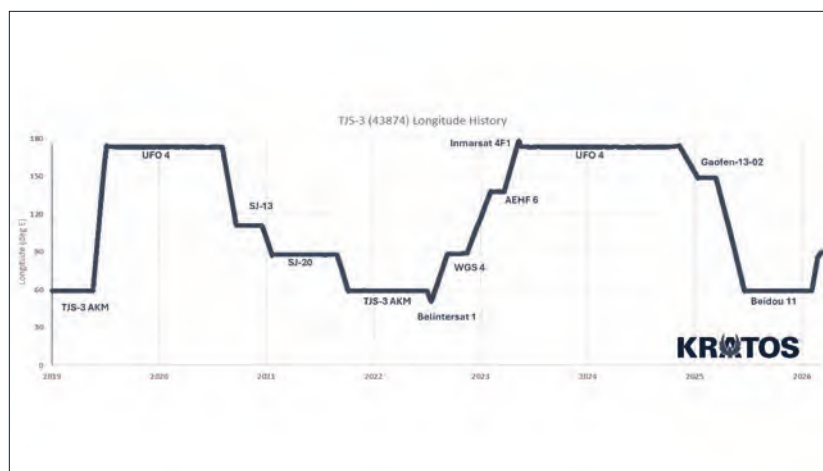
- 87 "China opens 2017 with obscure communications satellite launch," *Spaceflight101*, January 5, 2017, <http://spaceflight101.com/long-march-3b-tjs-2-launch/>.
- 88 See discussion of this in the following thread on the NASASpaceflight.com forums: <https://forum.nasaspaceflight.com/index.php?topic=46903.0;all>.
- 89 See discussion of this in the following thread on the NASASpaceflight.com forums, *ibid*.
- 90 See discussion of this in the following thread on the NASASpaceflight.com forums, *ibid*.
- 91 Colin Clark, "US, China, Russia Test New Space War Tactics: L. Sats Buzzing, Spoofing, Spying," *Breaking Defense*, October 28, 2021, <https://breakingdefense.com/2021/10/us-china-russia-test-new-space-war-tactics-sats-buzzing-spoofing-spying/>.
- 92 Andrew Jones, "A Chinese spacecraft has been checking out US satellites high above Earth," *Space.com*, March 3, 2023, <https://www.space.com/chinese-spacecraft-tjs-3-inspecting-us-satellites>.
- 93 Andrew Jones, "China launches mystery satellite on Long March 7A rocket (photo)," *Space.com*, November 6, 2023, <https://www.space.com/china-tjs-10-mystery-satellite-launch>.
- 94 "The Integrity Flash: Analysis of Developments in the Space Domain," *Space Force Association*, November 24, 2024, <https://isruniversity.com/wp-content/uploads/2024/12/110-24-Nov-2024-Integrity-Flash.pdf>.
- 95 "The Integrity Flash: Analysis of Developments in the Space Domain," *ibid*.
- 96 Greg Gillinger, email: "Flash Lite (8) UPDATE: Enter TJS-3," Integrity ISR, January 17, 2025
- 97 Gillinger, "Flash Lite (8) UPDATE: Enter TJS-3," *ibid*.
- 98 T.S. Kelso, "The object identified as TJS-3 AKM has completed a circuit of the GEO belt, 2 months after it maneuvered well above the threshold for the GEO graveyard. It is presumed to have been decommissioned and its ops status in the Celestrak SATCAT is being changed to reflect that," *Twitter*, January 25, 2022, https://twitter.com/TSKelso/status/1486138895196512256?s=20&t=CYW-fr_ZABtnxfFeSn-y2Q.

On December 23, 2018, China launched another mission to GEO that has also exhibited unusual behavior. Like its predecessors, the Tongxin Jishu Shiyan (TJS)-3 satellite was launched from Xichang Space Launch Center into an elliptical geosynchronous transfer orbit (GTO). Few details are known publicly about the TJS series, the first of which was launched in January 2017 (TJS-2, 2017-001A, 41911). Chinese official media has described them as communications technology test satellites but observers believe they may also be testing missile warning sensors, deployable antennas, or other technology.⁸⁷ The US military ended up cataloging two objects from the launch in GEO: the TJS-3 satellite (2018-110A, 43874) and a second object (2018-110C, 43917) that was assumed to be an apogee kick motor (AKM), a detachable rocket engine often used to circularize a satellite in GEO, as it was slowly drifting westward. While the modern practice is to separate and dispose of AKMs above GEO for space debris mitigation, it is not uncommon for them to be in GEO. However, shortly after the separation, object 43917 did a series of maneuvers to place it into a GEO slot at 59.07E, near TJS-3.⁸⁸ Object 43917 slowly drifted toward TJS-3 and according to AGI, exhibited photometry consistent with a stabilized object and not one that was tumbling.⁸⁹ Thus object 43917 appears to be a subsatellite, not an AKM, and was maintaining a relatively close distance (100 to 200 km) from TJS-3.⁹⁰ In May 2019, TJS-3 departed the TJS-AKM and moved to another location, suggesting that it was conducting initial check-out for the first few months while near TJS-AKM. However, its departure was accompanied by an unusual synchronization of maneuvers between TJS-3 and TJS-3 AKM, which some have suggested was a deliberate tactic to complicate tracking of TJS-3.⁹¹

Since May 2019, TJS-3 has circled the GEO belt and parked relatively close to multiple satellites, including the Russian Luch satellite that has conducted many of its own RPOs in GEO (see Russian Co-Orbital ASAT, Section 2.1), and several US national security satellites (including USA 263, also known as WGS 7 (2015-036A, 40746)), in July 2019, and USA 233, also known as WGS F4 (2012-003A, 38070), in March 2021 and October 2022, and has continued to remain active as shown in Figure 3-3.⁹² However, TJS-3 has typically maintained several hundred kilometers' distance from these US military satellites, suggesting it is doing something other than close RPO or has adopted a different pattern of behavior.

TJS-3 moved into 173.5 degrees east longitude in May 2023. Another Chinese satellite, TJS-10 (2023-169A, 58204), was launched on November 3, 2023 on a Long March 7A from Wenchang Satellite Launch Center; Chinese state media said it was intended to be "mainly used for multi-band and high-speed communication technology experiments."⁹³ By November 9, it had circularized its orbit and settled into GEO at 173.3 degrees east longitude. TJS-10 and TJS-3 spent about a year undertaking coordinated maneuvers in close proximity to each other (under 50 km) as they kept synchronized orbits with very similar inclination.⁹⁴ Around November 11-12, 2024, TJS-3 separated from TJS-10 in order to continue moving around the GEO belt.⁹⁵ It continued to move until it had reached 148.7 degrees East on January 13, 2025.⁹⁶ Over the next two days, the satellite's altitude was reduced by 53 km in order to stop its westward drift; on January 16, it was placed back on the GEO belt at 148.23 degrees East with a minimal drift.⁹⁷

In December 2021, TJS-3 AKM raised its orbit significantly above geostationary, which caused it to drift around the entire GEO belt and is now presumed decommissioned.⁹⁸

FIGURE 3-3 – LONGITUDINAL HISTORY OF THE TJS-3⁹⁹

The longitudinal history of the TJS-3 satellite since launch in 2018, including major RPOs with other satellites. Image credit: Kratos.

On October 24, 2021, China launched a classified satellite from the Xichang satellite launch center that it claimed was for a space debris mitigation mission.¹⁰⁰ The satellite, publicly named SJ-21 (49330, 2021-094A), was placed into an initial GTO inclined at 28.5 degrees by a Long March 3B. A statement from the China Aerospace and Technology Corporation, which conducted the launch, stated that it was built by SAST, and *Xinhua* reported that the satellite would be used, “mainly to test and verify space debris mitigation technologies.”¹⁰¹ By November 2, the SJ-21 used an apogee kick motor to circularize its orbit at about 156E and bring the inclination down to 8°, releasing the AKM as a piece of debris afterward. SJ-21 began drifting slowly westward at about 1 degree per day, although still inclined to geostationary orbit. For a while, SJ-21 maintained close proximity to the AKM, which suggested it was conducting an RPO.¹⁰²

On December 25, 2021, the SJ-21 rendezvoused with a defunct Chinese navigation satellite, Compass G2 (2009-018A, 34779). The Compass G2 was a second-generation navigation satellite launched in 2009 as part of China’s Beidou constellation and appeared to fail early in its orbital lifetime as it lost station keeping and began to drift both east-west and increase in inclination. Compass G2 also experienced a fragmentation event in 2016 that released at least six trackable pieces of debris.¹⁰³ While maintaining tight proximity to Compass G2 for several weeks, the SJ-21 docked to it at some point and then around January 21, 2022, used its onboard propulsion to pull both satellites to a higher altitude above the geostationary belt. By January 27, both objects were in an elliptical orbit ranging from 290 km to 3,100 km above the protected GEO zone, as observed by commercial trackers.¹⁰⁴ Shortly thereafter, SJ-21 reduced its orbital altitude back down to close to GEO, although maintained an inclination slightly higher than 8°. The SJ-21 was registered with the United Nations in August 2023 as a “Test satellite.”¹⁰⁵

On December 23, 2021, China launched a pair of satellites into GEO orbit as part of the Shiyen series officially labeled Shiyen (SY)-12 01 (2021-129A, 50321) and Shiyen (SY)-12 02 (2021-129B, 50322).¹⁰⁶ The two satellites remained relatively close to each other in GEO, indicating that they had maneuvering capability and may have been conducting RPO. In late January 2022, USA 270 (2016-052A, 41744), one of the four American GSSAP intelligence collection satellites (see US Co-Orbital ASAT, Section 1.1), maneuvered to approach SY-12 01 and SY-12 02. According to tracking data collected by ExoAnalytic Solutions,

⁹⁹ Data compiled by the Kratos.

¹⁰⁰ Stephen Clark, “China says its launched a space debris mitigation tech demo satellite,” *Spaceflight Now*, October 25, 2021, <https://spaceflightnow.com/2021/10/25/china-says-it-has-launched-a-space-debris-mitigation-tech-demo-satellite/>.

¹⁰¹ Clark, “China says its launched a space debris mitigation tech demo satellite,” *ibid*.

¹⁰² Andrew Jones, “An object is now alongside China’s Shiyen-21 debris mitigation satellite,” *SpaceNews*, November 5, 2021, <https://spacenews.com/an-object-is-now-orbiting-alongside-chinas-shiyen-21-debris-mitigation-satellite/>.

¹⁰³ “Orbital Debris Quarterly News,” *NASA Orbital Debris Program Office*, Volume 20, Issue 4, October 2016, <https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv20i4.pdf>.

¹⁰⁴ Theresa Hitchens, “China’s SJ-21 ‘tugs’ dead satellite out of GEO belt: Trackers,” *Breaking Defense*, January 26, 2022, <https://breakingdefense.com/2022/01/chinas-sj-21-tugs-dead-satellite-out-of-geo-belt-trackers/>.

¹⁰⁵ “Information Furnished in Conformity with the Convention on Registration of Objects Launched into Outer Space,” Note verbale dated 5 June 2023 from the Permanent Mission of China to the United Nations (Vienna) addressed to the Secretary-General, June 5, 2023, https://www.unoosa.org/res/osoindex/data/documents/cn/st/stsgser_e1123_html/2316744E.pdf.

¹⁰⁶ Andrew Jones, “Long March 7A launches classified Shiyen-12 satellites,” *SpaceNews*, December 23, 2021, <https://spacenews.com/long-march-7a-launches-classified-shiyen-12-satellites/>.

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- 107 Debra Werner, "An In-Orbit Game of Cat and Mouse: Close approaches prompt calls for communications and norms," *SpaceNews*, June 16, 2022, <https://spacenews.com/an-in-orbit-game-of-cat-and-mouse-close-approaches-prompt-calls-for-communications-and-norms/>.
- 108 SpaceNewsInc, "USA 270/Shiyan12 encounter," Youtube, Accessed February 22, 2023, <https://www.youtube.com/watch?v=H0ZlqmdjXjw>.
- 109 Greg Gillinger, "China: SY-12 02 Conducts Flyby of US SBIRS GEO 6," *Integrity Flash Issue* 129, September 14, 2025, <https://isruniversity.com/2025/09/15/issue-129/>.
- 110 Gillinger, "China: SY-12 02 Conducts Flyby," *ibid*.
- 111 Andrew Jones, "Pair of Chinese launches put classified and commercial satellites in orbit," *SpaceNews*, January 9, 2023, <https://spacenews.com/pair-of-chinese-launches-put-classified-and-commercial-satellites-into-orbit/>.
- 112 Andrew Jones, "Classified Chinese satellite releases small object in orbit," *Space.com*, January 24, 2023, <https://www.space.com/classified-chinese-satellite-shijian-23-releases-subsatellite>.
- 113 Andrew Jones, "China launches Shijian-25 satellite to test on-orbit refueling and mission extension technologies," *SpaceNews*, January 6, 2025, <https://spacenews.com/china-launches-shijian-25-satellite-to-test-on-orbit-refueling-and-mission-extension-technologies/>.
- 114 Jones, "China launches Shijian-25 satellite to test on-orbit refueling and mission extension technologies," *ibid*.
- 115 @COMSPOC_OPS, "Thanks to data from @OurSkyAI and @ObservableSpace," *Twitter*, June 3, 2025, https://x.com/COMSPOC_OPS/status/1930010703118631401.
- 116 @COMSPOC_OPS, "Recent observations from @OurSkyAI and @ObservableSpace," *Twitter*, June 9, 2025, https://x.com/COMSPOC_OPS/status/1932170356069978493.
- 117 Andrew Jones, "2 Chinese spacecraft just met up 22,000 miles above Earth. What were they doing?" *Space.com*, June 18, 2025, <https://www.space.com/space-exploration/satellites/2-chinese-spacecraft-just-met-up-22-000-miles-above-earth-what-were-they-doing>.

SY-12 01 and SY-12 02 made significant maneuvers to split up and begin rotating around the GEO belt in opposite directions, with SY-12 02 apparently also getting an imaging opportunity on USA 270.¹⁰⁷ A video animation released by COMSPOC Corporation also shows the encounter.¹⁰⁸ In September 2025, SY-12 02 conducted an RPO getting within 60 km of USA 336, the United States' SBIRS GEO 6 spacecraft (2022-092A, 53355).¹⁰⁹ Greg Gillinger noted, "The solar phase angle was ideal for SY-12 02 to image USA 336 with the sun nearly directly behind SY-12 02" but that it is "[u]nknown if China conducted this maneuver to optimize collection opportunity with USA 336."¹¹⁰

On January 8, 2023, China launched a satellite identified as SJ-23 (2023-002A, 55131) into a GTO using a Long March 7A from the Wenchang spaceport on Hainan island. China state media described the satellite as being used for "scientific experiments and technical verification" but provided no further details.¹¹¹ Around January 15, the SJ-23 appeared to release another object, which was catalogued as an apogee kick motor (2023-002C, 55180) but may be a functioning satellite.¹¹² Analysis of orbital data suggests that the two objects were within 10 km in February 2024.

Shijian (SJ)-25 (2025-002A, 62485) was launched into what appears to be a GTO on January 6, 2025, via a Long March 3B rocket from Xichang Satellite Launch Center.¹¹³ It was made and built by SAST, who said it was intended to be used for "satellite fuel replenishment and life extension service technology verification."¹¹⁴ In early June 2025, SJ-21 was detected maneuvering by commercial SSA companies; it was drifting westward along the GEO belt at 3.96 degrees/day on a trajectory to SJ-25.¹¹⁵ Two US GSSAP satellites, USA 270 and USA 271, maneuvered along the GEO belt as well, positioning themselves so that they were "flanking" SJ-21 and SJ-25, in the words of US commercial SSA company COMSPOC, most likely to monitor the two Chinese satellites' activities.¹¹⁶ The two satellites were seen conducting RPOs June 13-14 and at times were unable to be distinguished from each other.¹¹⁷

According to COMPSOC, on June 13, the two satellites got within 1 km of each, possibly docked, and then separated.¹¹⁸ They again appeared to come close enough to dock on June 30 according to imagery from Swiss commercial SSA company s2a systems.¹¹⁹ They got so close to each other between July 2 and July 6 that they were thought to have docked.¹²⁰ The SJ-21 and SJ-25 remained docked and started conducting minor maneuvers the first week of August; the second week of August, they conducted energy intensive, plane-changing maneuvers that reduced their inclination by 6°. ¹²¹ One analyst noted that this maneuver used the equivalent of six years of regular station-keeping fuel.¹²² By August 16, they had identical orbital information, were orbiting 3 km below the GEO belt at 127°E and a 4.4° inclination.¹²³ It is not clear why they moved - the Chinese government has not released any information about them - but one analyst pointed out that they were now in a similar orbit plane as classified objects from USSF-44 launch in November 2022.¹²⁴

s2a systems released images dated November 29, 2025, that showed the two satellites had undocked.¹²⁵ This was further confirmed by COMSPOC who said that SJ-25 had conducted a burn on November 25 “consistent with an undock or separation maneuver” and that while the two satellites were 10 km apart, they were distinguishable from each other.¹²⁶ Analysts believe that SJ-25 had served as a gas station for SJ-21.¹²⁷

SJ-21 and SJ-25 maneuvered mid-December to get within 1.3 km of each other on December 18; by December 20, optical imaging could not distinguish the two from each other again; and then by December 22, the two objects were distinct from one another.¹²⁸ The two satellites conducted RPOs in the first half of January 2026, often staying within 5 km of each other and having their closest approach - just under 3 km - on January 13; by January 16, they were 130 km apart and SJ-25 was moving away from SJ-21 at a rate of 50 km/day (while still remaining co-planar).¹²⁹

Research emerged that since 2018, SAST has been advertising “orbital mission extension vehicles” that could refuel satellites in GEO.¹³⁰ It advertised what it called an “on-orbit gas station” at the 2018 Zhuhai Air Show.¹³¹ The customer satellite would need to have SAST’s refuelling docking port and the refueler would use two robotic arms to connect once it got within two meters.¹³²

118 Andrew Jones, “Chinese spacecraft begin rendezvous and proximity operations in geostationary orbit,” *SpaceNews*, June 30, 2025, <https://spacenews.com/chinese-spacecraft-begin-rendezvous-and-proximity-operations-in-geostationary-orbit/>.

119 Jones, “Chinese spacecraft begin rendezvous and proximity operations in geostationary orbit,” *ibid*.

120 Phoebe Zhang, “China’s Shijian satellite pair appears to dock in orbit for historic refuelling mission,” *South China Morning Post*, July 13, 2025, <https://www.scmp.com/news/china/science/article/3318050/chinas-shijian-satellite-pair-appears-dock-orbit-historic-refuelling-mission>.

121 Greg Gillinger, “China: Docked SJ-21/SJ-25 Conduct Plane Change Maneuver,” *The Integrity Flash* issue 127, August 18, 2025, <https://isruniversity.com/2025/08/18/issue-127>.

122 Jim Shell, “A new cat and mouse in geosynchronous orbit,” *Space Domain Awareness, Orbital Debris, Norms of Behavior*, August 23, 2025, <https://spacedomain.substack.com/p/a-new-cat-and-mouse-in-geosynchronous>.

123 Gillinger, “China: Docked SJ-21/SJ-25 Conduct Plane Change Maneuver,” *ibid*.

124 Shell, “A new cat and mouse in geosynchronous orbit,” *ibid*.

125 @s2a_systems, “Bad weather delayed the obs, but here they are: SJ-25 and SJ-21A on 2025-11-29, 13:37:43 UTC,” *Twitter*, November 29, 2025, https://x.com/s2a_systems/status/1994773366704570496.

126 @COMPSOC_OPS, “THIS IS THE LAST STRAW: SHIJIAN-21 and SHIJIAN-25 Undocked,” *Twitter*, December 3, 2025, https://x.com/COMSPOC_OPS/status/1996330384468967448.

127 Jack C., “China Appears to Have Refueled a Geostationary Satellite in World-Leading Test,” *China in Space*, December 15, 2025, <https://www.china-in-space.com/p/china-appears-to-have-refueled-a>.

128 Greg Gillinger, “Reps & Sets: SJ-21 & SJ-25 Resume <2km RPO,” *The Integrity Flash* Issue 136, December 22, 2025, <https://isruniversity.com/2025/12/22/issue-136/#section-5>.

129 Greg Gillinger, “Update: Chinese GEO Refueling,” *The Integrity Flash* Issue 137, January 19, 2026, <https://isruniversity.com/2026/01/19/issue-137/>; Greg Gillinger, “Chinese GEO Refueling Update,” *The Integrity Flash* Issue 138, February 9, 2026, <https://isruniversity.com/2026/02/09/issue-138>.

130 Kristin Burke, “PLA On-Orbit Satellite Logistics,” *China Aerospace Studies Institute*, March 2024, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2024-03-18%20PLA%20On-Orbit%20Satellite%20Logistics.pdf>.

131 Burke, “PLA On-Orbit Satellite Logistics,” *ibid*.

132 Burke, “PLA On-Orbit Satellite Logistics,” *ibid*.

- 133 Andrew Jones, "China expands secretive satellite series with launch of TJS-15," *SpaceNews*, March 9, 2025, <https://spacenews.com/china-expands-secretive-satellite-series-with-launch-of-tjs-15/>.
- 134 Andrew Jones, "China launches classified TJS-16 spacecraft, companion object emerges alongside earlier TJS-15 satellite," *SpaceNews*, March 29, 2025, <https://spacenews.com/china-launches-classified-tjs-16-spacecraft-companion-object-emerges-alongside-earlier-tjs-15-satellite/>.
- 135 Andrew Jones, "China launches TJS-17, expanding classified geostationary satellite series," *SpaceNews*, April 10, 2025, <https://spacenews.com/china-launches-tjs-17-expanding-classified-geostationary-satellite-series/>.
- 136 Slingshot Aerospace, "Slingshot Orbital Alert: New Activity from Chinese TJS-17 Satellite in GEO," *LinkedIn.com*, April 15, 2025, <https://www.linkedin.com/feed/update/urn:li:activity:7317975685812142080/>; Spaceflux, "Orbital Update from GEO: New Activity from China's TJS-17 Satellite," *LinkedIn.com*, April 16, 2025, <https://www.linkedin.com/feed/update/urn:li:activity:7318266987296579584/>.
- 137 Andrew Jones, "China breaks annual launch record with VLEO Chutian and Shiyao technology test launches," *SpaceNews*, November 9, 2025, <https://spacenews.com/china-breaks-annual-launch-record-with-vleo-chutian-and-shiyao-technology-test-launches/>; Greg Gillinger, "Checking in on Shiyao-32 & Shijian-30 Triplets," *Integrity Flash Issue 137*, January 19, 2026, <https://isruniversity.com/2026/01/19/issue-137/>.
- 138 Jones, "China breaks annual launch record," *ibid.*
- 139 @LeoLabs_Space, "1/ LeoLabs has confirmed the release of a sub-satellite from the Chinese spacecraft Shiyao 32-02 on 17 December," *Twitter*, December 23, 2025, https://x.com/LeoLabs_Space/status/2003500275445932526?s=20.
- 140 Gillinger, "Checking in on Shiyao-32 & Shijian-30 Triplets," *ibid.*
- 141 <https://www.space-track.org/#decay>, accessed on March 6, 2026.
- 142 *Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion*, Defense Intelligence Agency, April 2022, https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf.

In March 2025, the Xichang Satellite Launch Center saw a launch of a Long March 3B rocket whose payload was later announced by CASC to be TJS-15 (2025-045A, 63157), which said that the satellite was going to be "mainly used to carry out multi-band, high-speed satellite communication technology verification."¹³³ An apogee kick motor was catalogued (2025-045C, 63299) from the flight and is now in a graveyard orbit above GEO.¹³⁴

In April 2025, another Long March 3B rocket from Xichang Satellite Launch Center launched TJS-17 (2025-073C, 63629) into GEO.¹³⁵ Its developer, SAST, said that it will be "mainly used to carry out multi-band, high-speed satellite communication technology verification," which is identical to how TJS-15 was described. Roughly five days after it was launched, two commercial SSA companies posted videos tracking an object that was released from TJS-17; it turned out to be the AKM (2025-073C, 63629) that had been used to get TJS-17 into its slot in GEO.¹³⁶

China launched a Long March 11 via a mobile platform off the coast of Haiyang, Shandong Province in November 2025; its payload consisted of SY32-01 (2025-255A, 66376), SY32-02 (2025-255C, 66378), and SY32-03 (2025-255D, 66379) which were put in an 53.0° inclined orbit at 450km x 432km.¹³⁷ Unusually, it took eight hours after launch for CASC to confirm the launch (usually it is done within an hour or so); CASC also said that the satellites were going to be "primarily used for conducting experiments on new space technologies."¹³⁸ One month later, in December 2025, US SSA company LeoLabs detected SY32-02 releasing a subsatellite, Object E (2025-255E, 67225).¹³⁹ It did not maneuver and quickly lost altitude.¹⁴⁰ It reentered the Earth's atmosphere about one week later and is no longer on orbit.¹⁴¹

The activities of all the aforementioned Chinese RPO satellites are consistent with the demonstration of RPO technologies for satellite servicing, space situational awareness, and inspection. Notably, a counterspace assessment released by the Defense Intelligence Agency (DIA) in April 2022 stated, "China is developing other sophisticated space-based capabilities, such as satellite inspection and repair. At least some of these capabilities could also function as a weapon;" it did not specifically state that any Chinese RPO activities were a weapons test.¹⁴²

That said, there is evidence to suggest there is more than one category of RPO missions being performed. For example, the SJ-17 has maintained long periods of time relatively close to other communications satellites, while the SY-12 01 and 02 pair have largely been drifting through the GEO belt. This suggests they are being used for a different purpose.

TABLE 3-2 – RECENT CHINESE RPOs

DATE(S)	TARGET SATELLITE	CHASER SATELLITE	ORBITAL PARAMETERS	RESULT
Sep. 2008	SZ-7	BX-1	–	BX-1 was deployed from SZ-7 and proceeded to orbit around the spacecraft, taking images.
Jun. – Aug. 2010	SJ-06F	SJ-12	570-600 km; 97.6°	SJ-12 moved to rendezvous with SJ-06F. Satellites may have bumped into each other.

DATE(S)	TARGET SATELLITE	CHASER SATELLITE	ORBITAL PARAMETERS	RESULT
Jul. 2013 – May 2016	SY-7, CX-3	SY-7, Payload A Debris, CX-3, SJ-15	Approx. 670 km; 98°	SY-7 released an additional object that it performed maneuvers with and may have had a telerobotic arm. CX-3 performed optical surveillance of other in-space objects. SJ-15 demonstrated altitude and inclination changes to approach other satellites. In Dec. 2015, SJ-15 raised its orbit to CX-3, demonstrating multi-orbit inspection.
Nov. 2016 – Aug. 2018	Chinasat 5A, Chinasat 20, Chinasat 1C	SJ-17	35,600 km; 0°	SJ-17 moved around the GEO belt and circumnavigated Chinasat 5A. The SJ-17 then lowered its orbit to reverse its drift and moved to RPO with Chinasat 20. It undertook a sudden, large change in inclination to rendezvous and follow Chinasat 1C for about a week, which had undergone an anomaly in its orbital trajectory and started drifting westward. This strongly suggests that SJ-17 was used to inspect Chinasat 1 to determine the source of the anomaly and then monitor the recovery attempt.
Jan. – Apr. 2019	TJS-3, TJS-3 AKM	TJS-3, TJS-3 AKM	35,600 km; 0°	TJS-3 AKM separated from the TJS-3 in the GEO belt, and both performed small maneuvers to maintain relatively close orbital slots. Both satellites then maneuvered away from each other.
May 2019 – present	Luch, USA 233, USA 263, Chinasat 10, Chinasat 16, SJ-20, Chinasat 12, TJS-10	TJS-3	35,600 km; 0°	TJS-3 is drifting around the GEO belt, periodically stopping to conduct RPO with other satellites.
Jan. – Oct. 2020	Chinasat 6B, SJ-20	SJ-17	35,600 km; 0°	SJ-17 conducted RPO with Chinasat 6B in January 2020 and SJ-20 in October 2020.
Dec. 2021 – Jan. 2022	Compass G2	SJ-21	35,876 km; 8°	SJ-21 maneuvered to dock with Compass G2 and pull it well past graveyard orbit.
Jan. 2022	SY-12 01, SY-12 02	USA-270	35,600 km; 0°	USA 270 maneuvered to approach SY-12 01 and SY-12 02. The two Chinese satellites made significant maneuvers to split up and begin rotating around the GEO belt in opposite directions, with SY-12 02 apparently also getting an imaging opportunity on USA 270.
Mar. – Oct. 2022	SJ-6 05B	SJ-6 05A	470 km	SJ-6 05A maneuvered to get within 1 km of SJ-6 05B repeatedly.
Nov. 2022 – Mar. 2023	Object J	PRC Test Spacecraft 2	–	PRC Test Spacecraft 2 released Object J and made multiple RPOs, including repeated docking, deployment, and formation flying.
Jan. – Feb. 2024	SJ-23 AKM	SJ-23	35,600 km; 0°	Shortly after its launch, SJ-23 appeared to release an object, which was cataloged as an apogee kick motor but may be a functioning satellite. Analysis of the orbital data suggests that the two objects got within 10 km of each other.
Jun. 2024	Object G	PRC Test Spacecraft 3	–	PRC Test Spacecraft 3 released Object G and conducted several RPOs with it.
Feb. 2023 – present	VENESAT-1, YAMAL 300K	SJ-17	35,600 km; 0°	SJ-17 started drifting eastward in Feb. 2023 and made a brief RPO in Nov. 2023 with VENESAT-1. SJ-17 continued to move, changing its altitude repeatedly to move above and below the GEO belt; it rejoined the GEO belt in November 2024. It officially entered the Western hemisphere on Nov. 20, 2024 and appears to be stable at 178 degrees West longitude, with the nearest operational satellite being Russia's YAMAL 300K.

DATE(S)	TARGET SATELLITE	CHASER SATELLITE	ORBITAL PARAMETERS	RESULT
Mar. – Apr., Sep., Dec. 2024	SY-24C 01, SY-24C 02, SY-24C 03, SJ-6 05A, SJ-6 05B	SY-24C 01, SY-24C 02, SY-24C 03, SJ-6 05A, SJ-6 05B	–	The five satellites conducted RPOs from March 2024 through the end of April 2024, at times separated by less than 1 km, and undertaking two simultaneous proximity events. In September 2024, SY-24C 02 and SY-24C 03 conducted three separate approaches, with two being multi-day actions. In December 2024, SY-24C 03 and SJ6 5A came within “tens of meters” of each other five different times; this was a multi-day event.
Jun. 2025 – Jan. 2026	SJ-25	SJ-21	35,600 km; 0°	The two satellites were conducting RPOs with each other June 13-14 and at times were unable to be distinguished from each other. They again appeared to come close enough to dock on June 30. They got so close to each other between July 2 and July 6 that they were thought to have docked. The SJ-21 and SJ-25 remained docked until November 2025, at which point they separated but continued to conduct RPOs until mid-January 2026.
Sep. 2025	USA 336	SY-12 02	35,600 km; 0°	SY-12 02 conducted an RPO, getting within 60 km of USA 336, possibly in an attempt to image it.

Potential Military Utility /

The most likely military utility of the capabilities demonstrated by the SJ-12, SJ-15, SJ-17, TJS-3, TJS-3 AKM, SJ-21, and SY-12 01 and 02 satellites is for on-orbit space situational awareness (SSA) and satellite servicing. Their operational pattern was consistent with slow, methodical, and careful approaches to rendezvous with other space objects in similar orbits. The satellites the SJ-12 and SJ-15 approached were in relatively similar orbits, differing in altitude by a couple of hundred kilometers and slightly in inclination. They did not make huge changes to rendezvous with satellites in significantly different orbits. This behavior is similar to several US RPO missions to test and demonstrate satellite inspection and servicing capabilities such as the XSS-11, which conducted inspections of satellites in LEO in 2005 and 2006 and DARPA's Orbital Express satellite that did satellite servicing demonstrations 2007 (see US Co-Orbital ASAT, Section 1.1).

The SJ-17's approach to Chinasat 5A was not inconsistent with the way other active satellites in the GEO belt relocate to different orbital slots. It is also not unusual for satellites to be co-located within several tens of kilometers to share a GEO slot, although it is rare for them to approach within 1 km as the SJ-17 eventually did. Such a close approach in GEO could be used for very detailed imaging or inspection of another satellite or to intercept radio frequency signals directed at another satellite from Earth. Likely examples of the latter are the activities of the US PAN satellite (35815, 2009-047A) between 2009 and 2014 (see US Co-Orbital ASAT, Section 1.1), and the Russian Luch/Olymp satellite (40258, 2014-058A) beginning in 2015 (see Russian Co-Orbital ASAT, Section 2.1).

While the known on-orbit activities of the SJ-12, SJ-15, SJ-17, TJS-3, TJS-3 AKM, SY-12 01 and 02, and SJ-21 did not include explicit testing of offensive capabilities or aggressive maneuvers, it is possible that the technologies they tested could be used for offensive purposes in the future. One potential offensive use would be to get a radio-frequency jammer close to a satellite, thereby greatly amplifying its ability to interfere with the satellite's communications. While possible, to date there is no direct public evidence of such systems being tested on orbit, although there have been multiple re-search articles published in Chinese journals discussing and evaluating the

concept and it is thought that China has launched an experimental satellite to GEO to practice conducting space-based jamming (see Chinese Electronic Warfare, Section 3.3)¹⁴³ A recent paper from Chinese researchers suggests that they are studying the ability to use RPO capabilities to plant small explosive charges in the nozzle of a spacecraft's engine, although only ground tests have been reported so far.¹⁴⁴

The onboard tracking and guidance systems used for rendezvous could be used to try and physically collide with another satellite to damage or destroy it. However, the approach would have to involve much higher relative velocities than what the Chinese RPO satellites have demonstrated to date, and potentially involve higher velocities and longer closing distances than what these satellites are capable of. Furthermore, the deliberate maneuvering to create a conjunction with the target satellite would be detectable with existing processes already in place to detect accidental close approaches. The warning time of such a close approach would likely be at least hours (for LEO) or days (for GEO) unless the attacking satellite was already in a very similar orbit.

If SJ-25 did indeed refuel SJ-21, this capability would be of great utility, as China's inspector satellites could stay on orbit and continue their missions while having the flexibility of maneuvering as the operators wished. If SJ-25 is a refueling satellite, it is unclear how much extra fuel SJ-25 has.

3.2 – CHINESE DIRECT-ASCENT ASAT

Assessment /

China has at least one, and possibly as many as three, programs underway to develop DA-ASAT capabilities, either as dedicated counterspace systems or as midcourse missile defense systems that could provide counterspace capabilities. China has engaged in multiple, progressive tests of these capabilities since 2005, indicating a serious and sustained organizational effort. Chinese DA-ASAT capability against LEO targets is likely mature and may be operationally fielded on mobile launchers. Chinese DA-ASAT capability against deep space targets (medium Earth orbit, or MEO, and GEO) is likely still in the experimental or development phase, and there is not sufficient evidence to conclude whether it will become an operational capability in the near future.

Specifics /

Program Background

The Chinese direct-ascent ASAT program has its roots in several programs that emerged from the 1960s through the 1990s. Program 640, initially tasked with the development of anti-ballistic missiles (ABM) and surface-to-air missile (SAM) sites, began a dedicated ASAT program in 1970 and oversaw most of China's counterspace funding and development for the first two decades. During this period, nearly all Chinese ASAT work appears to have taken place within the various subsidiaries of the Fifth Academy of the Chinese Ministry of Defense, especially the No. 2 General Design Department of the Second Academy.¹⁴⁵

These various subsidiaries have, over time, been consolidated into large state-owned companies, yet have retained deep-seated direct ties to the military, particularly regarding the development and use of ASAT technologies. Today, the General Design Department is a subsidiary of the China Aerospace Industry Corporation (CASIC), which is responsible, among other things, for a variety of derivatives of China's Dong-Feng ballistic missile series, including several with ASAT relevance.¹⁴⁶

143 David Chen, "Testimony before the US-China Economic and Security Review Commission," Hearing on 'China's Advanced Weapons' Panel on China's Directed Energy and Electromagnetic Weapons Programs, February 23, 2017, https://www.uscc.gov/sites/default/files/Chen_Testimony.pdf.

144 Stephen Chen, "Chinese scientists build anti-satellite weapons that can cause explosion inside exhaust," *South China Morning Post*, October 21, 2021, <https://www.scmp.com/news/china/military/article/3153174/chinese-scientists-build-anti-satellite-weapon-can-cause>.

145 Gregory Kulacki, "Anti-Satellite (ASAT) Technology in Chinese Open-Source Publications," *Union of Concerned Scientists*, July 1, 2009, <https://ucsusa.org/sites/default/files/2019-09/Kulacki-Chinese-ASAT-Literature-6-10-09.pdf>.

146 Kulacki, "Anti-Satellite (ASAT) Technology in Chinese Open-Source Publications," *ibid*.

- 147 Mark Stokes and Dean Cheng, "China's Evolving Space Capabilities: Implications for US Interests," report prepared for The US-China Economic and Security Review Commission, April 26, 2012, <https://www.hsdl.org/?view&did=708400>.
- 148 Stokes and Cheng, "China's Evolving Space Capabilities: Implications for US Interests," *ibid*; Michael Pillsbury, "An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies and Doctrines," report prepared for The US-China Economic and Security Review Commission, January 19, 2007, <https://www.uscc.gov/research/assessment-chinas-anti-satellite-and-space-warfare-programs-policies-and-doctrines>; John Pike, "HQ-19 Anti-Ballistic Missile Interceptor," *Global Security*, last updated February 6, 2018, <https://www.globalsecurity.org/space/world/china/hq-19.htm>.
- 149 Michael R. Gordon and David S. Cloud, "US Knew of China's Missile Test, but Kept Silent," *New York Times*, April 23, 2007, <http://www.nytimes.com/2007/04/23/washington/23satellite.html>.
- 150 T.S. Kelso, "Analysis of the 2007 Chinese ASAT Test and the Impact of its Debris on the Space Environment," AMOS Conference Technical Papers, (2007), pp. 321-330. <http://celestrak.com/publications/AMOS/2007/AMOS-2007.pdf>; "History of ASAT Tests in Space," *Secure World Foundation*, last updated Feb. 5, 2025, https://docs.google.com/spreadsheets/d/1e5GtZEz-do6xk41i2_ei3c8JRZDjvP4Xwz3BVuUHwi48/edit?gid=1252618705#gid=1252618705.
- 151 "Annual Threat Assessment of the US Intelligence Community," *Office of the Director of National Intelligence*, April 9, 2021, <https://www.dni.gov/files/ODNI/documents/assessments/ATA-2021-Unclassified-Report.pdf>.

The emergence of this structure is important for understanding the character of China's counterspace development. First, there is often little division between the 'private' and 'public' sectors, or between civilian and military space. Second, it is likely that bureaucratic imperatives for rent-seeking and sustainment, coupled with institutional inertia and silos of information and decision-making authority, are giving elements of Chinese counterspace development a life of their own, much as they did in the United States and USSR during the Cold War. The number and diversity of counterspace programs may be driven by competition between organizations more than a deliberate strategy to have multiple competing programs.

Program 640 was shuttered in 1980. A few years later, Program 863—a broad umbrella program for cutting edge technological developments—took its place. In 1995, a kinetic kill vehicle (KKV) project began which was housed within Program 863.¹⁴⁷ Initial testing began in the late 1990s, followed by further vector and velocity control testing in 2003, at which point the system entered service as the interceptor for the HQ-19 missile defense system.¹⁴⁸ The HQ-19 is a solid-propelled high altitude hit-to-kill (HTK) intercept system roughly equivalent to the US Terminal High Altitude Area Defense (THAAD) missile defense system. Since then, China has demonstrated significant advances in HTK capability, and engaged in large-scale modernization and development efforts for advanced rocket technology; tracking, targeting, and SSA capabilities; and launch infrastructure, both mobile and stationary.

Capabilities

China may be developing as many as three direct-ascent ASAT systems, although it is unclear whether all three are intended to be operational or whether their primary mission is counterspace or midcourse missile defense. The first known system is known as the SC-19, sometimes referred to as DN-1, and has been tested multiple times, as summarized in Table 3-2. The first known tests were in 2005 and 2006, both from Xichang Satellite Launch Center in Sichuan (see Imagery Appendix, pg. 17-16), and appear to have been tests of the missile itself.¹⁴⁹ On January 11, 2007, the SC-19 was tested for the third time from Xichang and destroyed an aging Chinese FengYun (FY)-1C weather satellite (1999-025A, 25730) at an altitude of 865 km, which created 3532 trackable pieces of debris, of which, 2351 are still in orbit.¹⁵⁰ The system was reportedly tested again in 2010 and 2013 from the Korla Missile Test Complex (see Imagery Appendix, pg. 17-13) with successful intercepts of a ballistic target. The move from Xichang to Korla may indicate the system entered a new phase of development, or possibly even operational testing. In April 2021, the US Office of the Director of National Intelligence assessed that China had "fielded ground-based ASAT missiles intended to destroy satellites in LEO."¹⁵¹

Naming Convention for Chinese DA-ASATs

The naming conventions for Chinese DA-ASATs are complicated and uncertain. The US intelligence community traditionally christens foreign missiles according to the launch site at which they were first observed, followed by a number indicating how many other unique missile types already bear that moniker. For example, SC-19 corresponds to the nineteenth missile type observed from Shuang cheng zi, the US intelligence designation for Jiuquan Space Launch Center. The Chinese DA-ASATs have also been referred to as "DN," indicating shorthand for Dong Neng (动能), a Chinese phrase translating to "Kinetic Energy." Although this is somewhat in line with the taxonomy for China's designations for its ballistic and cruise missiles, the Dong-Feng-XX (东风, literally "East Wind"), the only public mentions of the DN label have been in US news reports citing anonymous US officials. Thus, the DN-X designation may be a leak of the Chinese internal name for the system as divined by US intelligence. If so, that suggests that DN-1 is the Chinese designation for the SC-19, DN-2 is the longer range GEO version, and DN-3 could be an upgraded LEO version or a midcourse missile defense interceptor.

While the specifications of the SC-19 are not publicly available, analysis of its technological foundations and demonstrated capabilities is revealing. The SC-19 appears to be based on the DF-21C ballistic missile, but also derives some elements from the HQ-19 missile defense system, including the intercept vehicle and certain rocket stages.¹⁵² The DF-21 has an operational range of 2150-2500 km, which typically would amount to a vertical reach of about half that or approximately 1250 km. Subsequent analyses have concluded that while the SC-19 incorporates many design aspects of the DF-21, it may feature three solid stages and a liquid upper stage.¹⁵³

FIGURE 3-4 – DF-21 MRBM



Missile version upon which the SC-19 is likely based, mounted atop a TEL. Image credit: Defence Blog.¹⁵⁴

The organizational history of the SC-19 yields further clues. Chinese rocket development is centralized in two state-owned corporations. According to Chinese bloggers, CASIC sought to leverage the DF-21 and its expertise in solid rockets to develop a new line of solid rocket space launch vehicles (SLV).¹⁵⁵ The first attempt was the Kaituoze 1 (KT-1), a four-stage rocket 13.6 m in length and 1.4 m in diameter that was designed to place a 50 kg payload in a 400 km sun-synchronous orbit. Both known tests of the KT-1 failed, and the project was apparently canceled. A larger 1.7 meter diameter version called the KT-2 was planned but never developed. However, in 2002, CASIC won a contract to build a 1.4 m diameter, four-stage rocket (three solid stages with a liquid upper stage) called the KT-409 that was launched from a WS2500 TEL. This is likely the SC-19.

China has also conducted at least one test of what is likely a DA-ASAT that might be able to reach higher orbits. On May 13, 2013, China launched a rocket from the Xichang Satellite Launch Center, which the Chinese Academy of Sciences stated was a high-altitude scientific research mission.¹⁵⁶ A US military official stated that “the launch appeared to be on a ballistic trajectory nearly to [GEO]. We tracked several objects during the flight...and no objects associated with this launch remain in space,”¹⁵⁷ but unofficial US government sources say it was a test of a new ballistic missile related to China’s ASAT program.¹⁵⁸ Subsequent launch analysis strongly supports this conclusion.

The details of the launch were different from those of either a standard satellite launch to GEO or the launch of a sounding rocket. The Notice to Airmen (NOTAM) released by China to provide warning of the flight path in case of complications covered a ground track lining up with a GEO launch trajectory,¹⁵⁹

¹⁵² Rick Fisher finds that the DF-21 forms the basis for the SC-19. See: Fisher, “China’s Military Modernization: Building for Regional and Global Reach,” pp. 2, 131; MissileThreat provides an operational range of 2500 km for the DF-21, while think tank analyst Sean O’Connor pegs the range at 2150 km. See “DF-21 (Dong Feng-21 / CSS-5)”, MissileThreat, Center for Strategic and International Studies, <https://missilethreat.csis.org/missile/df-21>; Sean O’Connor, “PLA Ballistic Missiles,” (Report prepared under contract APA-TR-2010-0802 for Air Power Australia in 2010, Last updated: 27 January 2014), <http://www.ausairpower.net/APA-PLA-Ballistic-Missiles.html#mozTocId8319>.

¹⁵³ Phillip C. Saunders and Charles D. Lutes, “China’s ASAT Test: Motivations and Implications,” *Joint Force Quarterly*, Issue 46, (2007): pp. 39-45, <http://oai.dtic.mil/oai/oai?verb=get-Record&metadataPrefix=html&identifier=A-DA517485>.

¹⁵⁴ Dylan Malyasov, “China displays DF-21D Anti-Ship Ballistic Missile,” *Defence Blog*, September 3, 2015, <https://defence-blog.com/china-displays-df-21d-anti-ship-ballistic-missile/>.

¹⁵⁵ Brian Weeden, “Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space,” *The Space Review*, March 17, 2014, <http://www.thespacereview.com/article/2473/1>.

¹⁵⁶ “中国再次高空科学探测试验：高度更高数据更多,” *China News*, May 14, 2013, <http://www.chinanews.com/gn/2013/05-14/4817925.shtml>.

¹⁵⁷ Marc V. Schanz, “Chinese Anti-Satellite Test?,” *Air Force Magazine*, May 16, 2013, <http://www.airforcemag.com/DRArchive/Pages/2013/May%202013/May%2016%202013/Chinese-Anti-Satellite-Test.aspx>.

¹⁵⁸ Bill Gertz, “China Conducts Test of New Anti-Satellite Missile,” *The Washington Free Beacon*, May 14, 2013, <http://freebeacon.com/national-security/china-conducts-test-of-new-anti-satellite-missile/>.

¹⁵⁹ “Chinese Officials provide initial Information on Monday’s Sub-Orbital Launch,” *Spaceflight101*, May 15, 2013, <http://www.spaceflight101.net/chinese-rocket-launch-may-2013.html>.

- 160 Brian Weeden, "Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space," *ibid.*
- 161 Note that in the Chinese language, 10,000 is a base amount of something, so this may have been used as an order of magnitude statement rather than meant as an absolute distance. Still, it was less than forthcoming about the actual apogee of the test.
- 162 Andrea Shalal-Esa, "US sees China launch as test of anti-satellite muscle: source," *Reuters*, May 15, 2013, <https://www.reuters.com/article/us-china-launch/u-s-sees-china-launch-as-test-of-anti-satellite-muscle-source-idUS-BRE94E07D20130515>.
- 163 Brian Weeden, "Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space," *ibid.*
- 164 Weeden, "Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space," *ibid.*
- 165 "USCC 2015 Annual Report," pp. 294-294, November 2015, <https://www.uscc.gov/annual-report/2015-annual-report-congress>.
- 166 Bill Gertz, "China Conducts Test of New Anti-Satellite Missile," *The Washington Free Beacon*, May 14, 2013, <http://freebeacon.com/national-security/china-conducts-test-of-new-anti-satellite-missile/>.
- 167 "Space Threat Fact Sheet," *Headquarters Space Force Intelligence*, July 16, 2024, <https://www.andrewerickson.com/wp-content/uploads/2024/09/20240716-S2-Space-Threat-Fact-Sheet-v5-RELEASE.pdf>.

but stretching further south than either GEO satellite launches or a typical sounding rocket. The resultant rocket launch went far higher than a typical sounding rocket, and the rocket plume was much larger and more intense than would be expected with a sounding rocket. Moreover, there is no evidence that it "released a barium cloud" as claimed by CAS, nor has there been any subsequent scientific research published because of the launch.

Analysis of the launch site also points to something other than either an orbital or sounding rocket.¹⁶⁰ Both are typically larger and more complicated than ballistic missiles. As a result, they are usually launched from fixed launch pads, with standing support structures. In Xichang, however, there are only two official launch pads: one was unavailable at the time of the May 13 launch (as it was being retrofitted after use for the LM-3A), while the other played host to a LM-3B/E launch on May 1, leaving insufficient time to prep another SLV for launch.

Furthermore, the launch appeared to go much higher than the altitude claimed by the Chinese government. In their statement, CAS claimed the rocket reached 10,000 km¹⁶¹, whereas the US military claimed it went "nearly to GEO" at 36,000 km. US officials also stated that the upper stages re-entered the Earth's atmosphere "over the Indian Ocean".¹⁶² A technical analysis concluded that re-entry location was only possible if the apogee was at least 30,000 km; if the apogee was only 10,000 km, the Earth would not have had enough time to rotate for it to land in the Indian Ocean.¹⁶³ The flight trajectory is also far beyond what the SC-19 is believed to be capable of.

The most plausible explanation for the May 2013 launch was that it was a test of the rocket component of a new DA-ASAT weapons system derived from a road-mobile ballistic missile. Commercial satellite imagery shows a transporter-erector-launcher (TEL), commonly associated with mobile ballistic missiles, located on a purpose-built launch pad towards the southeast corner of Xichang (see Imagery Appendix, pg. 17-17), as shown in Figure 3-5.¹⁶⁴ The pad is similar to the one believed to have been constructed for the SC-19 testing in the northwest of Xichang. A report from the US-China Economic and Security Review Commission labeled this new rocket as DN-2 and claimed it may reach operational status in 2020-2025.¹⁶⁵ However, the only known sources of this designation are news reports that cite anonymous US defense officials.¹⁶⁶ As of February 2026, the DN-2 is not known to have been flown again. A 2024 USSF fact sheet cited the 2013 test as evidence of a rudimentary ASAT capability beyond LEO and asserted, "Intelligence suggests China also likely intends to field ASAT weapons capable of destroying satellites up to GEO."¹⁶⁷

FIGURE 3-5 – XICHANG SPACE LAUNCH COMPLEX ON APRIL 3, 2013

Imagery shows a TEL on the southeast pad. Image © 2013 DigitalGlobe. All rights reserved.
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In 2014, China conducted another rocket test, this time claiming that it was part of a missile defense interceptor program.¹⁶⁸ Very little information is available in the public record about this launch, other than that it occurred, remained suborbital, and does not appear to have had an evident target, ballistic or otherwise. However, the United States government openly declared it an anti-satellite test: the only time since 2007 that any event has been so-labeled publicly. When asked for comment, then-Assistant Secretary of State for Arms Control, Verification, and Compliance Frank Rose noted on the record that “Despite China’s claims that this was not an ASAT test, let me assure you the United States has high confidence in its assessment, that the event was indeed an ASAT test.”¹⁶⁹ A report published by the US-China Economic and Security Review Commission also stated that the 2014 test was of the SC-19/DN-1, but did not provide independent evidence.¹⁷⁰

Since 2014, evidence suggests China has conducted at least six more tests that may be linked to their DA-ASAT program. A launch on October 30, 2015, from Korla created unusual contrails that were seen on Chinese social media.¹⁷¹ Photos from another test on July 22, this time launched from Jiuquan Satellite Launch Center (see Imagery Appendix, pg. 17-11) were captured by a pilot on a Dutch commercial airliner flying over the Himalayas.¹⁷² On February 5, 2018, Chinese state media announced it had carried out “land-based midcourse missile interception test within its territory.”¹⁷³ In all three cases, anonymous US officials were cited by news sources claiming that the tests were of a system known publicly as DN-3 and labeled by US intelligence agencies as KO-09, as the ninth missile type seen out of Korla.¹⁷⁴ DN-3 could refer to an upgraded version of the LEO-capable DN-1 or an adaptation of the same weapon system for midcourse missile defense, akin to the US sea-based Standard Missile (SM)-3 interceptor or Ground-based Interceptor (GBI), with latent ASAT capabilities (see US DA-ASAT, Section 1.2).¹⁷⁵ China publicly announced additional “land-based midcourse missile intercept technology test[s]” on February 4, 2021,¹⁷⁶ and June 21, 2022,¹⁷⁷ and April 14, 2023,¹⁷⁸ with very similar descriptions as previous tests of the DN-1 and its derivatives.

168 Mike Gruss, “US State Department: China Tested Anti-satellite Weapon,” *SpaceNews*, July 28, 2014, <http://spacenews.com/41413us-state-department-china-tested-anti-satellite-weapon/>.

169 Mike Gruss, “Senior US Official Insists China Tested ASAT Weapon,” *SpaceNews*, August 25, 2014, <http://spacenews.com/41676senior-us-official-insists-china-tested-asat-weapon/>.

170 “USCC 2015 Annual Report,” p. 293, November 2015, accessed March 23, 2018, <https://www.uscc.gov/annual-report/2015-annual-report-congress>.

171 Jing Heng, “网友11月1日拍到新疆库勒勒神奇天象 疑似航天或反导试验,” *Guancha.cn*, November 1, 2015, http://www.guancha.cn/military-affairs/2015_11_01_339656.shtml.

172 Tom Demerly, “Commercial Pilot Catches Remarkable Photos of Alleged Secret Chinese Anti-Missile Test,” *The Aviationist*, July 29, 2017, <https://theaviationist.com/2017/07/29/commercial-pilot-catches-remarkable-photos-of-alleged-secret-chinese-anti-missile-test/>.

173 Ankit Panda, “Revealed: The Details of China’s Latest Hit-To-Kill Interceptor Test,” *The Diplomat*, February 21, 2018, <https://thediplomat.com/2018/02/revealed-the-details-of-chinas-latest-hit-to-kill-interceptor-test/>.

174 Bill Gertz, “China Carries Out Flight Test of Anti-Satellite Missile,” *Washington Free Beacon*, August 2, 2017, <http://freebeacon.com/national-security/china-carries-flight-test-anti-satellite-missile/>.

175 Ankit Panda, “Revealed: The Details of China’s Latest Hit-To-Kill Interceptor Test,” *The Diplomat*, February 21, 2018, <https://thediplomat.com/2018/02/revealed-the-details-of-chinas-latest-hit-to-kill-interceptor-test/>.

176 Wang Xinjuan, “China conducts land-based mid-course missile interception test,” *Chinese Ministry of National Defense*, February 5, 2021, http://eng.chinamil.com.cn/view/2021-02/05/content_9980841.htm.

177 Emma Helfrich, “China Conducts Midcourse Missile Defense Test One Year After Last,” *The Warzone*, June 21, 2022, <https://www.thedrive.com/the-war-zone/china-conducts-sixth-missile-defense-test-one-year-after-the-last-one>.

178 “China says it conducted mid-course missile interception test,” *Associated Press*, April 15, 2023, <https://apnews.com/article/china-interceptor-missile-test-defense-c77ae53a43f5e74bc48c4be45e46af80>.

- 179 National Air and Space Intelligence Center, "Competing in Space", December 2018, <https://media.defense.gov/2019/jan/16/2002080386/-1/-1/1/190115-F-NV711-0002.PDF>.
- 180 Daniel Coats, "Worldwide threat assessment of the United States intelligence community," Senate Select Committee on National Intelligence, January 29, 2019, <https://www.intelligence.senate.gov/sites/default/files/documents/os-dcoats-012919.pdf>.
- 181 Data compiled from multiple sources already cited in the text of this document.
- 182 Liu Xuanzun, Fan Wei and Liang Rui, "China debuts HQ-29 antiballistic missile weapon at V-Day military parade," *Global Times*, September 3, 2025, <https://www.globaltimes.cn/page/202509/1342511.shtml>.
- 183 "HQ-29 Chinese Mobile Interceptor Missile System," OE Data Integration Network (ODIN), US Army, September 3, 2025, <https://odin.tradoc.army.mil/WEG/Asset/5a061d8eaba14c72b-55b91ee544148af>.
- 184 "China Unveils Long Awaited HQ-29 Space Defence System Built to Take Down Western Satellites," *Military Watch Magazine*, August 25, 2025, <https://militarywatchmagazine.com/article/china-long-awaited-hq29-space-defence>.
- 185 Alcott Wei, "How China's HQ-29 mid-course missile interceptor stacks up against US rivals," *South China Morning Post*, November 17, 2025, <https://www.scmp.com/news/china/military/article/3332993/how-chinas-hq-29-mid-course-missile-interceptor-stacks-against-us-rivals>.
- 186 "HQ-29 Chinese Mobile Interceptor Missile System," OE Data Integration Network (ODIN), US Army, September 3, 2025, <https://odin.tradoc.army.mil/WEG/Asset/5a061d8eaba14c72b-55b91ee544148af>.

Some reporting suggests that at least one of these systems, likely the SC-19, has achieved operational status. In December 2018, the National Air and Space Intelligence Center (NASIC) released a public counterspace assessment of foreign space and counterspace capabilities that stated, "China has military units that have begun training with anti-satellite missiles."¹⁷⁹ In his statement for the record before the United States Senate on January 29, 2019, Director of National Intelligence Daniel Coats stated that China "has an operational ground-based ASAT missile intended to target low-Earth-orbit satellites."¹⁸⁰ Taken together, these statements suggest that China has operationally deployed DA-ASAT systems to at least some units and has developed operational training for their use, although there has not been independent confirmation of this through open sources.

TABLE 3-3 – HISTORY OF CHINESE DA-ASAT TESTS¹⁸¹

DATE	SYSTEM	LAUNCH SITE	PAYLOAD	APOGEE	NOTES
July 7, 2005	SC-19	Xichang	None known	?	Likely rocket test
Feb. 6, 2006	SC-19	Xichang	Unknown satellite	?	Likely near-miss of orbital target
Jan. 11, 2007	SC-19	Xichang	FY-1C satellite	865 km	Destruction of orbital target, 3533 pieces of debris created
Jan. 11, 2010	SC-19	Korla	CSS-X-11 ballistic missile launched from Jiuquan	250 km	Destruction of suborbital target
Jan. 27, 2013	Possible SC-19	Korla	Unknown ballistic missile launched from Jiuquan	Suborbital	Destruction of suborbital target
May 13, 2013	Possible DN-2	Xichang	None known	~30,000 km	Likely rocket test
July 23, 2014	Possible DN-2	Korla? (Jiuquan?)	Likely ballistic missile launched from Jiuquan	Suborbital	Likely intercept test
Oct. 30, 2015	Possible DN-3	Korla	None known, possible ballistic missile	Suborbital	Likely rocket test
July 23, 2017	Possible DN-3	Jiuquan?	Likely ballistic missile	Suborbital, malfunctioned	Likely intercept test
Feb. 5, 2018	Possible DN-3	Korla	Likely ballistic missile	Suborbital	Likely intercept test
Feb. 4, 2021	Possible DN-3	Korla	Likely ballistic missile	Suborbital	Likely intercept test
Jun. 19, 2022	Possible DN-3	Korla	Likely ballistic missile	Suborbital	Likely intercept test
Apr. 14, 2023	Possible DN-3	Korla	Likely ballistic missile	Suborbital	Likely intercept test

At a September 2025 military parade in Beijing, China unveiled a new missile interceptor that is thought to possibly have ASAT capabilities: the HQ-29 missile.¹⁸² It is carried on six-axle transporter-erector-launcher (TEL) and its hit-to-kill kinetic kill vehicle is intended to conduct midcourse exoatmospheric intercepts of longer ranged ballistic missiles.¹⁸³ Some Chinese media sources have been calling it a "double-barrelled satellite hunter," although that does not appear to be its official name.¹⁸⁴ Due to its size - the interceptors are believed to be 1.2 m in diameter and 10.5 m in length - the HQ-29 is considered to be on par with the United States' SM-3 and Ground-based Midcourse Defense missile defense interceptors.¹⁸⁵ It is thought to have an interception altitude of 150-500 km, however it is unclear if any flight tests have been held of the system.¹⁸⁶

There has been speculation by Western analysts that China may also have sea- or air-based capabilities that could be used as DA-ASATs. Some have suggested that the JL-2 submarine-launched ballistic missile (SLBM) developed for basing on China's JIN-class SSBNs may have an ASAT capability. Others have suggested China may be developing an air-launched DA-ASAT, similar to the US ASM-135 (see US Direct-Ascent ASAT, Section 1.2) or Russian Kontakt (see Russian Direct-Ascent ASAT, Section 2.2) systems. However, there is very little to no publicly available evidence to support these claims, other than the theoretical possibility.

Potential Military Utility /

China's 2007 ASAT test, and the subsequent ballistic intercepts, have demonstrated the ability to hit and destroy space objects in LEO using a KKV. Their heritage from road-mobile ballistic missiles indicates the systems may be mobile, which would create additional challenges for locating the threat prior to launch. However, the known tests to date have all occurred from prepared pads, leaving the possibility that a minimum level of infrastructure may be required.

Given the known testing, it is likely that China either has fielded, or could field, an operational DA-ASAT capability against most LEO satellites. This would include satellites performing military weather and ISR functions. China would have to wait for such satellites to overfly an area where one of the systems is deployed, but most LEO satellites would do so daily to every few days. However, once launched, the target would only have an estimated 5-15 minutes of warning time before impact.

It is unlikely that China currently possesses an operational DA-ASAT capability against high altitude satellites in MEO or GEO orbits. Only one test, in May 2013, is known to have targeted higher altitudes, and given the unique nature of such a system, it would likely require multiple tests to become militarily useful. In addition, the primary target in MEO for such a system, the US military's Global Positioning System (GPS) navigation constellation, consists of more than 30 satellites distributed across multiple orbital planes. Many of the GPS satellites would need to be destroyed to have an appreciable impact on the GPS system, and their higher altitude (20,000 km) would provide at least an hour of warning time after launch. Other potential targets in the GEO belt, such as US missile early warning, data relay, or electronic intelligence satellites, are much fewer in number and less distributed, making the capabilities easier to eliminate. However, their even higher altitude (36,000 km) would mean an even longer warning time of several hours after launch. The ability of the DA-ASAT kill vehicle to adjust for any changes in the target's trajectory over that time is unknown, and unlikely at present.

At the same time, there are also constraints on the military utility of such systems, particularly as China improves its space capabilities. The use of a kinetic DA-ASAT against an orbital target will invariably create large amounts of orbital space debris, as was seen in the 2007 test. Aggressive use of such a capability would invariably lead to widespread condemnation, as happened after the 2007 test, and appears to have shaped Chinese testing practices since. Moreover, as China invests in and deploys its military satellites and space capabilities, the long-lasting debris from the use of DA-ASATs will be increasingly likely to threaten their own capabilities. The use of a DA-ASAT would also be relatively easy to attribute to China. Thus, the military utility of DA-ASATs would have to be weighed against the potential costs, particularly relative to less destructive capabilities such as jamming or blinding.

- 187 Michael Gordon and Jeremy Page, "China installed military jamming equipment on Spratly Islands, US says," *Wall Street Journal*, April 9, 2018, <https://www.wsj.com/articles/china-installed-military-jamming-equipment-on-spratly-islands-u-s-says-1523266320>.
- 188 Mark Harris, "Ghost Ships, Crop Circles, and Soft Gold: A GPS Mystery in Shanghai," *MIT Technology Review*, November 15, 2019, <https://www.technologyreview.com/s/614689/ghost-ships-crop-circles-and-soft-gold-a-gps-mystery-in-shanghai/>.
- 189 "Challenges to Security in Space," *Defense Intelligence Agency*, January 2019, p. 20 <https://apps.dtic.mil/sti/pdfs/AD1082341.pdf>.
- 190 Stephen Chen, "Chinese researchers simulate large-scale electronic warfare against Elon Musk's Starlink," *South China Morning Post*, November 23, 2025, <https://www.scmp.com/news/china/science/article/3333523/chinese-researchers-simulate-large-scale-electronic-warfare-against-elon-musks-starlink>.
- 191 Liu Zhen, "Targeted jamming incident blinds GPS and BeiDou in east China's Nanjing," *South China Morning Post*, December 20, 2025, <https://www.scmp.com/news/china/science/article/3337181/targeted-jamming-incident-blinds-gps-and-beidou-east-chinas-nanjing>.

3.3 – CHINESE ELECTRONIC WARFARE

Assessment /

China is likely to have significant EW counterspace capabilities against GNSS and satellite communications, although the exact nature is difficult to determine through open sources. Chinese military doctrine places a heavy emphasis on electronic warfare as part of the broader information warfare. While there is significant evidence of Chinese scientific research and development of EW capabilities for counterspace applications and some open-source evidence of Chinese EW counterspace capabilities being deployed, there is no public evidence of their active use in military operations.

Specifics /

GNSS Jamming

GNSS jamming, particularly of the US GPS system, is a well-known technology, and jammers are widely proliferated throughout the globe. China is assessed to be proficient in GNSS jamming capabilities, having developed both fixed and mobile systems. The known systems are downlink jammers, which affect GNSS receivers within a local area. There is no publicly known system that targets uplink jamming of GNSS satellites themselves.

In April 2018, news reports revealed satellite imagery indicating China had placed military jamming equipment on the Mischief Reef, part of the disputed Spratly Islands in the South China Sea.¹⁸⁷ The imagery shows what appears to be mobile military jamming trucks that are designed to interfere with GPS or other GNSS signals.

In November 2019, a report detailed multiple incidents of GNSS jamming and spoofing near the Chinese port of Shanghai.¹⁸⁸ Analysts from the Center for Advanced Defense Studies determined that jamming and spoofing of the GNSS signals used by the automatic identification system (AIS) to track commercial shipping began in the summer of 2018. The attacks culminated in July 2019 with spoofed locations for over three hundred ships in Shanghai or the Huangpu River on a single day. The effect of the spoofing was also unique: the position of the ships was jumping every few minutes in a ring pattern that showed as large circles over weeks. Additional analysis showed that the spoofing was affecting fitness tracks as well, suggesting it was impacting all GPS receivers in the area.

SATCOM Jamming

The January 2019 US DIA space and counterspace report stated that China is developing jammers to target SATCOM over a range of frequency bands, including military protected extremely high frequency communications, citing Chinese scientific papers describing the status of research and potential operational techniques.¹⁸⁹

Chinese researchers published a paper in November 2025 that examined how to jam Starlink for an area the size of Taiwan; they found that it would theoretically be possible, but only if 1000-2000 EW air-based jammers were used.¹⁹⁰

In December 2025, Nanjing, China, suffered a blackout of satellite navigation systems for six hours: affected were both GPS' and Beidou's civilian frequency bands.¹⁹¹ According to the Nanjing Satellite Application Industry Association, this was due to "temporary interference and suppression" of those signals. It is unclear as to the cause of the GNSS interference, but the industry association noted, "If this navigation disruption was caused by temporary signal control

measures implemented for security during a major event, such actions are considered standard industry safety protocols,” and that “Relevant signals have already gradually returned to normal after the event concluded.”

SAR Jamming

The January 2019 US DIA space and counterspace report stated that China is developing jammers dedicated to targeting SAR aboard military reconnaissance platforms, including LEO satellites, citing Chinese scientific papers describing the status of research and potential operational techniques.¹⁹²

In October 2020, an Indian newspaper reported that China had deployed “counterspace jammers” near Lakdah, Kashmir, close to the disputed Line of Actual Control on the border between China and India.¹⁹³ The report suggests that the purpose of these jammers is to prevent satellites from tracking the deployment of Indian troops, but this has not been verified.

Space-Based Jamming

It is thought that China has launched an experimental satellite to GEO to practice conducting space-based jamming. This is largely based on PLA reports that discuss their capabilities to do so; one example of this can be seen in the writing from an author in an SSF unit, who said that their “existing jamming techniques and strategies don’t work for GEO communications satellites using Ka-band [for data relay, and possibly crosslinks], so we need to research new techniques and strategies.”¹⁹⁴ It is not clear which satellite or satellites has been undertaking experimental space-based jamming. One SSA unit (32032) was awarded a patent in 2022 for inventing something that could figure out if a satellite’s electronic countermeasures functions were effective, with the functions described as electronic reconnaissance, orbital maneuvers, and jamming.¹⁹⁵ This same unit wrote in 2019 about natural and human-made sources of space-based electronic interference.¹⁹⁶ A PLA NDU Space Information Assisting-Support Operations book in 2014 noted, “Under unified command by the Joint Operations Command’s Information Operations Center... with the communication jamming satellites and the enemy communication satellites flying in the same orbits or different orbits, having the communication jamming satellites at proper time opportunities or in proper zones emit broadband electromagnetic jamming signals, to carry out blanket jamming of multiple channels of the enemy’s spectrum.”¹⁹⁷

In November 2023, new research emerged indicating that Chinese military authors had been discussing the apparent prevalence of space-based jamming of satellite capabilities by other space powers, notably the United States and Russia.¹⁹⁸ No public evidence exists of such jamming being done by any country, but several states included a mention of space-based jamming as a growing threat in their submissions and statements to the UN General Assembly Resolution 75/36 in 2021.¹⁹⁹

Military Utility /

RF jamming is an effective means of negating certain space capabilities. The most significant and prevalent, thus far, is using EW to degrade the accuracy of GPS-guided systems in tactical scenarios. Given this high reliance of modern militaries on GNSS, and GPS in particular, China is likely to yield significant military utility from being able to actively prevent, or even undermine confidence in, the ability of adversaries to use GNSS in a future conflict.

EW is an attractive option for counterspace because of its flexibility: it can be temporarily applied, its effects on a satellite are completely reversible, it generates no on-orbit debris, and it may be narrowly targeted, which could affect only

192 Zhen, “Targeted jamming incident blinds GPS and BeiDou in east China’s Nanjing,” *ibid.*

193 Shishir Gupta, “China builds new structures near LAC, relocates troops. India reads a message,” *Hindustan Times*, October 20, 2020, <https://www.hindustantimes.com/india-news/india-spots-movement-across-lac-china-is-building-new-structures-relocating-troops/story-DIe6zUzawUyTwEBrakZ45K.html>.

194 Kristin Burke, “PLA Counterspace Command and Control,” *China Aerospace Studies Institute*, December 2023, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLASSF/2023-12-11%20Counterspace-%20web%20version.pdf>.

195 Burke, “PLA Counterspace Command and Control,” *ibid.*

196 Burke, “PLA Counterspace Command and Control,” *ibid.*

197 Burke, “PLA Counterspace Command and Control,” *ibid.*

198 Kristin Burke, “Is military space-based jamming normal? Some worry it is,” *War on the Rocks*, November 13, 2023, <https://warontherocks.com/2023/11/is-military-space-based-jamming-normal-some-worry-it-is/>.

199 Burke, “Is military space-based jamming normal? Some worry it is,” *ibid.*

- 200 Brandon Davenport and Rich Ganske, "Recalculating Route: A Realistic Risk Assessment for GPS," *War on the Rocks*, March 11, 2019, <https://warontherocks.com/2019/03/recalculating-route-a-realistic-risk-assessment-for-gps/>.
- 201 Richard Fisher, Jr. "China's Progress with Directed Energy Weapons," Testimony before the US-China Economic and Security Review Commission on China's Advanced Weapons, February 23, 2017, https://www.uscc.gov/sites/default/files/Fisher_Combined.pdf.
- 202 Based on personal communication with Sean O'Conner.
- 203 Eli Hayes, "The Bohu Laser Facility, Part 1: History and Organization," *Arms Control Wonk blog*, December 20, 2022, <https://www.armscontrolwonk.com/archive/1216848/the-bohu-laser-facility-part-1-history-and-organisation/>.
- 204 Vinayak Bhat, "These Futuristic Chinese Space Denial Weapons Can Disable or Destroy Opposing Satellites," *The Print*, March 23, 2019, <https://theprint.in/defence/these-futuristic-chinese-space-denial-weapons-can-disable-or-destroy-opposing-satellites/210212/>.
- 205 Eli Hayes, "The Bohu Laser Facility, Part 1: History and Organization," *Arms Control Wonk blog*, December 20, 2022, <https://www.armscontrolwonk.com/archive/1216848/the-bohu-laser-facility-part-1-history-and-organisation/>.
- 206 Andrew Salerno-Garthwaite, "Is China's Korla laser ASAT site hacking Western satellites," *Army Technology*, May 1, 2023, <https://www.army-technology.com/features/is-chinas-korla-laser-asat-site-hacking-western-satellites/?cf-view=>.
- 207 Glenn Kessler, "Bachman's claim that China 'blinded' US satellites," *Washington Post*, October 4, 2011, https://www.washingtonpost.com/blogs/fact-checker/post/bachmanns-claim-that-china-blinded-us-satellites/2011/10/03/gIQAHvm7IL_blog.html?utm_term=.1bdb2e34aa46.

one of a satellite's many capabilities (e.g., specific frequencies or transponders). EW is an extremely attractive option for China in a future conflict with the United States as it is likely to take place in the Asia-Pacific region and thus the United States would be heavily reliant on satellite communications, space-based ISR, and GNSS for successful military operations.

However, conducting operationally-useful, dependable, and reliable jamming of highly-used military space capabilities, such as GNSS, is more difficult than most commentators suggest. Military GNSS signals are much more resilient to jamming than civil GNSS signals, and a wide variety of tactics, techniques, and procedures exist to mitigate attacks.²⁰⁰ It is much more likely that an EW counterspace weapon would degrade military space capabilities rather than completely deny them.

3.4 – CHINESE DIRECTED ENERGY WEAPONS

Assessment /

China is likely to be developing directed energy weapons (DEW) for counterspace use, although public details are scarce. There is strong evidence of dedicated research and development and reports of testing at four different locations, but limited details on the operational status and maturity of any fielded capabilities. USSF officials have claimed that China has space-based DEW but no further information has emerged.

Specifics /

China has been actively pursuing DEW for counterspace and other applications since the 1960s, and there are significant scientific and technical discussions of research and possible future military applications as part of the Project 640 Anti-Ballistic Missile program.²⁰¹ However, information about how advanced Chinese DEW counterspace weapons are remains unknown and there is very little public evidence of their deployment or use.

Open-source research suggests at least five main sites are supporting China's DEW work.²⁰² Two of these sites are the Center for Atmospheric Optics at the Anhui Institute for Optics and Fine Mechanics in Hefei, Anhui Province, and the Chinese Academy of Engineering Physics campus in Mianyang, Sichuan Province (see Imagery Appendix, pg. 17-29). Both facilities have strikingly similar large, rectangular buildings with retractable roofs and suggest facilities where DEW aimed at satellites could have been developed. A third site is located near the Korla Missile Test facility in Xinjiang Province, known as "Korla", "Bosten Lake", or "Bohu",²⁰³ and features camouflaged buildings and security fences that strongly suggest it is military-operated (see Imagery Appendix, pg. 17-30). In March 2019, a retired Indian Air Force officer published an article showing commercial satellite imagery of the Xinjiang facility and four buildings suspected of housing laser weapons.²⁰⁴ Evidence suggests that Unit 63655 of the SSF operates the Korla/Bohu complex.²⁰⁵ In May 2023, the US commercial satellite remote sensing company BlackSky reported seeing the roof of the Korla East facility open during multiple satellite passes and large lasers inside that looked like larger versions of the Silent Hunter vehicle-mounted tactical laser system.²⁰⁶

In 2006, a report by *DefenseNews* cited anonymous US defense officials who claimed that China had used ground-based lasers to "dazzle" or blind US optical surveillance satellites on multiple occasions.²⁰⁷ Subsequent reporting suggested that the satellites may have been merely illuminated by the lasers and senior US officials at the time stated that no US satellites were materially

damaged. A Chinese scientific journal also documented a successful test in 2005 of a vehicle mounted laser stationed in Xinjiang.²⁰⁸

In December 2013, an article in a Chinese scientific journal stated that a successful laser blinding test had been carried out in 2005 against a LEO satellite at 600 km altitude.²⁰⁹

The December 2018 NASIC counterspace assessment stated that Chinese defense research has proposed the development of several reversible and non-reversible counterspace directed-energy weapons, although did not provide more specifics.²¹⁰ The January 2019 DIA space and counterspace report stated that China was likely pursuing laser weapons for counterspace applications and assessed that China was likely to field a ground-based laser weapon by 2020.²¹¹ The DIA report cited several Chinese scientific papers on DEW research or proposals for military uses but did not provide additional evidence of real-world systems. Additional open source research suggests that the Korla/Bohu complex is the main site for this R&D and it may be aimed at developing vehicle-mounted dazzling or destructive lasers.²¹² The April 2022 DIA space and counterspace report assessed, “China has multiple ground-based laser weapons of varying power levels to disrupt, degrade, or damage satellites that include a current limited capability to employ laser systems against satellite sensors;” it however pushed back fielding these technologies: “By the mid- to late-2020s, China may field higher power systems that extend the threat to the structures of nonoptical satellites.”²¹³ A USSF fact sheet from December 2025 had this assessment: “The PLA has multiple ground-based laser weapons able to disrupt, degrade, or damage satellite sensors. By the mid-to-late 2020s, the PRC could have higher-power systems able to damage satellite structures.”²¹⁴

In December 2021, a Chinese research team from Zhejiang University published a paper documenting their development of a “small but powerful” laser that could be used for several different applications in space.²¹⁵ The research team created a laser that weighs 1.5 kilograms and can deliver 5 nanosecond pulses of about 5 millijoules each at up to 100 times per second for 30 minutes before overheating. While it is not powerful enough to do physical damage to another space object, the research suggests significant improvements in power to weight ratio for space-capable laser systems.

In March 2022, a team of Chinese scientists reported development of a high-powered relativistic klystron amplifier (RKA) that could create short pulses of up to 5 megawatts in the Ka frequency band.²¹⁶ RKAs are a decades-old technology for creating high-power microwave beams and have broad applications in radars, particle accelerators, and communications systems. While not a new technology, RKA development has posed challenges in both increasing the power of the beams and moving to high frequencies. One application of this new development by Chinese scientists could be satellite-mounted RKAs that could be used to damage or interfere with the electronics of other satellites from relatively close range. Around the same time, a different group of Chinese scientists published their own research on new ways to protect satellites against attacks by high-power microwave weapons.²¹⁷

A group of Chinese researchers at a PLA-run research institute reported in October 2022 that they had been able to model via computer simulations the results of a near-space nuclear explosion.²¹⁸ Their research found that a 10 megaton warhead detonated at an altitude of 80 km could create a debris cloud (described as an “upside down pear”) that could spread out over 140,000 square km and reach an altitude of 500 km.²¹⁹ The researchers posited, “The

208 Minghui Gao, Yuquan Zheng, and Zhihong Wang, “Development of Space-Based Laser Weapons,” *Chinese Optics* 20:6 (2013): 810–17.

209 Gao Min-hui, Zhou Yu-quan and Wang Zhi-hong, “Development of Space Based Laser Weapons,” *Chinese Optics*, December 2013, <http://chineseoptics.net.cn/en/article/doi/10.3788/CO.20130606.810>.

210 “Competing in Space”, National Air and Space Intelligence Center, December 2018, <https://media.defense.gov/2019/Jan/16/2002080386/1/-1/1/190115-F-NV711-0002.PDF>.

211 “Challenges to Security in Space,” Defense Intelligence Agency, January 2019, p. 20, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.

212 Eli Lake, “The Bohu Laser Facility, Part 2: Operations,” *Arms Control Wonk* blog, December 21, 2022, <https://www.armscontrolwonk.com/archive/1216867/the-bohu-laser-facility-part-2-operations/>.

213 “2022 Challenges to Security in Space,” *Defense Intelligence Agency*, April 12, 2022, https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf.

214 “Space Threat Fact Sheet,” USSF, December 2025, <https://www.spaceforce.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/4297159/space-threat-fact-sheet/>.

215 Stephen Chen, “The powerful Chinese megawatt laser ‘small enough for a satellite,’” *South China Morning Post*, January 7, 2022, <https://www.scmp.com/news/china/science/article/3162566/chinese-megawatt-laser-powerful-small-enough-be-used-satellite>.

216 Gabriel Honrada, “China in a microwave weapon great leap forward,” *Asia Times*, March 17, 2022, <https://asiatimes.com/2022/03/china-in-a-microwave-weapon-great-leap-forward/>.

217 Stephen Chen, “New device could protect satellites from microwave attacks, say Chinese scientists,” *South China Morning Post*, February 23, 2022, <https://www.scmp.com/news/china/science/article/3167937/chinese-scientists-say-new-device-could-protect-satellites>.

218 Stephen Chen, “Chinese physicists simulate nuclear blast against satellites,” *South China Morning Post*, October 20, 2022, <https://www.scmp.com/news/china/science/article/3196629/chinese-physicists-simulate-nuclear-blast-against-satellites>.

219 Chen, “Chinese physicists simulate,” *ibid*.

- 220 Chen, "Chinese physicists simulate," *ibid.*
- 221 Stephen Chen, "Scientists shrink China's Starlink-killing microwave weapon with a new power source," *South China Morning Post*, March 30, 2023, <https://www.scmp.com/news/china/science/article/3214251/scientists-shrink-chinas-starlink-killing-microwave-weapon-new-power-source>.
- 222 Stephen Chen, "Chinese scientists build powerful microwave weapon that can fire from a moving truck, using Stirling engine to cool technology," *South China Morning Post*, February 8, 2024, <https://www.scmp.com/news/china/science/article/3251381/chinese-scientists-build-powerful-stirling-engine-based-microwave-weapon-can-fire-moving-truck>.
- 223 Holly Chik, "Chinese scientist named as new chairwoman of international nuclear standards committee," *South China Morning Post*, January 23, 2025, <https://www.scmp.com/news/china/science/article/3295912/chinese-scientist-named-new-chairwoman-international-nuclear-standards-committee>.
- 224 Chik, "Chinese scientist named as new chairwoman of international nuclear standards committee," *ibid.*
- 225 Stephen Chen, "Chinese scientists build world-first 20GW microwave weapon that can fire 60-second bursts," *South China Morning Post*, February 5, 2026, <https://www.scmp.com/news/china/science/article/3342443/chinese-scientists-build-world-first-20gw-microwave-weapon-can-fire-60-second-bursts>.
- 226 "US Officials Raise Concerns on China's Rapid Space Advancements," *NTD News*, April 3, 2025, https://www.ntd.com/us-officials-raise-concerns-on-chinas-rapid-space-advancements_1058434.html.

strong residual radiation of the debris cloud may cause failures of spacecraft moving in it, such as satellites, or even cause direct damage that can lead to destruction."²²⁰

In March 2023, another group of Chinese military scientists reported that they had developed a small pulse power device that could generate a 10-gigawatt electron beam, which in turn could be small and powerful enough to drive a high-power microwave beam weapon.²²¹ Another report in February 2024 indicated that researchers had successfully used a Stirling engine to power a high-power microwave beam weapon, which could greatly increase its efficiency and ability to operate for longer periods of time.²²² Researchers with the Naval Submarine Academy (of the PLA Navy) wrote in July 2024 about the possibility of submarines being kitted with mega-watt class, solid-state lasers; these submarines would stay submerged while a retractable, "optoelectronic" mast would surface and shoot at Starlink satellites or space-based surveillance systems.²²³ They did acknowledge, "Due to the limitations of the submarine's detection equipment, other forces are required to provide satellite position guidance for the submarine to attack the satellite."²²⁴ Using lasers in submarines against satellites seems to be at best a notional concept and is included here because of the military connection of the researchers.

Scientists at a Chinese military research institution announced in December 2025 that they had successfully made and tested a driver for a high powered microwave (HPM) weapon that can emit 20 GW of power for up to 1 minute; some Chinese researchers believe that HPMs that can emit 1GW or higher can disrupt or damage satellites in LEO.²²⁵ The driver, the TPG1000Cs, is small enough to be put on a mobile platform; it is unclear if it has been tested in that capacity. The researchers wrote that the driver could do 3,000 pulses in a single session and "has already accumulated more than 200,000 operational pulses."

During a hearing by the US-China Economic and Security Commission in April 2025, General B. Chance Saltzman, Chief of Space Operations for the US Space Force, talked about three different types of weapons that each have ground- and space-based variants: "There's directed energy, RF like jammers, and kinetic weapons...The PRC is investing heavily in all six categories right now; we are not investing in all six categories."²²⁶ The implication is that China thus has space-based DEW but any further information is unknown.

Military Utility /

DEWs, primarily lasers, offer significant potential for military counterspace applications. They offer the possibility of interfering with or disabling a satellite without generating significant debris. The technologies required for ground-based lasers systems are well developed. Ground-based systems can dazzle or blind EO satellites, or even inflict thermal damage on most LEO satellites.

In contrast, the technical and financial challenges to space-based DEW for counterspace remain substantial. These include the mass of the weapon, consumables and disturbance torques (chemical lasers), electrical power generation (solid state and fiber lasers, particle beams), target acquisition and tracking, and the potential required large size of a constellation. The acquisition and tracking challenges are greatly simplified in a co-orbital GEO or LEO scenario.

However, both ground- and space-based DEW counterspace capabilities do have significant drawbacks in assessing their effectiveness. It can be very difficult to determine the threshold between temporary dazzling or blinding and causing long-term damage, particularly since it may depend on the

internal design and protective mechanisms of the target satellite that are not externally visible. Moreover, it can be difficult for an attacker to determine whether a non-destructive DEW attack actually worked.

3.5 – CHINESE SPACE SITUATIONAL AWARENESS CAPABILITIES

Assessment /

China is developing a sophisticated network of ground-based optical telescopes and radars for detecting, tracking, and characterizing space objects. Like the United States and Russia, several of the Chinese SSA radars also serve missile warning functions. While China lacks an extensive network of SSA tracking assets outside its borders, it does have a fleet of tracking ships and has ground stations in other countries which could contribute to its SSA capabilities. China has satellites that are used to conduct space-based SSA.

Specifics /

China's definition of SSA is broader than that of the United States and "includes satellite-to-space object scanning, tracking, cataloging, information fusion, intention determination, and maneuver decision processes."²²⁷ China's main optical SSA capabilities are operated by the Purple Mountain Observatory (PMO) (see Imagery Appendix, pg. 17-52), which operates multiple telescopes in seven separate locations that can track satellites throughout all orbital regimes.²²⁸ PMO originated from civilian and scientific research on astronomy and maintains a strong scientific focus. Since the early 2000s, PMO has increasingly been involved in tracking human-generated space objects and orbital debris and is China's main contributor to the Inter-Agency Space Debris Coordination Committee (IADC) that researches orbital debris.²²⁹

Few details are known about China's radar SSA capabilities as they are primarily operated by the PLA. The PLA operates at least six large phased-array radars (LPARs) (see Imagery Appendix, pg. 17-50) that likely have a primary mission of ballistic missile warning but could also support an SSA mission. The existing radars are located near Huanan (46.53N, 130.76E), Hangzhou (30.29N, 119.13E), Korla (41.64N, 86.24E), Kongtong (35.4829 N 106.571 E), and two radars at Yiyuan (36.02N, 118.09E).²³⁰ The radars are approximately 30 meters in diameter and likely have a coverage arc of 90 to 120 degrees, similar to a US BMEWS radar (see US Space Situational Awareness Capabilities, Section 1.5).²³¹ The Korla radar can be rotated and is likely used to support the ballistic missile and ASAT testing done at Korla.

China does have a base which conducts foreign space object tracking and missile early warning, which is known as Base 37. Base 37 is composed of units from the CMC former general departments, individual PLA services, and also civilians; it most likely is operated by PLAASF.²³² It is likely headquartered in Lintong City, Sha'anxi Province.²³³ However, it has many units stationed across China near other deep space and LPAR facilities, including "Urumqi, Hangzhou, Shandong, Yunnan, Qinghai, Hubei, Jiamusi, and Beijing and Chongqing Municipalities."²³⁴ Other PLAASF facilities are involved in SSA capabilities; for example, Base 26 tracks, provides mission control and telemetry, and conducts anomaly resolution for most Chinese satellites.²³⁵

In June 2021, China held a ceremony to break ground on a new tracking telescope in Xining, Qinghai Province. The announced plans include the construction of a large array of telescopes called the Multi-Application Survey Telescope Array (MASTA).²³⁶ It evolved into the Wide Field Survey Telescope (WFST), which was developed by Purple Mountain Observatory and the University of Science and

227 Kristin Burke, "China's Different Approach to Space Situational Awareness," *China Aerospace Studies Institute*, December 2, 2024, <https://www.airuniversity.af.edu/CASI/Display/Article/3980318/chinas-different-approach-to-space-situational-awareness/>.

228 "About Purple Mountain Observatory (PMO)," *Purple Mountain Observatory*, accessed February 28, 2022, <http://english.pmo.cas.cn/au/>.

229 Charles Choi, "China Says Work Under Way to Mitigate Space Junk," *Space.com*, September 3, 2007, <https://www.space.com/4301-china-work-mitigate-space-junk.html>.

230 Andrew Tate, "China integrates long-range surveillance capabilities," *IHS Jane's*, 2017, https://www.janes.com/images/assets/477175477/China_integrates_long-range_surveillance_capabilities.pdf; James Acton, "ADDENDUM. Turns out China actually has a SIXTH publicly documented ballistic missile EW radar. There's two at Yiyuan (shame on me for missing this). H/T @luritie This faces NE and provides coverage of the Pacific. (20/20)," *Twitter*, March 30, 2023, https://x.com/james_acton32/status/1641428299682291712?s=20.

231 Tate, "China integrates long-range surveillance capabilities," *ibid*; Acton, "ADDENDUM. Turns out China actually has a SIXTH publicly documented ballistic missile EW radar. There's two at Yiyuan (shame on me for missing this). H/T @luritie This faces NE and provides coverage of the Pacific. (20/20)," *ibid*.

232 Kristin Burke, "The PLA's New Base for Space Situational Awareness - Opportunities and Challenges for the US," *China Aerospace Studies Institute*, September 2023, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLASSF/2023-09-11%20The%20PLA's%20New%20Base%20for%20SSA.pdf>.

233 Burke, "PLA Counterspace Command and Control," *ibid*.

234 Decker Eveleth, "PLA Aerospace Force Base 37: An Open-Source Case Study in Integrating Geospatial Data," *China Aerospace Studies Institute*, September 2024, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2024-09-16%20PLAASF%20Base%2037.pdf>.

235 Eveleth, "PLA Aerospace Force Base 37: An Open-Source Case Study in Integrating Geospatial Data," *ibid*.

236 "New survey telescope in NW China's Qinghai will help detect space debris in medium and high orbits," *Global Times*, June 28, 2021, <https://www.globaltimes.cn/page/202106/1227223.shtml>.

- 237 "China releases first image captured by new wide-field survey telescope," *Xinhua*, September 17, 2023, <https://english.news.cn/20230917/761e761982ce4f7cb9f9245c7b-1f4347/c.html>.
- 238 "China releases first image captured by new wide-field survey telescope," *ibid*.
- 239 Na Chen, "Agency Set to Track, Deal with Space Junk," *Chinese Academy of Sciences*, June 10, 2015, http://english.cas.cn/newsroom/archive/news_archive/nu2015/201506/t20150610_148380.shtml.
- 240 Fan Wei, "Following 'extremely dangerous rendezvous' between Russian space debris and Chinese satellite, Chinese expert says it's possible the two get closer again," *Global Times*, January 20, 2022, <https://www.globaltimes.cn/page/202201/1246440.shtml>.
- 241 Chen Guoling and Zou Weirong, "China Advances Maritime Space Monitoring and Control Capability," *Ministry of Defense of the People's Republic of China*, June 23, 2017, http://eng.mod.gov.cn/news/2017-06/23/content_4783536.htm.
- 242 Meia Nouwens, "China's dual-use space sector goes global," *IISS*, July 17, 2025, <https://www.iiss.org/online-analysis/charting-china/2025/07/chinas-dual-use-space-sector-goes-global>; "Breaking News: China Deploys New Liaowang-1 Space Tracking Ship Capable of Monitoring US Military Satellites and Missile Launches," *Global Defense News - Army Recognition Group*, April 14, 2025, <https://www.armyrecognition.com/news/navy-news/2025/breaking-news-china-deploys-new-liaowang-1-space-tracking-ship-capable-of-monitoring-u-s-military-satellites-and-missile-launches>.

Technology of China and took its first pictures in September 2023.²³⁷ It can survey the whole northern hemisphere sky once every three nights and is anticipated to enhance China's monitoring of near space objects.²³⁸

In June 2015, China launched the Space Debris Monitoring and Application Center to collate SSA data from various sensors and help protect Chinese satellites from on-orbit collisions. The Space Debris Monitoring and Application Center, part of the China National Space Administration, is responsible for tracking waste, analyzing hazards, developing prevention and disposal plans, setting up a database, and communicating with other nations and international organizations.²³⁹ Officials stated that the Center would provide early warnings of close approaches and possible collisions to Chinese satellite operators. In January 2022, the Space Debris Monitoring and Applications Center sent a warning about a close approach between a piece of debris from the November 2021 Russian ASAT test and a Chinese science satellite. The analysis provided by the Center suggested that a piece of Cosmos 1408 debris would pass within 14.5 meters of the Tsinghua Science satellite (2020-054B, 46026), a small satellite launched in 2020 to provide Earth observation.²⁴⁰

China maintains a fleet of Yuanwang ships that are primarily used to support Chinese space launches.²⁴¹ The ships will deploy to areas around the world where they can augment China's ground-based satellite tracking, telemetry, and control (TT&C) located in its territory. These ships are the Liao Wang-1 (which was deployed April 2025), Yuan Wang-3, Yuan Wang-5, Yuan Wang-6, and Yuan Wang-7.²⁴²

China built a ground station in Addis Ababa, Ethiopia, which began operations in May 2021, while a second antenna funded by China and built in cooperation with Ethiopian engineers became operational in December 2024.²⁴³ China built a ground station in Windhoek, Namibia, with a 7.8 m satellite dish and handed it over to the local authorities in November 2025; it is working on a second antenna at a ground station in Swakopmund, Namibia originally built in 2001 to support China's crewed spaceflight program.²⁴⁴ It also has ground stations in Guárico and Leupa, Venezuela; Río Gallegos, Argentina; Amachuma and La Guardia, Bolivia; and Alcantara and Cuiaba, Brazil.²⁴⁵ As well, China has a remote sensing ground station in Kashi, Pakistan; it used to have access to ground stations operated by the Swedish Space Corporation (SSC) in Kiruna, Sweden, Santiago, Chile, and Dongara, Australia, but citing geopolitical changes, the SSC announced in September 2020 that it would not be renewing China's contracts allowing this.²⁴⁶ In June 2023, Egypt announced it was building a new satellite tracking station in cooperation with China.²⁴⁷ The facility is supposed to include two optical telescopes with diameters of 120 cm and 70 cm, as well as lasers for rangefinding. A *Reuters* article in February 2025 noted that the two telescopes had been erected "recently."²⁴⁸ In February 2023, China announced that it would be building a ground station at its Zhongshang station in Antarctica.²⁴⁹ And while not a ground station, China completed a radio telescope in Chiang Mai, Thailand, in May 2025, and is working on a second telescope in Sonklha; both of these are intended to provide deep space tracking and thus could contribute to China's SSA network.²⁵⁰

All of these TT&C capabilities are coordinated through the Xi'an Satellite Measurement and Control Center. Typically, TT&C facilities use antennas to detect signals from active satellites and broadcast commands to them or receive transmissions from them, which would not be able to track orbital debris or satellites broadcasting on different frequencies. These facilities may include telescopes or other SSA sensors that could do such tracking, and their spread has prompted concerns about the PLA using them for military operations or espionage.²⁵¹ However, to date, there is no evidence that the international TT&C sites operated by China are fundamentally different from similar sites operated by other countries.

243 "Ethiopia launches innovative satellite data service in partnership with China, official says," *Xinhua*, March 5, 2024, <https://english.news.cn/20240305/00aaebd994b-c408ea3089f7b82b7bcb/c.html>; Joey Roulette, "China builds space alliances in Africa as Trump cuts foreign aid," *Reuters*, February 11, 2025, <https://www.reuters.com/investigations/china-builds-space-alliances-africa-trump-cuts-foreign-aid-2025-02-11/>.

244 Joey Roulette, "China builds space alliances in Africa as Trump cuts foreign aid," *Reuters*, February 11, 2025, <https://www.reuters.com/investigations/china-builds-space-alliances-africa-trump-cuts-foreign-aid-2025-02-11/>; Embassy of the People's Republic of China in the Republic of Namibia, "Ambassador Zhao Weiping Attends the Handover and Takeover Certificate Signing Ceremony of China-Aided Satellite Ground Data Receiving Station and Processing System Construction Project in Namibia," November 28, 2025, https://na.china-embassy.gov.cn/eng/sqxw/202511/t20251128_11762799.htm; Matthew P. Funaiole, Brian Hart, and Aidan Powers-Riggs, "In China's Orbit: Beijing's Space Diplomacy in the Global South," CSIS, January 15, 2026, <https://features.csis.org/hiddenreach/china-space-diplomacy-global-south/>.

245 Cate Cadell, "A growing global footprint for China's space program worries Pentagon," *Washington Post*, November 21, 2023, <https://www.washingtonpost.com/world/interactive/2023/china-space-program-south-america-defense/>.

246 "China Remote Sensing Satellite Ground Station," *China Academy of Science Aerospace Information Research Institute*, Accessed February 11, 2025, http://english.aircas.cn/research2020/bsi/202302/t20230213_327036.html; Jonathan Barrett and Johan Ahlander, "Exclusive: Swedish space company halts new business helping China operate satellites," *Reuters*, September 21, 2020, <https://www.reuters.com/article/world/exclusive-swedish-space-company-halts-new-business-helping-china-operate-satell-idUSKCN26C1ZS/>.

247 "Egypt to establish 2nd largest monitoring station for satellites, space debris globally," *Egypt Independent*, June 8, 2023, <https://egyptindependent.com/egypt-to-establish-2nd-largest-monitoring-station-for-satellites-space-debris-globally/>.

248 Joey Roulette, "China builds space alliances in Africa as Trump cuts foreign aid," *Reuters*, February 11, 2025, <https://www.reuters.com/investigations/china-builds-space-alliances-africa-trump-cuts-foreign-aid-2025-02-11/>.

249 Andrew Jones, "China to build satellite ground stations in Antarctica," *SpaceNews*, February 2, 2023, <https://spacenews.com/china-to-build-satellite-ground-stations-in-antarctica>.

250 Ling Shin, "China doubles down on building telescopes in Thailand to monitor Earth using space signals," *South China Morning Post*, May 31, 2025, <https://www.scmp.com/news/china/science/article/3312374/china-doubles-down-building-telescopes-thailand-monitor-earth-using-space-signals>.

251 Victor Robert Lee, "China Builds Space-Monitoring Base in Argentina," *The Diplomat*, May 24, 2016, <https://thediplomat.com/2016/05/china-builds-space-monitoring-base-in-the-americas/>; The Select Committee Between the United States and the Chinese Communist Party, US Congress, *China in our Backyard, Volume II: Pulling Latin America into China's Orbit*, February 26, 2026, <https://chinaselectcommittee.house.gov/media/press-releases/new-select-committee-investigation-uncovers-china-s-space-operations-in-latin-america>.

- 252 "About APSCO," *Asia-Pacific Space Cooperation Organization*, <http://www.apsco.int/html/comp1/content/WhatisAPSCO/2018-06-06/33-144-1.shtml>, accessed February 18, 2020.
- 253 "Ground-Based Space Object Observation Network," *Asia-Pacific Space Cooperation Organization*, accessed February 18, 2020, <http://www.apsco.int/html/comp1/content/APOSOS/2019-03-01/59-261-1.shtml>.
- 254 "NewsAPSCO," *Asia-Pacific Space Cooperation Organization*, April 2019, <http://www.apsco.int/upload/file/20190508/2019050809583923213.pdf>.
- 255 "Challenges to Security in Space," *Defense Intelligence Agency*, January 2019, p. 20, https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Space_Threat_V14_020119_sm.pdf.
- 256 Kristin Burke, "China's Different Approach to Space Situational Awareness," *China Aerospace Studies Institute*, December 2024, <https://www.airuniversity.af.edu/CASI/Display/Article/3980318/chinas-different-approach-to-space-situational-awareness/>.
- 257 Ling Xin, "China's Shenzhou 20 debris crisis: a catalyst for space war – or peace?" *South China Morning Post*, November 22, 2025, <https://www.scmp.com/news/china/science/article/3333672/chinas-shenzhou-20-debris-crisis-catalyst-space-war-or-peace>.
- 258 Kristin Burke, "China's Commercial SSA Company and 'TLE Localization'," *China Aerospace Studies Institute*, October 2025, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2025-10-06%20China's%20Commercial%20SSA%20Company.pdf?ver=LulDX8ZlvkzVjp2l6-1oPA%3D%3D>.
- 259 Ling Xin, "China's Xingyan 'Star Eye' network to track satellites and space debris," *South China Morning Post*, November 30, 2025, <https://www.scmp.com/news/china/science/article/3334681/chinas-xingyan-star-eye-network-track-satellites-and-space-debris>; Zhu Yanran, "China to Launch 'Star Eye' Satellite Network for Space Debris Warnings," *Yicai Global*, November 28, 2025, <https://www.yicai.com/news/china-to-launch-star-eye-satellite-constellation-to-protect-crowded-orbits>.
- 260 "Space Weather Products," *National Center for Space Weather*, accessed February 18, 2020, <http://www.nsmc.org.cn/NSMC/spaceweather/en/sws/index.html>.
- 261 "Members," *International Space Environment Service*, accessed February 18, 2020, <http://www.spaceweather.org/ISES/rwc/rwc.html>.

In addition to its national effort, China has also engaged in international cooperation efforts on SSA through the Asia-Pacific Space Cooperation Organization (APSCO). APSCO is a China-led intergovernmental organization for space cooperation that includes Bangladesh, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey as members and Mexico as an observer.²⁵² In 2012, APSCO started the Asia-Pacific Ground-Based Space Object Observation System (APOSOS) Phase 1 project to integrate data from three telescopes in Pakistan, Peru, and Iran with a Data Centre in Beijing.²⁵³ In April 2019, APSCO kicked off the Asia-Pacific Space Science Observatories (APSSO) Project that expanded the scope of APOSOS and included plans for a future Space Debris Observation and Data Application Center (SDOAC).²⁵⁴ While some publications have described APOSOS as being fully capable of providing global GEO coverage,²⁵⁵ publications from ASPCO suggest the project is still nascent and has only limited capabilities.

A December 2024 report by the China Aerospace Studies Institute (CASI) identified ten satellites China has used for space-based SSA, as well as eight more that possibly have been as well (based on Chinese discussion of their sensors or orbits).²⁵⁶ It also noted that China was likely to be more dependent on its space-based SSA sensors than the United States, as the latter has an extensive and global ground network of SSA sensors that it can draw upon, and warned that this might increase China's threat perception should access to its SSA satellites be interrupted. Because of its limited ground-based SSA sensors, Chinese satellites in LEO have been given more autonomy to determine intent and ability to maneuver to try to compensate.

Two space-based SSA constellations were initiated in 2025. The first was the Kaiyun-1 constellation, launched in September 2025, which will be run by Kaiyun United and is expected to have over 100 satellites on orbit eventually.²⁵⁷ While Kaiyun United is a commercial company, it is a subsidiary of Zhongke Xingtu (a SOE): a recent CASI report noted that it "receives funding from stock holders, multiple provinces, and the listed arm of an SOE" [state-owned enterprise] and that "In the United States, we have referred to these Chinese companies as mixed-ownership companies (MOEs)." ²⁵⁸ In November 2025, reports emerged about plans to launch the Xingyan or Star Eye SSA constellation, with 12 satellites intended to be launched by 2027, and the whole constellation of 154 satellites operational after 2028.²⁵⁹ Its developer is Xingtu Cekong, which is also a spin-off of Zhongke Xingtu.

China's work on space weather is conducted through the National Space Weather Monitoring and Warning Center, which was established by the Central Planning Committee in 2002 and is part of the China Meteorological Administration.²⁶⁰ The Center provides daily space weather forecasts and warnings of severe space weather based mainly from sensors and payloads carried by the Feng Yung series of meteorological satellites in LEO and GEO. China is a member of the Asia-Oceania Space Weather Alliance and the International Space Environmental Service (ISES), where it shares space weather data with 21 other countries.²⁶¹

Military Utility /

China's existing SSA capabilities likely allow it to maintain accurate orbital positions on and characterize most LEO, MEO, and GEO space objects. This tracking information may be good enough for targeting of anti-satellite weapons, as shown by the 2007 ASAT test, although that was against a Chinese satellite that may have been providing additional information from telemetry. China's current SSA capabilities lack robust geographic coverage outside of its borders that negatively impact the quality of its trajectory

propagations in LEO and the ability to track satellites in GEO over Western Europe and the Americas. China's efforts to develop a global network of TT&C stations and SSA collaboration within APSCO may offset these limitations in the near future, although the utility and reliability of these efforts for military operations is unknown.

3.6 – CHINESE COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Assessment /

Although official Chinese statements on space warfare and weapons have remained consistently aligned to the peaceful purposes of outer space, unofficially they have become more nuanced. China has designated space to be a domain of military conflict, and military writings state that the goal of space warfare and operations is to achieve space superiority using offensive and defensive means in connection with their broader strategic focus on asymmetric cost imposition, access denial, and information dominance. In 2015, China reorganized its space and counterspace forces, as part of a larger military reorganization, and placed them in a new major force structure - the Strategic Support Force (SSF) - that also had control over electronic warfare and cyber. In 2024, China proceeded to disband the SSF in favor of splitting up its responsibilities among three forces and putting renewed efforts into information services. China's considerable investment in developing and testing counterspace capabilities, as detailed in this chapter, suggest they see space as a domain for future conflicts, whether or not that is officially stated. That said, it is uncertain whether China would fully utilize its offensive counterspace capabilities in a future conflict or whether the goal is to use them as a deterrent against US aggression. There is no public evidence of China actively using destructive counterspace capabilities in current military operations, although it is likely they are using SSA and electronic warfare in at least some support roles.

Specifics /

Chinese Views on Space Warfare

Official Chinese public statements on space warfare and space weapons have remained consistent: "China always adheres to the principle of the use of outer space for peaceful purposes and opposes the weaponization of or an arms race in outer space."²⁶² Chinese officials have made an explicit distinction between their views and the recent US public declaration of space as a warfighting domain (see US Counterspace Policy, Doctrine, and Organization, Section 1.6) However, since 2015, other official writings suggest China's internal position on space warfare and space weapons has become more nuanced. China's 2015 defense white paper, *China's Military Strategy*, for the first-time designated outer space as a military domain and linked developments in the international security situation to defending China's interests in space. The defense white paper states, "Outer space has become a commanding height in international strategic competition. Countries concerned are developing their space forces and instruments, and the first signs of weaponization of outer space have appeared." As a result, "China will keep abreast of the dynamics of outer space, deal with security threats and challenges in that domain, and secure its space assets to serve its national economic and social development and maintain outer space security."²⁶³ In particular, the white paper states that "threats from such new security domains as outer space and cyberspace will be dealt with to maintain the common security of the world community." In 2015, defense of China's interests in space was made legally binding in China's *National Security Law*.²⁶⁴ China's 2019 defense white paper,

262 Statement by Ms. Pan Kun of the Chinese Delegation at the 71st Session of the UN General Assembly on Agenda Item 48: International Cooperation in the Peaceful Uses of Outer Space, October 13, 2016, <http://www.china-un.org/eng/hyfy/t1405942.htm>; "China firmly opposes arms race in outer space: defense spokesperson," *Xinhua*, December 14, 2023, <https://english.news.cn/20231214/c0eec39b-9f634023b91daaac8f1aa751/c.html>.

263 *China's Military Strategy*, White Paper issued by the State Council Information Office of the People's Republic of China, May 2015, <http://eng.mod.gov.cn/Database/WhitePapers/>.

264 "Authorized Release: National Security Law of the People's Republic of China," (授权发布：中华人民共和国国家安全法), *Xinhua*, July 1, 2015, http://news.xinhuanet.com/politics/2015-07/01/c_1115787801_3.htm.

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- 266 Howard Wang, Gregory Graff, Alexis Dale-Huang, *China's Growing Risk Tolerance in Space: People's Liberation Army Perspectives and Escalation Dynamics*, RAND, June 24, 2024, https://www.rand.org/pubs/research_reports/RRA2313-2.html.
- 267 *China's Arms Control, Disarmament, and Non-proliferation in the New Era*, The State Council Information Office of the People's Republic of China, November 27, 2025, https://www.fmprc.gov.cn/mfa_eng/xw/wjbxw/202511/t20251127_11761653.html.
- 268 China's Arms Control Disarmament, and Nonproliferation in a New Era, *ibid*.
- 269 China's Arms Control Disarmament, and Nonproliferation in a New Era, *ibid*.
- 270 China's Arms Control Disarmament, and Nonproliferation in a New Era, *ibid*.
- 271 China's Arms Control Disarmament, and Nonproliferation in a New Era, *ibid*.
- 272 See Kevin L. Pollpeter, Michael S. Chase, and Eric Heginbotham, *The Creation of the Strategic Support Force and Its Implications for Chinese Military Space Operations*, (Santa Monica: RAND, 2017).
- 273 Daniel Coats, "Worldwide Threat Assessment of the US Intelligence Community," unclassified statement for the record before the Senate Armed Services Committee, March 6, 2018, <https://www.dni.gov/files/documents/Newsroom/Testimonies/Final-2018-ATA---Unclassified---SASC.pdf>.
- 274 "Military and Security Developments Involving the People's Republic of China 2024," US Department of Defense, December 18, 2024, <https://media.defense.gov/2024/Dec/18/2003615520/-1/-1/0/MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA-2024.PDF>.
- 275 Xu Nengwu and Huang Changyun, "Space Deterrence: Changes in the US Strategic Deterrence System and Global Strategic Stability" (太空威慑: 美国战略威慑体系调整与全球战略稳定性), *Foreign Affairs Review* (外交评论), No. 5, 2014, p. 62; Xiao Lei, Qing Mu, and Wang Qu, "Who Stirs Up a Space War?" (谁在挑起太空战争?), *Decision & Information* (决策与信息), Vol. 2, No. 339, 2013, p. 18; Yang Caixia and Ai Dun, "On the Legality of the Development of ASATs for China" (论中国发展反卫星武器的合法性), *Journal of Journal of Beijing University of Aeronautics and Astronautics* (Social Sciences Edition) (北京航空航天大学学报 (社会科学版)), Vol. 23, No. 2, March 2010, pp. 46, 47, 50.
- 276 Jiang Yu, "Space Thunder: Development of Hard-Kill Antimissile Weapon and China's Antimissile Testing" (太空惊雷 反导硬杀伤武器的发展及中国反导试验), *Shipborne Weapons* (舰载武器), No. 2, 2010, p. 14.
- 277 AMS, *Science of Military Strategy*, p. 102.
- 278 Jiang and Wang, *Study of Space Operations*, p. 150.
- 279 Chang Xianqi, *Military Astronautics* (军事航天学), (Beijing: National Defense Industry Press, 2002), 257–58.

China's National Defense in the New Era, stated "threats to outer space...loom large" and stated a goal to "safeguard China's security interests in outer space."²⁶⁵ The PLA's National Defense University published its *Science of Military Strategy* in 2020, which states that "in the context of the new military revolution, space has already become a new domain of military conflict, not only changing the traditional form of warfare of mankind, but also expanding the struggle for national strategic interests."²⁶⁶

In November 2025, China's Foreign Ministry released a white paper on arms control, disarmament, and non-proliferation.²⁶⁷ It says that China "is always committed to the peaceful uses and the security of outer space" and that "It objects to the use of commercial space activities to intervene in other countries' armed conflicts or internal affairs."²⁶⁸ The white paper states that China "resolutely opposes offensive space military policies, the creation of space military alliances, the weaponization of outer space, any attempt to turn outer space into a new theater of conflict, and any arms race there."²⁶⁹ As well it notes, "China adheres to the principles of equality, mutual trust, transparency, and openness in aerospace activities and outer space governance."²⁷⁰ Finally, it calls out the United States, in a way: "In pursuit of absolute security, this certain country has advanced the Golden Dome global missile defense system without restraint and sought to deploy weapons in outer space, severely threatening outer space security" and that "China will resolutely counter any acts that threaten or undermine its core interests."²⁷¹

Chinese Counterspace Doctrine

The Chinese military does not appear to have an official doctrine governing the use of space in military operations and most of what can be assessed about Chinese thinking on the role of counterspace weapons must be based on unofficial Chinese military writings. This may change in the coming years, however. On December 31, 2015, the Chinese military established the Strategic Support Force (SSF), an organization intended, in part, to help unify the command and control of China's space forces and to make them more operationally responsive.²⁷² More recently, US intelligence officials state that the People's Liberation Army (PLA) has "formed military units and begun initial operational training with counterspace capabilities that it has been developing, such as ground-launched ASAT missiles" toward the end of better integrating counterspace capabilities with other domains.²⁷³ A 2024 assessment by the US Department of Defense asserts, "The PLA probably plans to conduct ASAT and other spacebased kinetic and non-kinetic operations during a conflict and will refine the specific operational details regarding ASAT or counterspace functions during wartime as new capabilities are fielded."²⁷⁴ Nevertheless, Chinese thinking on space has remained consistent for at least the past two decades. According to the 2015 defense white paper, the PLA will "endeavor to seize the strategic initiative in military struggle" and "proactively plan for military struggle in all directions and domains."

Chinese analysts argue that China must develop counterspace weapons to balance US military superiority and protect Chinese interests.²⁷⁵ As one researcher writes, China's development of ASAT weapons is to protect its own national security and adds that "only by preparing for war can you avoid war."²⁷⁶ The authors of the 2013 *Science of Military Strategy* write that given the wide-range of rapid strike methods, "especially space and cyber attack and defense methods," China must prepare for an enemy to attack from all domains, including space.²⁷⁷

Chinese analysts assess that the US military relies upon space for 70–80 percent of its intelligence²⁷⁸ and 80 percent of its communications.²⁷⁹ Based

on this assessment, Chinese analysts surmise that the loss of critical sensor and communication capabilities could imperil the US military's ability to achieve victory. In this context, the Chinese military seeks to deny the US military use of information from its space-based assets. Chinese military analysts have noted the dependence of the US military on space and have concluded that the loss of the use of space for the US military may cause it to lose the conflict. China's approach to deterrence allows for a certain amount of risk escalation to get political wins: the goal is not to have stability but to achieve deterrence (which also includes an element of compellence, or forcing the opponent to take actions in China's favor). For example, the Academy of Military Studies (AMS), the Chinese military's top think tank, writes that successful space deterrence is "breaking the enemy's resistance without fighting or with minimal fighting."²⁸⁰

In addition to actual warfighting, space power can also be used to coerce. Chinese analysts write that having the ability to destroy or disable an opponent's satellites may deter an adversary from conducting counterspace operations against Chinese satellites. Space and counterspace capabilities may also deter action in other domains.²⁸¹ Space power can also improve the overall capabilities of a military and serve as a deterrent force not just against the use of specific types of weapons, but also as a general capability that can deter a country from becoming involved in a conflict.²⁸²

Chinese military writings state that the goal of space warfare and space operations is to achieve space superiority. Space superiority is defined as "ensuring one's ability to fully use space while at the same time limiting, weakening, and destroying an adversary's space forces." It not only includes offensive and defensive operations in space against an adversary's space forces, but also air, ground, and naval operations against space assets.

Chinese writers make the oft-repeated statement that "whoever controls space will control the Earth" and that outer space is the new high ground of military operations. They assert that the center of gravity in military operations has transitioned from the sea to the air and is now transitioning to space.²⁸³ According to a textbook published by the AMS, "Whoever is the strongman of military space will be the ruler of the battlefield; whoever has the advantage of space has the power of the initiative; having 'space' support enables victory, lacking 'space' ensures defeat."²⁸⁴ The authors of the influential *Science of Military Strategy*, also published by AMS, similarly conclude that space is the new high ground and that without space superiority one is at a disadvantage in all other domains.²⁸⁵

Chinese military writings overall place a heavy emphasis on gaining the initiative at the outset of a conflict, including during the deployment stage. Looking at the 1991 Gulf War, and the initial invasions of Afghanistan in 2001 and Iraq in 2003, Chinese military analysts assess that the PLA cannot allow the US military to become fully prepared lest they cede victory. According to the authors of *Study of Space Operations*, China will "do all it can at the strategic level to avoid firing the first shot,"²⁸⁶ but recommend that China should "strive to attack first at the campaign and tactical levels in order to maintain the space battlefield initiative."²⁸⁷ They also argue that fighting a quick war is one of the "special characteristics of space operations" and that a military should "conceal the concentration of its forces and make a decisive large-scale first strike."²⁸⁸ In April 2022, a study sponsored by the PLA's Strategic Support Force recommended that China develop counterspace capabilities to also target commercial capabilities, such as SpaceX's Starlink broadband communications constellation in case of a future armed conflict with the United States.²⁸⁹

280 Howard Wang, Gregory Graff, Alexis Dale-Huang, *China's Growing Risk Tolerance in Space: People's Liberation Army Perspectives and Escalation Dynamics*, RAND, June 24, 2024, https://www.rand.org/pubs/research_reports/RRA2313-2.html.

281 "Coercive Space Activities: The View From PRC Sources," *China Aerospace Studies Institute*, February 26, 2024, <https://www.airuniversity.af.edu/CASI/Display/Article/3674437/coercive-space-activities-the-view-from-prc-sources/>.

282 Jiang Lianju and Wang Liwen (Eds.), *Textbook for the Study of Space Operations* (空间作战学教程), Beijing: Military Science Publishing House, 2013, 127.

283 Jiang Lianju and Wang Liwen (Eds.), *Textbook for the Study of Space Operations* (空间作战学教程), Beijing: Military Science Publishing House, 2013, p. 14.

284 Lianju and Liwen, *Textbook for the Study of Space Operations* (空间作战学教程), *ibid.*, p. 1.

285 China Academy of Military Science (AMS) Military Strategy Studies Department, *Science of Military Strategy* (战略学), Beijing: Military Science Press, December 2013; p. 96.

286 Jiang Lianju and Wang Liwen (Eds.), *Textbook for the Study of Space Operations* (空间作战学教程), Beijing: Military Science Publishing House, 2013, p. 42.

287 Lianju and Liwen, *Textbook for the Study of Space Operations* (空间作战学教程), *ibid.*, p. 52.

288 Lianju and Liwen, *Textbook for the Study of Space Operations* (空间作战学教程), *ibid.*, pp. 142-143.

289 Stephen Chen, "Chinese researchers say China's military must be able to destroy Elon Musk's Starlink satellites in a war," *South China Morning Post*, May 25, 2022, <https://www.businessinsider.com/china-need-ability-to-destroy-elon-musk-starlink-researchers-say-2022-5>.

- 290 Howard Wang, Gregory Graff, Alexis Dale-Huang, *China's Growing Risk Tolerance in Space: People's Liberation Army Perspectives and Escalation Dynamics*, RAND, June 24, 2024, https://www.rand.org/pubs/research_reports/RRA2313-2.html.
- 291 Kevin Pollpeter, "Coercive Space Activities the View from PRC Sources," *China Aerospace Studies Institute*, February 2024, <https://www.airuniversity.af.edu/CASI/Display/Article/3674437/coercive-space-activities-the-view-from-prc-sources/>.
- 292 Kevin Pollpeter, Elizabeth Barrett, and April Herlevi, "Deterring China's Use Of Force In The Space Domain: A Proposed Scorecard For Weighing The Risks," Prepared by CNA for the China Aerospace Studies Institute, May 19, 2025, <https://www.airuniversity.af.edu/CASI/Display/Article/4164901/deterring-chinas-use-of-force-in-the-space-domain/>.
- 293 Pollpeter, Barrett, and Herlevi, "Deterring China's Use Of Force In The Space Domain: A Proposed Scorecard For Weighing The Risks," *ibid*.
- 294 Pollpeter, Barrett, and Herlevi, "Deterring China's Use Of Force In The Space Domain: A Proposed Scorecard For Weighing The Risks," *ibid*
- 295 Pollpeter, Barrett, and Herlevi, "Deterring China's Use Of Force In The Space Domain: A Proposed Scorecard For Weighing The Risks," *ibid*.
- 296 John Costello, "The Strategic Support Force: Update and Overview," *The Jamestown Foundation*, China Brief Volume 16 Issue 19, December 21, 2018, <https://jamestown.org/program/strategic-support-force-update-overview/>.
- 297 "Military and Security Developments Involving the People's Republic of China 2020," *US Department of Defense*, p. 63, <https://media.defense.gov/2020/Sep/01/2002488689/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF>.
- 298 "Military and Security Developments Involving the People's Republic of China 2021," *US Department of Defense*, p. 64, <https://media.defense.gov/2021/Nov/03/2002885874/-1/1/0/2021-CMPR-FINAL.PDF>.
- 299 "Military and Security Developments Involving the People's Republic of China 2021," *ibid*.

A 2024 RAND study of PLA writings about US space capabilities found three common strains of thinking: they view its intent to consistently be to weaponize space and achieve "space hegemony;" they have a tendency to inflate US capabilities and abilities to incorporate new technologies and efforts into its space programs; and they see agreements with commercial or international partners as either efforts to limit the PLA or to strengthen US military power.²⁹⁰

Kevin Pollpeter comments that Chinese military writing does not have any "discussion of the effects of attacks against entangled nuclear/conventional early warning systems and space domain awareness systems," which he points out, "raises the possibility that strikes against these systems could be interpreted as purposefully degrading a country's nuclear command and control systems as a prelude to a nuclear strike."²⁹¹

A 2025 CNA analysis states, "PLA researchers perceive space capabilities as a more usable and effective means of both influencing an adversary before a conflict begins and defeating an adversary during wartime."²⁹² It points out that while China is asymmetrical to the United States when it comes to space capabilities, "Advancements in China's space program could make the PLA more effective in its warfighting capabilities. They may also make the PRC more reluctant to engage in space warfare."²⁹³ Space is described as the "new commanding height of war."²⁹⁴ The CASI researchers believe that China's "perceptions that it is a moral force in the use of space and that the US is a destabilizing and malign force may be used to justify actions in space as a necessary means to stop what China sees as the illegitimate use of space power by the US"²⁹⁵

Chinese Space and Counterspace Organization

In the past decade, China has undertaken several significant reorganizations of its military space and counterspace forces. In 2015, Chinese President Xi Jinping created the Strategic Support Force (SSF) as the fifth military service by merging existing space, cyber, and electronic warfare units under a new unified command that reported directly to the Central Military Commission. The intent was to shift the PLA's most strategic, informatized missions from a discipline-centric to domain-centric force structure and enable full-spectrum war-fighting.²⁹⁶ The SSF provided oversight of the Space Systems Department, which was responsible for nearly all PLA space operations, including space launch and support; space surveillance; space information support; and space telemetry, tracking, and control and space warfare.²⁹⁷ The 2021 US Department of Defense Report on Military and Security Developments in China assessed that the SSF was responsible for the development of counterspace capabilities.²⁹⁸ It is unclear if the SSF also had authority for conducting ASAT operations or whether that remains with the PLA Rocket Force.²⁹⁹

The SSF had two main function departments.³⁰⁰ One of them, the Space Systems Department, handled military uses of space, including space launches, remote sensing, and the BeiDou navigation Satellites. The second department, the Network Systems Department, was in charge of cyber operations, electronic warfare, and signals intelligence. In December 2023, new research shed light on how the SSF was organized for counterspace command and control.³⁰¹ It found differences in the level of control for different counterspace capabilities and some remaining roles for other services, including the PLA Air Force and Rocket Force.³⁰² It found that the Central Military Commission (CMC) tasked Chinese DA-ASAT capabilities and ground to space satellite electronic jammers, while offensive cyber and reversible DEW dazzling counterspace capabilities were likely under the control of theater commanders.

In April 2024, the PLA announced that it was disbanding the SSF and creating the Information Support Force. In making the announcement at the launch of the Information Support Force, Xi stated that “the information support force is a newly created strategic branch of the military and a key support for the coordinated construction and use of the network information system.”³⁰³ With this change, the former SSF is no longer a full service but instead has its responsibilities divided up into what is called the “four services and four arms.”³⁰⁴ The former SSF is now the Aerospace Force (PLAASF); the Electronic and Electromagnetic Systems Department is now the Information Support Force (PLAISF); and the Cyber Systems Department is now the Cyber Support Force (PLACSF). The fourth “arm” is the Joint Logistics Support Force (JLSF), which already exists (having been created in 2016).³⁰⁵ The four services are the Army, Navy, Air Force, and Rocket Forces. One possible impetus driving this reorganization was the large mandate of the SSF; dividing responsibilities into four organizations will allow for specialization. Alternatively, some believe that the SSF’s organization hampered Xi’s ability to monitor China’s space, cyber, and information service efforts and that this shuffle will allow him to get more direct input, particularly into the latter, as information services are increasingly important to the PLA.³⁰⁶ Another could be that China felt its information systems needed improvement, especially when compared to US information service capabilities.³⁰⁷ A Chinese defense ministry spokesperson said that the Aerospace Force will “strengthen the capacity to safely enter, exit and openly use space.”³⁰⁸ The deputy commander for the SSF, Lt. Gen. Bi Yi, became the head of the Information Support Force.³⁰⁹ In February 2026, news emerged that the PLA is transitioning much of the information support and mission assurance responsibilities away from the PLAASF and to the PLAISF; according to Kristin Burke, this may be so that PLAASF can focus on “specialized capabilities and plans for offensive and defensive ground and space-based operations.”³¹⁰

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301 Kristin Burke, “PLA Counterspace Command and Control,” *China Aerospace Studies Institute*, December 2023, <https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/PLASSF/2023-12-11%20Counterspace-%20web%20version.pdf>.

302 Burke, “PLA Counterspace Command and Control,” *ibid*.

303 Ou Can Li Jianwen (欧灿 李建文), “The founding ceremony of the Chinese People’s Liberation Army Information Support Force was held in Beijing. Xi Jinping awarded the military flag to the Information Support Force and delivered a speech (中国人民解放军信息支援部队成立大会在京举行 习近平向信息支援部队授予军旗并致训词),” Ministry of National Defense of the People’s Republic of China, April 19, 2024, http://www.mod.gov.cn/gfbw/sy/tt_214026/16302017.html.

304 Ying Yu Lin and Tzu-Hao Liao, “IP, SSF: Unpacking the PLA’s Latest Restructuring,” *The Diplomat*, April 23, 2024, <https://thediplomat.com/2024/04/rip-ssf-unpacking-the-plas-latest-restructuring/>.

305 Lin and Liao, “IP, SSF: Unpacking the PLA’s Latest Restructuring,” *ibid*.

306 Gordon Arthur, “Why China axed the Strategic Support Force and reshuffled the military,” *DefenseNews*, April 26, 2024, <https://www.defense-news.com/global/asia-pacific/2024/04/26/why-china-axed-the-strategic-support-force-and-reshuffled-the-military/>.

307 Annette Lee and James Bellacqua, “The Chinese Military’s New Information Support Force,” *CNA*, August 2, 2024, <https://www.cna.org/our-media/indepth/2024/08/chinese-information-support-force>; Joel Wuthnow, “China’s New Info Warriors: The Information Support Force Emerges,” *War on the Rocks*, June 24, 2024, <https://warontherocks.com/2024/06/chinas-new-info-warriors-the-information-support-force-emerges/>.

308 Gordon Arthur, “Why China axed the Strategic Support Force and reshuffled the military,” *DefenseNews*, April 26, 2024, <https://www.defense-news.com/global/asia-pacific/2024/04/26/why-china-axed-the-strategic-support-force-and-reshuffled-the-military/>.

309 Brendan S. Mulvaney, “The PLA’s New Information Support Force,” *China Aerospace Studies Institute*, April 22, 2024, <https://www.airuniversity.af.edu/CASI/Display/Article/3749754/the-plas-new-information-support-force/>.

310 Kristin Burke, “PLA Reorganizes Space Information Support and Assurance Mission,” *Jamestown China Brief Volume 26 Issue 4*, February 20, 2026, <https://jamestown.org/pla-reorganizes-space-information-support-and-assurance-mission/>.

- 311 Feng Shuxing, Reflection on Development of Space Power and Space Security (我国空间力量发展与空间安全的思考), *Journal of Academy of Equipment* (装备学院学报), October 2012, p. 9.
- 312 Office of the Secretary of Defense, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2019," *United States Department of Defense*, May 2, 2019, p. 23, [https://media.defense.gov/2019/May/02/2002127082/-1/-1/1/2019%20CHINA%20MILITARY%20POWER%20REPORT%20\(1\).PDF](https://media.defense.gov/2019/May/02/2002127082/-1/-1/1/2019%20CHINA%20MILITARY%20POWER%20REPORT%20(1).PDF).
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Chinese Counterspace Budget and Exercises

Little reliable information has been provided on the budget for China's entire space program, let alone its budget for counterspace technologies. It is likely that in relative terms, China spends much less on space than the United States, yet still manages to fund an extensive and robust program. According to one 2012 source, China invests less than 0.1 percent of its GDP on its space program. If correct, this would have placed China's annual spending on its entire space program below \$8.227 billion.³¹¹ However, any estimate of China's spending and budget should be seen with a great deal of skepticism.

According to the US Department of Defense, in 2018, China's SSF conducted the LUOYANG series of force-on-force exercises to train in a complex electronic warfare environment, although it is uncertain to what extent the exercise involved space capabilities.³¹² It is reported to have been held at least three times.³¹³ Elements of the SSF have reportedly participated in more than eleven different exercises since May 2018, although it is unclear if any of them involved space operations.³¹⁴

The head of US Space Forces Indo-Pacific, Brig. Gen. Anthony J. Mastalir, said in March 2025 that China is incorporating some of its counterspace capabilities during exercises: "[W]hen you think about the counter-space weapons that China is building, including direct-ascent ASATs... those are going out and being postured at the same time that the exercise is unfolding in the East China Sea."³¹⁵

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INDIA

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India has over five decades of experience with space capabilities, but most of that has been civil in focus. It is only relatively recently that India has started organizationally making way for its military to become active users of space and creating explicit military space capabilities. India demonstrated its ASAT capability in March 2019 when it destroyed one of its satellites and has reportedly demonstrated EW counterspace capabilities. In 2025, India successfully showcased twice its ability to maneuver civilian space assets in orbit, marking an important step toward developing rendezvous and docking technology for space assets.

4.1 – INDIAN CO-ORBITAL ASATs

In April 2023, the Indian Space Research Organisation (ISRO) announced it had autonomously landed its prototype for a Reusable Launch Vehicle Autonomous Landing Mission (RLV LEX).¹ The experiment, which has been described as a space plane and looks very similar to the US' X-37B and China's Reusable Experimental Spacecraft (see US Co-Orbital ASAT, Section 1.1, and Chinese Co-Orbital ASAT, Section 3.1), was taken via helicopter to an altitude of 4.5 km, released, and then was able to land by itself on a runway.² This was the second time this technology was flown; the first was in May 2016, when it was launched to an altitude of 65 km via a rocket and landed in the ocean.³ In March 2024, ISRO declared it successfully carried out its second RLV Landing Experiment (RLV-LEX-02) with a 21-foot-long (6.5 meters) prototype space plane, known as Pushpak.⁴ At the Aeronautical Test Range in the southwestern state of Karnataka, Pushpak was released from an Indian Air Force Chinook helicopter at an altitude of 2.8 miles (4.5 kilometers) and autonomously touched down on a runway 2.5 miles (4 kilometers) away.⁵ A new test facility for testing landing gear of the Pushpak was inaugurated in April 2025.⁶ While the program has been described as developing technologies for a reusable launch vehicle and not as a counterspace capability, the possibility has been raised that the spaceplane could spend up to a month in space, conducting experiments and releasing payloads; if it does eventually develop that capability, then it may have a latent counterspace capacity.

India is also developing rendezvous and proximity capabilities. As these technologies evolve, they contribute to a broader spectrum of space maneuvering capabilities, which, in some contexts, have been associated with co-orbital activities. In January 2025, India demonstrated with SpaDeX that they can maneuver civil space assets in orbit in order to validate the technology necessary for autonomous rendezvous and docking of spacecraft.⁷ Three months later, ISRO demonstrated this again by docking the two SpaDeX satellites, SDX 01 (2024-253A, 62459) & SDX 02 (2024-253B, 62460), and this time conducting a power transfer from one satellite to the other by using the power of one satellite to operate a heater in the other.⁸

There were reports in September 2025 that the Indian government is considering developing "bodyguard" satellites, or co-orbital satellites intended to protect Indian satellites from in-space threats.⁹ This was prompted by an incident in mid-2024 when an ISRO satellite, orbiting at an altitude between 500-600 km, was approached by an unnamed neighboring country's satellite.¹⁰ This satellite was reported to have gotten within one kilometer of the Indian satellite.¹¹

4.2 – INDIAN DIRECT-ASCENT ASATs

India launched its first rocket, a US-supplied Nike-Apache, in November 1963.¹²

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- 9 Mihir Mishra, "India plans 'bodyguard' satellites after neighbour's risky orbit move," *Economic Times*, Sept. 22, 2025, <https://economictimes.indiatimes.com/news/science/india-plans-bodyguard-satellites-after-neighbours-risky-orbit-move/articleshow/124036809.cms>.
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- 11 Mishra, "India plans 'bodyguard'," *ibid*.
- 12 Amrita Shah, "Flashback 1963: The beginnings of India's dazzling space programme; An excerpt from Amrita Shah's 'Vikram Sarabhai – A Life', about the father of India's space initiatives," *Scroll.In*, February 15, 2017, <https://scroll.in/article/829466/flashback-1963-the-beginnings-of-indias-dazzling-space-programme>.

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- 25 Snehash Alex Philip, "India's Ballistic Missile Shield Ready, IAF & DRDO To Seek Govt Nod To Protect Delhi," *The Print*, January 8, 2020, <https://theprint.in/defence/indias-ballistic-missile-shield-ready-iaf-drdo-to-seek-govt-nod-to-protect-delhi/345853/>.

In July 1980, with the Rohini RS-1 satellite, India became the 7th nation to have indigenous satellite launch capabilities.¹³

India's space program was at first primarily focused on peaceful uses and development. However, as more countries incorporated space into their security capabilities, this became more attractive to India as well. China had its first successful ASAT missile test intercept in 2007, which generated space debris and worries globally about its military space capacity. Indian officials operating in the context of historically fraught Indo-Chinese relations, including a war in 1962, ongoing border disputes, and concerns about China's role in the Asia-Pacific, began to consider whether India should have its own ASAT capability. Lt. Gen. H.S. Lidder, then Integrated Defense Staff chief, was quoted as saying, "[W]ith time, we will get sucked into the military race to protect space assets and inevitably there will be a military contest in space. In a life-and-death scenario, space will provide the advantage."¹⁴

Dr. K. Kasturirangan, former head of the ISRO, said in September 2009 that, "India has spent a huge sum to develop its capabilities and place assets in space. Hence, it becomes necessary to protect them from adversaries. There is a need to look at means of securing these."¹⁵ Air Chief Marshal P.V. Naik said in February 2010, "Our satellites are vulnerable to ASAT weapon systems because our neighborhood possesses one."¹⁶

In February 2010, V.K. Saraswat, who at that time was the head of India's Defense Research and Development Organisation (DRDO), stated, "In Agni-III, we have the building blocks and the capability to hit a satellite but we don't have to hit a satellite," due to debris concerns; instead, India "will validate the anti-satellite capability on the ground through simulation."¹⁷ In 2012, Saraswat asserted, "Today, India has all the building blocks for an anti-satellite system in place. We don't want to weaponize space but the building blocks should be in place. Because you may come to a time when you may need it... We will not do a physical test (actual destruction of a satellite) because of the risk of space debris affecting other satellites."¹⁸ He went on to say that the Long Range Tracking Radar used for Indian missile defense had a range of 600 km, but that it could be extended to 1,400 km to track satellites in orbit, and noted the work done on the BMD system's communications and kill vehicles.¹⁹ In promoting the Agni-V intercontinental ballistic missile (ICBM), he pointed out, "An ASAT weapon would require to reach [sic] about 800 km altitude... Agni V gives you the boosting capability and the 'kill vehicle', with advanced seekers, will be able to home into the target satellite," but iterated, "India does not believe in weaponization of space. We are only talking about having the capability. There are no plans for offensive space capabilities."²⁰

India's missile defense system was intended to have two phases: one that would intercept an intermediate-range ballistic missile (IRBM), a capability that initially was planned to be in place around 2012/2013, and one that would intercept an ICBM, a capability that initially was planned to be in place around 2016. The first phase's interceptors were the Prithvi Air Defense system (later to be replaced by the Prithvi Defense Vehicle, or PDV) and the Advanced Area Defense (AAD) system; the second phase would use the AD-1 missile. The PDV was successfully test-fired in February 2017 and is intended to provide exoatmospheric intercepts; it was reported to have destroyed its target at an altitude of 97 km.²¹ It was tested at night in September 2018 and was able to "successfully engage" its target.²² The AAD was launched in March 2017 to make a successful intercept at an altitude of 15-25 km.²³ It was tested in August 2018 and successfully destroyed its target, which was surrounded by decoys.²⁴ In January 2020, government officials stated that the system was complete.²⁵ The AD-1 missile was successfully flown for the

first time in a November 2022 test and is designed to be able to provide both endo- and exoatmospheric intercepts.²⁶ On July 24, 2024, using the two-stage AD-1 interceptor, DRDO successfully carried out a flight test for the Phase-II Ballistic Missile Defence System, which is designed to intercept medium- to long-range ballistic missiles.²⁷ Phase III is intended to defend against hypersonic threats and MIRV'd ballistic missiles; DRDO is reported to be developing two new interceptors, AD-AH and AD-AM, to do so.²⁸

India has also negotiated a deal with Russia to buy four of its S-400 Triumf surface-to-air missile systems for \$5.5 billion.²⁹ Russia has delivered three units of the long-range missile systems; India was supposed to receive its final two units in 2025, but now the timeline is 2026 for the 4th unit and 2027 for the 5th.³⁰ In April 2023, Indian military officials announced the successful first test of a sea-based endoatmospheric missile interceptor.³¹ India's missile defense network uses the Swordfish long range tracking radar (see Imagery Appendix, pg. 17-56), which is a derivative of the Green Pine radar developed by Israel as part of its Arrow missile defense system.

FIGURE 4-1 – MISSION SHAKTI ASAT³²



Image Credit: Defense Research & Development Organisation

On March 27, 2019, the Indian Prime Minister Narendra Modi announced that they had successfully conducted Mission Shakti, where a KKV launched from the Kalam Island launch complex (see Imagery Appendix, pg. 17-19) successfully intercepted one of India's satellites at an altitude of about 300 km. The missile used was from India's indigenously developed missile defense system, a PDV MK-II, and the satellite target was Microsat-R (2019-006A, 43947), a medium-sized

26 Ahmad Adil, "India conducts maiden flight-test of ballistic missile defense interceptor," *Andalou Agency*, Nov. 2, 2022, <https://www.aa.com.tr/en/asia-pacific/india-conducts-maiden-flight-test-of-ballistic-missile-defense-interceptor/2727822>.

27 Defence Research and Development Organisation (DRDO), Newspaper Clipping, vol. 49, no. 139 (July 27–29, 2024), pages 2 and 8, <https://www.drdo.gov.in/drdo/sites/default/files/drdo-news-documents/NPC27to29July2024.pdf>; "S-400 air defence system 'shot down' almost entire 'enemy' package in exercise; major success for IAF," *The Times of India*, Jul 27, 2024, <https://timesofindia.indiatimes.com/india/s-400-air-defence-system-shot-down-almost-entire-enemy-package-in-exercise-major-success-for-iaf/articleshow/112066904.cms>; Vijinder K. Thakur, "THAAD's Analog, S-400's Partner, DRDO's AD-1 Missile Interceptor Puts India In The Elite League," *Eurasian Times*, July 26, 2024, <https://www.eurasiantimes.com/thaads-analog-s-400s-partner-drdo/>.

28 Diksha Modi, "DRDO Builds Next-Gen Shield To Destroy Hypersonic Missiles Flying At 10,000 Kmph," *News18.com*, January 22, 2026, <https://www.news18.com/india/drdo-builds-next-gen-shield-to-destroy-hypersonic-missiles-flying-at-10000-kmph-ws-kl-9848737.html>.

29 Rahul Bedi, "Why Is the US Saying India Could Face Sanctions for Buying Russian S-400 Missile Systems?," *The Wire*, January 20, 2021, <https://thewire.in/security/us-india-sanctions-caatsa-s400-russia>.

30 "India to Receive Remaining S-400 Triumf Missile Regiments from Russia by Next Year," *The Economic Times*, April 23, 2024, <https://economictimes.indiatimes.com/news/defence/india-to-receive-remaining-s-400-triumf-missile-regiments-from-russia-by-next-year/articleshow/109538365.cms?from=mdr>; "Fourth S-400 Squadron to Reach India by May 2026 as Russia Reaffirms Defence Ties and Air Defence Commitments," *Defence Security Asia*, January 11, 2026, <https://defencesecurityasia.com/en/russia-confirms-fourth-s400-delivery-india-may-2026-indo-pacific-air-defence/>.

31 Adithya Krishna Menon, "India Conducts First Test Of New Ship-Based BMD System," *Naval News*, April 25, 2023, <https://www.navalnews.com/naval-news/2023/04/india-conducts-first-test-of-new-ship-based-bmd-system/>.

32 Masao Dahlgren, "Some shots I hadn't seen of India's Mission Shakti ASAT from its 2020 outreach brochure," *Twitter*, April 19, 2021, https://twitter.com/masao_dahlgren/status/1384192441020911616.

- 33 Ankit Panda, "ISRO wasn't told that Microsat-R was being launched to serve as an ASAT target," *Twitter*, April 20, 2021, <https://twitter.com/nktpnd/status/1384531089901998081>.
- 34 Dinakar Peri, "Two Years Since ASAT Test, DRDO Working on Several Key Space Technologies," *The Hindu*, March 26, 2021, <https://www.thehindu.com/news/national/two-years-since-asat-test-drdo-working-on-several-key-space-technologies/article34171447.ece>.
- 35 Indranil Roy, "All You Need To Know About The PDV MK-II: India's Satellite Killer," *Delhi Defence Review*, April 3, 2019, <https://delhidefencereview.com/2019/04/03/all-you-need-to-know-about-the-pdv-mk-ii-indias-satellite-killer/>. This article goes into deep detail about the interceptor. Also: Bulbul Khan, Sk Ahamed Ali, Sanjay Kumar Srivastava, Rajesh Kumar Gupta, Pulkit Kumar, "Mission Shakti aka Project XSV-1: India's First Anti-Satellite Test (ASAT)," 2025, https://www.researchgate.net/publication/390096204_Mission_Shakti_aka_Project_XSV-1_India's_First_Anti-Satellite_Test_ASAT.
- 36 "Frequently Asked Questions on Mission Shakti, India's Anti-Satellite Missile test conducted on 27 March, 2019," Ministry of External Affairs, Government of India, March 27, 2019, https://www.mea.gov.in/press-releases.htm?dtl/31179/Frequently_Asked_Questions_on_Mission_Shakti_Indias_AntiSatellite_Missile_test_conducted_on_27_March_2019.
- 37 Snehes Alex Philip, "DRDO Rules Out A-SAT Tests In Lower Earth Orbits, But Keeps Options Open In Higher Orbits," *ThePrint.in*, April 6, 2019, <https://theprint.in/defence/drdo-rules-out-a-sat-tests-in-lower-earth-orbits-but-keeps-options-open-in-higher-orbits/217879/>.
- 38 Pradip Sagar, "A year after Mission Shakti, DRDO says it has no plans to repeat it," *The Week*, March 27, 2020, <https://www.theweek.in/news/india/2020/03/27/a-year-after-mission-shakti-drdo-says-it-has-no-plans-to-repeat-it.html>.
- 39 Ankit Panda, "Exclusive: India Conducted a Failed Anti-Satellite Test in February 2019," *The Diplomat*, March 30, 2019, <https://thediplomat.com/2019/04/exclusive-india-conducted-a-failed-anti-satellite-test-in-february-2019/>.
- 40 Marco Langbroek, "Why India's ASAT Test Was Reckless: Publicly available data contradicts official Indian assertions about its first anti-satellite test," *The Diplomat*, April 30, 2019, <https://thediplomat.com/2019/05/why-indias-asat-test-was-reckless/>.
- 41 Bulbul Khan, Sk Ahamed Ali, Sanjay Kumar Srivastava, Rajesh Kumar Gupta, Pulkit Kumar, "Mission Shakti aka Project XSV-1: India's First Anti-Satellite Test (ASAT)," 2025, https://www.researchgate.net/publication/390096204_Mission_Shakti_aka_Project_XSV-1_India's_First_Anti-Satellite_Test_ASAT.

(740 kg) Indian military imaging satellite launched into a low Sun-synchronous orbit in January 2019. ISRO launched the satellite but did not know that it was intended to be an ASAT target, just that it was intended to have a defense application.³³ The kill vehicle's terminal guidance used a ring laser gyro-based inertial navigation system and a strap-down Imaging Infrared Seeker; the interception was done at a speed of 10 km/second, with the electro optical tracking system tracking the entire engagement.³⁴ Reportedly, the decision was made in 2017 to undertake the test (initially called Project XSV-1), giving DRDO engineers about 30 months to ensure that the kill vehicle was ready for it.³⁵ In a fact sheet released about the ASAT test, the Indian government explained, "The test was done to verify that India has the capability to safeguard our space assets. It is the Government of India's responsibility to defend the country's interests in outer space," but went on to say, "We are against the weaponization of Outer Space and support international efforts to reinforce the safety and security of space-based assets."³⁶ After the test was held, DRDO Chair G. Sateesh Reddy told reporters that, "We don't need any more tests in this orbit now," but did not rule out tests at higher orbits.³⁷ Minister of Defence Rajnath Singh tweeted on the one-year anniversary of Mission Shakti, "The success of 'Mission Shakti' proved our capability to defend the assets in outer space and made India the 4th Space Power in the world."³⁸

Shortly after the test, anonymous US government sources stated that they had detected an earlier failed ASAT test in February 2019 where the PDV's booster failed thirty seconds into flight.³⁹ The Indian government issued a NOTAM just before this flight and the time of the launch correlated with an overflight of Microsat-R, another indication that it was launched into orbit to be a target for an ASAT test.

TABLE 4-1 – INDIAN DA-ASAT TESTS IN SPACE

DATE	INTERCEPTOR	LAUNCH SITE	TARGET	ALTITUDE REACHED	NOTES
Feb. 12, 2019	PDV-MK II	Abdul Kalam Island	Microsat-R	Suborbital	Booster failed within 30 seconds, no intercept.
Mar. 27, 2019	PDV-MK II	Abdul Kalam Island	Microsat-R	300 km	Successfully intercepted orbital target, debris generated.

Indian officials downplayed concerns about large amounts of debris being created by this test, stating that the test was at a low enough altitude that most of the debris would re-enter in a few days, with the entirety of it coming back down within 45 days at most.⁴⁰ Microsat-R was similar in mass to the FY-1C satellite (1999-025A, 25730) destroyed by China in January 2007, which resulted in more than 3,500 pieces of orbital debris larger than 10 cm (see Chinese Direct-Ascent ASAT, Section 3.2). However, Microsat-R was at a much lower altitude when destroyed, 300 km versus 880 km for the FY-1C, meaning the orbital debris generated had a shorter lifespan. The US military catalogued 130 pieces of trackable orbital debris from India's test; the final piece of trackable debris re-entered the atmosphere in June 2022, 3.2 years after the test occurred. At least some pieces had been thrown to an altitude of 2250 km due to collision dynamics, as what also happened with the February 2008 intercept of USA 193 (2006-057A, 29651) by the United States (see US Direct-Ascent ASAT, Section 1.2).⁴¹

A prime motivation for the test was likely to ensure India would be grandfathered into any future ban on DA-ASAT testing. Indian officials are still upset that India was left out of the Nuclear Non-Proliferation Treaty (NPT) as a non-nuclear-

weapon state and believe, probably rightfully so, that if they had tested a nuclear weapon before the treaty's 1968 inception (as opposed to when they did test it, in 1974), they would have been grandfathered in to be a nuclear weapon state. Successfully demonstrating its DA-ASAT capability might have been a political prerequisite for India to support discussions on a future ban.

India's main space vehicle launchpad is at Satish Dhawan Space Centre near Sriharikota (see Imagery Appendix, pg. 17-18). Officials announced in August 2017 that work began on a second vehicle assembly building at the center that was anticipated to be completed by mid-2018; it was dedicated in 2019.⁴² According to A.S. Kiran Kumar, then ISRO chairperson, "With the new assembly facility, we will be able to assemble the launch vehicle [in parallel] and bring it to existing two launchpads. It will thus help boost the launch capability of the Sriharikota centre."⁴³ Launches from the center were initially expected to increase from seven a year to 12 a year, and in fact, while 14 launches were planned for 2023, nine actually occurred.⁴⁴ Undeterred, Indian officials announced in February 2024 that they would hold 30 launches over 15 months.⁴⁵ In 2024, all the launches carried out from the Satish Dhawan Space Centre were successful, including five launch vehicle missions, one sounding rocket launch, and one experimental mission.⁴⁶ A third launch pad is planned to be ready by March 2029.⁴⁷

In February 2024, the foundation stone was laid for India's second spaceport, Kulasekarapattinam Spaceport in Tamil Nadu; at the same time, it held the successful flight of a Rohini Sounding Rocket.⁴⁸ The spaceport is expected to be fully open by December 2026, and is intended to be able to support 20-25 launches a year and rockets up to 500 kg.⁴⁹ Tamil Nadu-based startup Space Zone India launched Mission RHUMI 2024, the country's first reusable hybrid rocket, from TTDC Ground in Thiruvudandai, Chennai, in August 2024.⁵⁰ The rocket carried three cube satellites and 50 pico satellites on a suborbital trajectory.⁵¹

4.3 – INDIAN ELECTRONIC WARFARE

India demonstrated its EW capability against Pakistani radars and communications. It has developed several indigenous offensive EW systems, including the Samyukta and Himshakti.⁵² The Himshakti is reported to have the ability to jam satellite phones; the Indian Ministry of Defence announced in March 2023 an award of \$364 million (30 billion rupees) to deliver two systems to the Indian Army.⁵³ There have been increased reports of GPS interference happening in the Indian-Pakistani border region: between November 2023 and February 2025, roughly 465 incidents were reported, although it is unclear which side was responsible for this.⁵⁴ During Operation Sindoor against Pakistan in May 2025, India sent electronic warfare forces to the conflict zone to interfere with GNSS signals in order to hamper Pakistani military aircrafts' use of them for strikes and navigation.⁵⁵

42 "ISRO readying for a number of launches," *Deccan Chronicle*, January 27, 2018, <https://www.deccanchronicle.com/science/science/270118/isro-readying-for-a-number-of-launches.html>; "ISRO acquiring land in TN for its 2,300-acre second launch centre," *New Indian Express*, January 2, 2020, <https://www.newindianexpress.com/nation/2020/jan/02/isro-acquiring-land-in-tn-for-its-2300-acre-second-launch-centre-2083911.html>.

43 Surendra Singh, "ISRO's launch capacity will get boost with new facility at Sriharikota by year-end," *Times of India*, August 3, 2017, <http://timesofindia.indiatimes.com/india/isros-launch-capacity-will-get-boost-with-new-facility-at-sriharikota-by-year-end/article-show/59890384.cms>.

44 Ibid; "Sriharikota Launch Schedule," Space Launch Schedule, last accessed Feb. 20, 2023, <https://www.spacelaunchschedule.com/category/sriharikota/>; "Timeline," ISRO, last updated January 2, 2024, <https://www.isro.gov.in/Timeline.html>.

45 Andrew Jones, "India targets a surge in civil and commercial launches," *SpaceNews*, February 16, 2024, <https://spacenews.com/india-targets-a-surge-in-civil-and-commercial-launches/>.

46 "Launches from Sriharikota - A Summary," ISRO, 2025, <https://www.shar.gov.in/sdscshar/launchvehicles.jsp>.

47 Lele, "India unveils its space vision to 2040," *ibid*.

48 "Honourable Prime Minister Lays the Foundation Stone for India's Second Spaceport," *ISRO*, February 28, 2024, https://www.isro.gov.in/Second_Spaceport_FoundationStone_Laid_Hon_PrimeMinister.html.

49 "Stage Set for ISRO's New Spaceport," *Times of India*, August 29, 2025, <https://timesofindia.indiatimes.com/city/chennai/stage-set-for-isros-new-spaceport/articleshow/123568481.cms>.

50 "Tamil Nadu-based space startup launches India's first reusable hybrid rocket," *The Times of India*, August 25, 2024, <https://timesofindia.indiatimes.com/india/tamil-nadu-based-space-startup-launches-indias-first-reusable-hybrid-rocket/article-show/112769989.cms>.

51 "Tamil Nadu-based space startup launches India's first reusable hybrid rocket," *ibid*.

52 Lt. Gen. (Dr) R.S. Panwar, "India's Space Programme: Organisations and Warfighting Potential," *Future Wars*, August 2, 2021, <https://futurewars.rspanwar.net/indias-space-programme-organisations-and-warfighting-potential/>.

53 Inder Singh Bisht, "India Procures Indigenous Electronic Warfare Systems for \$364M," *The Defense Post*, March 27, 2023, <https://www.thedefensepost.com/2023/03/27/india-electronic-warfare-systems/>.

54 Johan Jose, "What is GPS spoofing, common along India-Pakistan border and now disrupting Delhi airport," *ThePrint.in*, November 6, 2025, <https://theprint.in/feature/what-is-gps-spoofing-common-along-india-pakistan-border-and-now-disrupting-delhi-airport/2778509/>.

55 Sandeep Dhawan, "Jamming and Spoofing of Civilian Airspace: Are the Days of GPS-based Navigation Over?" *Insightful Geopolitics*, Nov. 6, 2025, <https://insightful.co.in/2025/11/06/jamming-and-spoofing-of-civilian-airspace-are-the-days-of-gps-based-navigation-over/>.

- 56 Soumya Awasthi, "Securing India's Skies: Countering the Threat of GPS Spoofing and Hybrid Warfare," *Observer Research Foundation*, April 17, 2025, <https://www.orfonline.org/expert-speak/securing-india-s-skies-countering-the-threat-of-gps-spoofing-and-hybrid-warfare>.
- 57 Jose, *ibid.*
- 58 Dhawan, *ibid.*
- 59 Rajeswari Pillai Rajagopalan, "What Are India's Plans for Directed Energy Weapons?" *The Diplomat*, Sept. 24, 2020, <https://thediplomat.com/2020/09/what-are-indias-plans-for-directed-energy-weapons/>.
- 60 Sanjib Kr Baruah, "What are India's top-secret Directed Energy Weapons?" *The Week*, July 30, 2023, <https://www.theweek.in/theweek/current/2023/07/21/what-are-indias-top-secret-directed-energy-weapons.html>.
- 61 Sanjib Kr Baruah, "What are India's top-secret Directed Energy Weapons?" *The Week*, July 30, 2023, <https://www.theweek.in/theweek/current/2023/07/21/what-are-indias-top-secret-directed-energy-weapons.html>.
- 62 Rajat Pandat, "DRDO plans Star Wars-style weapons for battles of future," *Times of India*, Sept. 14, 2020, <https://timesofindia.indiatimes.com/india/drdo-plans-star-wars-style-weapons-for-battles-of-future/article-show/78096712.cms>.
- 63 Ranjan Brothers, "DURGA 2: India's Direct Energy Weapon to be tested soon," *Indian Defense Analysis*, February 21, 2024, <https://indiandefenseanalysis.wordpress.com/2024/02/21/durga-2-indias-direct-energy-weapon-to-be-tested-soon/>; "First Prototype Of Durga Directed Energy Weapon In 2023," *Indian Defence News*, January 8, 2023, <https://www.indiandefensenews.in/2023/01/first-prototype-of-durga-directed.html>; PC Katoch, "Next-Level DURGA DEW System," *SP's Land and Forces*, Oct. 27, 2025, <https://www.spslandforces.com/experts-speak/?id=1327&h=Next-Level-DURGA-DEW-System>.
- 64 "Indian Navy Conducts Trials Of 2-Kw Directed Energy Weapon (DEW)," *Indian Defence News*, September 4, 2024, <https://www.indiandefensenews.in/2024/09/indian-navy-conducts-trials-of-2-kw.html>.
- 65 "From hypersonic missiles to laser weapons, DRDO's game-changing weapons to steal the show at Republic Day parade," *The Week*, January 23, 2025, <https://www.theweek.in/news/defence/2025/01/23/from-hypersonic-missiles-to-laser-weapons-drdo-s-game-changing-weapons-to-steal-the-show-at-republic-day-parade.html>; "DRDO Tableau To Showcase 'Raksha Kavach' Theme In Republic Day Parade," *NDTV*, January 23, 2025, <https://www.ndtv.com/india-news/drdo-tableau-to-showcase-raksha-kavach-theme-in-republic-day-parade-7540251>.
- 66 Katoch, "Next-Level DURGA DEW System," *ibid.*

Over the past several years, GPS interference has moved beyond the border zone. Over 10 percent of flights in the Delhi region have reported spoofing incidents.⁵⁶ In November 2025, GPS spoofing around the Indira Gandhi International Airport in New Delhi interfered with civilian airline navigation systems to the extent where some flights had to divert to another airport.⁵⁷ Pilots have reported issues flying over Srinagar, Amritsar, and Chandigarh as well.⁵⁸

4.4 – INDIAN DIRECTED ENERGY WEAPONS

India is reportedly in the early stages of working on directed energy weapons. In August 2019, Reddy acknowledged, "We have been working in this area for the past three to four years to develop 10-kW and 20-kW" weapons.⁵⁹ In March 2022, the Indian MoD identified 18 platforms it wanted to see industry-led design and development of; this included DEWs of 300 kw and above, so this level of power is something that they are tentatively interested in.⁶⁰ Work being done by DRDO and the Centre for High Energy Systems and Sciences (CHESS) is also reported to have yielded systems that can shoot down drones.⁶¹ However, the targets for these weapons are aerial or electronic:⁶² they do not appear to be working towards a counterspace capability. In April 2024, DRDO requested \$100 million for a project called "Directionally Unrestricted Ray-Gun Array (DURGA)-II," a 100-kilowatt lightweight laser defense system prototype.⁶³ It is unclear whether these capabilities can reach space-based systems. The Indian Navy was reported to have conducted in September 2024 trials of a 2-kilowatt DEW system.⁶⁴ In January 2025, during the 76th Republic Day Parade at Kartavya Path, New Delhi, DRDO displayed selected innovations for national security, including laser-based DEW.⁶⁵ A 30-kw version, the DURGA Mk-II (A), was tested in April 2025; it is focused on aerial threats.⁶⁶

4.5 – INDIAN SPACE SITUATIONAL AWARENESS CAPABILITIES

India has made many strides in its tracking and situational awareness capabilities. It currently has ground stations in Brunei, Biak (Indonesia), Mauritius, and the Andaman and Nicobar Islands for tracking satellites, and is building a satellite tracking and data reception center in Vietnam.⁶⁷ In September 2019, ISRO began Project Network for space object Tracking and Analysis (NETRA), which is intended to give India its own SSA network by bringing together radars, telescopes, data processing, and a control center.⁶⁸ NETRA will start by focusing on identifying and tracking objects in LEO up to 2000 km, but eventually is hoped to have the ability to detect objects in GEO.⁶⁹ NETRA has been used to monitor asteroid Apophis' potential close approach to Earth, expected in 2029.⁷⁰ In December 2024, NETRA was approved by the Government of India for SSA capacity building.⁷¹ ISRO's annual SSA report noted in May 2025 that the Multi-Object Tracking Radar (MOTR) at Sriharikota has been refurbished and is tracking space objects; additionally, work has begun on an optical telescope at Hanle, Ladakh, and a radar at Chandrapur, Assam.⁷²

ISRO announced in December 2020 that its SSA Control Centre in Bengaluru is now operational, stating that "the Directorate of SSA and Management (DSSAM) has been established to engage in evolving improved operational mechanisms to protect space assets through effective coordination amongst ISRO centres, other space agencies and international bodies, and establishment of necessary supporting infrastructure."⁷³

In September 2021, Air Marshal Vivek Ram Chaudhari, Vice Chief of the Indian Air Force (IAF), acknowledged that India lacks the ability to identify, observe, and track non-cooperative objects in orbit.⁷⁴ In April 2022, India and the United States signed a space situational awareness agreement to expedite sharing of SSA data.⁷⁵ Air Force Air Chief Marshall VR Chaudhari noted in June 2022 that Mission Shakti, "brought to fore the need for Comprehensive Space Situational Awareness (SSA) through a robust Space Surveillance Network (SSN)."⁷⁶

In April 2024, the Indian startup Digantara established a command-and-control center for the operation of their sensor network and to serve as a facility for satellite assembly, integration and testing. The goal of the company is to launch a constellation of 40 space surveillance satellites.⁷⁷ In January 2025, Digantara launched SCOT (Space Camera for Object Tracking), a space surveillance mission via SpaceX's Transporter-12.⁷⁸ DRDO and India's Department of Science and Technology (DST) signed an MOU in May 2025 to bring together two scientific facilities (DRDO's Instruments Research and Development Establishment, IRDE, and DST's Arabhatta Research Institute of Observational Sciences, ARIES) to work together to improve space surveillance and data analytics.⁷⁹

67 "India building satellite tracking station in Vietnam to track China's movements in South China sea," *Catch News*, February 14, 2017, <http://www.catchnews.com/world-news/india-is-building-a-satellite-tracking-station-in-vietnam-to-track-china-s-movements-in-the-south-china-sea-1453791004.html>.

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4.6 – INDIAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

After many years of being in the works, India's cabinet office officially approved its national space policy in April 2023. Prior to its completion, the only national laws specifically dealing with space for India were its Constitution from 1950, Satellite Communications Policy from 2000, and revised Remote Sensing Data Policy from 2011. There was a draft Geospatial Information Regulation Bill in 2016, but it did not progress; in February 2021, the Indian government announced that it was deregulating geospatial information.⁸⁰ India's National Space Policy describes as its vision: "To augment space capabilities; enable, encourage and develop a flourishing commercial presence in space; use space as a driver of technology development and derived benefits in allied areas; pursue international relations, and create an ecosystem for effective implementation of space applications among all stakeholders; for, the nation's socio-economic development and security, protection of environment and lives, pursuing peaceful exploration of outer space, stimulation of public awareness and scientific quest."⁸¹ It spells out the division of labor between the Indian government (ISRO, the Department of Space, Indian National Space Promotion and Authorization Center (IN-SPACe), and NewSpace India Limited (NSIL)) and the private sector. It does not give guidance on its national security space programs.

In October 2007, the Defence Space Vision was released, and listed intelligence, surveillance, reconnaissance, communication, and navigation as primary thrust areas.⁸² In 2010, the Ministry of Defense wrote a "Technology Perspective and Roadmap" which discussed developing ASATs for "for electronic or physical destruction of satellites (2,000 km altitude above earth's surface) and GEO-synchronous orbits."⁸³

In June 2010, India established an Integrated Space Cell, located in the Integrated Defense Headquarters, which is comprised of all three branches of India's armed forces.⁸⁴ The Integrated Space Cell oversaw defense-specific space capability requirements and was composed of the armed forces, the Department of Space, and ISRO. When announcing the cell, Antony stated that part of why India needed it was "[o]ffensive counter-space systems like anti-satellite weaponry, new classes of heavy-lift and small boosters and an improved array of military space systems have emerged in our neighborhood."⁸⁵ There has been discussion by the Ministry of Home Affairs of a "Border Space Command," that would use space capabilities to monitor India's disputed borders.⁸⁶ In July 2017, at a unified commanders' meeting conference, the defense secretary "apprised the audience that the Defence Cyber & Space Agencies and Special Operations Division will soon become a reality."⁸⁷

In September 2018, Prime Minister Narendra Modi announced the creation of a Defence Space Agency (DSA) to coordinate the space assets of the three branches of the Indian armed forces and work on space protection policies for Indian space assets; it became operational late in 2019.⁸⁸ The DSA is intended to eventually have 200 personnel assigned to it and will incorporate the Defence Satellite Control Centre and the Defence Imagery Processing and Analysis Centre.⁸⁹ It was followed by the establishment in June 2019 of the Defence Space Research Organisation, which conducts research and provides technical support to the DSA.⁹⁰ With these new organizations, India may be shifting to a more offensive approach to its counterspace capabilities, but it is too soon to be certain. With these new organizations, India may be shifting to a more offensive approach to its counterspace capabilities, or at least be open to doing so. G. Satheesh Reddy, head of DRDO, stated in April 2019 that "We are working on a number of technologies like DEWs, lasers, electromagnetic

pulse and co-orbital weapons etc. I can't divulge the details, but we are taking them forward," which does lend credence to the idea that India is considering many different options.⁹¹ Government officials asserted in March 2021, "In the last two years, a lot of work has been done to increase [India's] capabilities in space through the development of sensors and satellites by the Space group formed within the DRDO."⁹²

In April 2023, IAF chief Air Chief Marshal V R Chaudhari said, "In the future, instead of having purely land-based offensive systems, we should also have space-based offensive systems. It will reduce the response time...The future lies in having space-based offensive platforms."⁹³ He also stated, "In the future, the IAF will be called upon to take part in space situational awareness, space denial exercises or space control exercises." At the same time, India's Chief of Defence Staff Gen. Anil Chauhan stated that due to the need for India to move from "space support" to "space enhancement," it should focus on "developing dual-use platforms with a special focus towards incorporating cutting-edge technology."⁹⁴ However, it is unclear how much of these statements are leaving possibilities open to India for future efforts versus actual steps being taken at present.

In September 2025, at the Kolkata Combined Commanders Conference 2025, India released its Joint Military Space Doctrine.⁹⁵ This deems space to be an operational domain and sets as a goal a unified approach to space across the three services in order to integrate space operations.⁹⁶ It is reported to emphasize "the critical importance of incorporating sophisticated electronic warfare capabilities and enhancing cyber resilience."⁹⁷

India's answer to GPS, the Navigation with Indian Constellation (NavIC) precision, navigation, and timing system, started off life as the Indian Regional Navigation Satellite System. Initially planned as a seven-satellite constellation that would provide an accuracy of 20 meters within India and within 1,500-2,000 km surrounding it,⁹⁸ the NVS series now is planned to be expanded by 11 more satellites in GEO and 24 more satellites in MEO.⁹⁹ After the launch of NVS-01 (2023-076A, 56759) to GEO in 2023, the second satellite, NVS-02 (2025-020A, 62850), launched in January 2025, could not carry out orbit raising operations towards positioning the satellite to the designated orbital slot due to a malfunction.¹⁰⁰ There are four fully functioning NavIC satellites in orbit as of January 2026, two of which are nearing the end of their lives.¹⁰¹

On June 17, 2024, the US and Indian national security advisors co-chaired the second US-India initiative on Critical and Emerging Technology (iCET) meeting in New Delhi, advancing cooperation in various sectors, including outer space. Both India and the United States committed to cooperate co-development and co-production in the commercial and civil space sectors while addressing barriers to strategic trade and preventing sensitive technology transfers. India joined as an observer of the US Space Command's Global Sentinel Exercise at Vandenberg Space Force Base in February 2024 and returned as a full participant in the 2025 iteration, held in May of that year.¹⁰²

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94 "War in Space a Possibility, Need to Develop Dual-use Platforms in that Domain: CDS Anil Chauhan," *Economic Times*, April 11, 2023, <https://economictimes.indiatimes.com/news/defence/war-in-space-a-possibility-need-to-develop-dual-use-platforms-in-that-domain-cds-anil-chauhan/articleshow/99404159.cms?from=mdr>.

95 Joseph P. Chacko, "Space: India's Fourth Warfighting Domain," *raksha-Anirveda*, September 20, 2025, <https://raksha-anirveda.com/space-indias-fourth-warfighting-domain>.

96 Chacko, "Space: India's Fourth Warfighting Domain," *ibid*.

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100 "GSLV-F15 / NVS-02 MISSION: Update on GSLV-F15/NVS-02 Mission" (Dated 02/02/2025), ISRO, January 24, 2025, https://www.isro.gov.in/GSLV-F15_NVS-02_Mission.html.

101 Anshuman Narang, "A call to reenergise the Indian space ecosystem," *Hindustan Times*, January 15, 2026, <https://www.hindustantimes.com/opinion/a-call-to-reenergise-the-indian-space-ecosystem-101768491795489.html>.

102 "JOINT FACT SHEET: The United States and India Continue to Chart an Ambitious Course for the Initiative on Critical and Emerging Technology," *The American Presidency Project*, June 17, 2024, <https://www.presidency.ucsb.edu/documents/joint-fact-sheet-the-united-states-and-india-continue-chart-ambitious-course-for-the>; LaDonna Davis, "US Space Command hosts Global Sentinel 2025 exercise," *AF News Service*, May 6, 2026, <https://www.spaceforce.mil/news/article-display/article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.

- 103 Rajeswari Pillai Rajagopalan, "A First: India to Launch First Simulated Space Warfare Exercise: Reports of a tabletop wargame speak to India's ongoing efforts to develop its space policy," *The Diplomat*, June 12, 2019, <https://thediplomat.com/2019/06/a-first-india-to-launch-first-simulated-space-warfare-exercise/>.
- 104 "India's First-Ever Space Exercise 'Antariksha Abhyas' Begins In Delhi," *NDTV*, November 11, 2024, <https://www.ndtv.com/india-news/indias-first-ever-space-exercise-antariksha-abhyas-begins-in-delhi-6996620>; Pallab Bhattacharya, "Indian Armed Forces for the First Time Brainstorm on Space Race," *Daily Sun*, November 30, 2024, <https://www.daily-sun.com/post/779804>.
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India has held several tabletop exercises to game out space warfare possibilities and identify gaps and weaknesses in its space security. The first one, IndSpaceEx, was held in July 2019.¹⁰³ The second was a closed-door table-top exercise called "Antariksha Abhyas-2024," held in November 2024 by India's DSA. During two days, participants worked on integrating India's space capability in military operations and gained an understanding of operational dependency on space segments.¹⁰⁴ Involving military personnel from the DSA and its allied units, as well as representatives from ISRO and DRDO, observers noted that the exercise was composed of a mix of simulation-based war games, technical briefings, and strategic discussions.¹⁰⁵

Potential Military Utility /

India has recently made significant investments in its national security space infrastructure and capabilities and incorporated those capabilities into its military operations, as well as having held several tabletop exercises related to military space operations. India has demonstrated a DA-ASAT capability against a LEO satellite. However, it is likely of limited military utility: the capability is more likely to be useful as a bargaining chip or a way to publicly demonstrate that India is keeping pace with China than a militarily useful capability in a future conflict. Like many other countries, India likely has counterspace EW capabilities and is developing DEW technologies that may in the future be applied in a counterspace role. Finally, India has a nascent but still very rudimentary SSA capability, so its ability to target non-Indian satellites is unclear but probably limited.

05

ORBITAL DEBRIS

Created by Destructive ASAT Testing

5. ORBITAL DEBRIS CREATED BY ASAT TESTS IN SPACE

The countries listed in the prior section have carried out 16 destructive ASAT tests in space, all of which have created orbital debris that persisted long after the test itself. While some of the orbital debris from past ASAT tests has decayed from orbit, significant portions of it remain on orbit today.

The amount of orbital debris created by a destructive ASAT test depends on the nature of the event: primarily the speed of the intercept and the altitude at which it occurred, as well as the mass and structure of the target. If either the interceptor or target was in orbit when the test occurred, a significant portion of the resulting debris is likely to remain in orbit as well. The lifespan of that resulting debris is primarily a function of the altitude at which the destruction happened.

Table 5-1 below lists the known destructive ASAT testing done to date, along with the number of orbital debris tracked on orbit following the test and how much remains on orbit as of the publication of this report. Note that tracked debris generally only includes pieces larger than 10 cm in size. These tests also likely created tens of thousands of pieces of small debris (less than 10 cm) that are not tracked or catalogued but pose additional threats to other spacecraft.

TABLE 5-1 – ORBITAL DEBRIS CREATED BY ASAT TESTS IN SPACE

DATE	COUNTRY	INTERCEPTOR	INTERCEPTOR TYPE	TARGET	INTERCEPT ALTITUDE	TRACKED DEBRIS	DEBRIS STILL ON ORBIT	TOTAL DEBRIS LIFESPAN
Oct. 20, 1968	Russia	Cosmos 249, Cosmos 252 (IS)	Co-orbital	Cosmos 248	–	252	71	57.4 years
Oct. 23, 1970	Russia	Cosmos 374, Cosmos 375 (IS)	Co-orbital	Cosmos 373	–	147	33	55.4 years
Feb. 25, 1971	Russia	Cosmos 397 (IS)	Co-orbital	Cosmos 394	–	117	43	55 years
Dec. 3, 1971	Russia	Cosmos 462 (IS)	Co-orbital	Cosmos 459	–	28	0	3.3 years
Dec. 17, 1976	Russia	Cosmos 886 (IS)	Co-orbital	Cosmos 880	–	127	54	49.2 years
Dec. 21, 1977	Russia	Cosmos 970 (IS)	Co-orbital	Cosmos 967	–	121	115	48.2 years
Apr. 18, 1980	Russia	Cosmos 1174 (IS-M)	Co-orbital	Cosmos 1171	–	47	4	45.9 years
Jun. 18, 1982	Russia	Cosmos 1379 (IS-M)	Co-orbital	Cosmos 1375	–	62	59	43.7 years
Sep. 13, 1985	US	ASM-135	Direct-Ascent	Solwind	530 km	285	0	18.7 years
Sep. 5, 1986	US	Delta 180 PAS	Co-orbital	Delta 2 R/B	–	18	0	< 1 year
Dec. 26, 1994	Russia	Naryad-V	Co-orbital	Unknown	–	26	22	31.2 years
Jan. 11, 2007	China	SC-19	Direct-Ascent	FY-1C	880 km	3532	2351	19.1 years
Feb. 20, 2008	US	SM-3	Direct-Ascent	USA 193	220 km	175	0	1.7 years
Mar. 27, 2019	India	PDV-MK II	Direct-Ascent	Microsat-R	300 km	130	0	3.2 years
Aug. – Dec. 2019	Russia	Cosmos 2535	Co-orbital	Cosmos 2536	–	30	16	6.5 years
Nov. 15, 2021	Russia	Nudol	Direct-Ascent	Cosmos 1408	470 km	1807	5	4.3 years
Total						6904	2773	



Countries Developing Counterspace Technologies



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06

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Australia is a relative newcomer in space, although it has long played a support role by hosting ground infrastructure for satellite communications and command and control. Recently, however, Australia has been laying the groundwork for more indigenous space capabilities, including military. It has recently started a military space organization, is building out a policy framework for its military space priorities, is putting concerted efforts and resources into building its own SSA capabilities, is examining an EW capability for its Department of Defence (DoD) and is looking into non-destructive ways in which to interfere with enemy satellites.

6.1 – AUSTRALIAN ELECTRONIC WARFARE

Australia announced in July 2021 the creation of Defence Project 9358 which is intended to explore the options for a ground-based EW counterspace capability and create recommendations on next steps.¹ In March 2023, Air Vice Marshall Cath Roberts, the head of Australia's Defence Space Command, said, "I think it's a really important part of where we go to is just looking at how we can have that sort of electronic warfare-type of capability to allow us to deter attacks or certainly interfere."² This was part of a larger conversation about the need to have non-kinetic ways to deter impacts on Australian satellites. AVM Roberts did not give a timeline for when Australia would have those EW capabilities, other than, "As soon as I can."³

In October 2023, Lt. Gen. Michael Guetlein, commander of USSF Space Systems Command, announced that Australia would be purchasing one of the US military's Counter Communications System (CCS), which is an offensive electronic warfare counterspace capability (see US Electronic Warfare, Section 1.3).⁴

Australia's DoD is expected to invest \$2.7-3.7 billion AUD over the next decade toward electronic warfare capabilities, according to the MoD's 2024 Integrated Investment Program.⁵ Also in 2024, the US Defense Innovation Unit (DIU) announced a trilateral prize challenge under AUKUS Pillar II. The trilateral prize challenge aims to acquire innovative electromagnetic spectrum (EMS) technologies, for both offensive and defensive purposes.⁶

6.2 – AUSTRALIAN SPACE SITUATIONAL AWARENESS CAPABILITIES

Australia's DoD launched a program in July 2020 called JP9360 (Space Domain Awareness) with the goal of combining six earlier SSA projects into one program.⁷ It was reported that \$2 billion AUD will be invested via this project.⁸ Air Commodore Philip Gordon, Director General Air Defence and Space, noted, "SDA is absolutely critical to space control and everything we do in space. It seeks to give us an independent ability to assess and verify what's going on in space, and at the same time contribute to a broader SDA enterprise with the US and our allies."⁹ It expects industry to first provide data as a service (DAAS) but later iterations ("tranches") hope to develop its own data capability and mission systems.¹⁰

Australia is host to several of the new sensors that contribute to the United States' SSA capacity and fill in critical geographical gaps. A C-band mechanical tracking radar originally located in Antigua was moved to Naval Communication Station Harold E. Holt near Exmouth, Western Australia (see Imagery Appendix, pg. 17-39) in March 2017.¹¹ The SST, a 3.5-meter telescope originally developed by the US Defense Advanced Research Projects Agency (DARPA), was also moved to Naval Communication Station Holt (see Imagery Appendix, pg. 17-40)

- 1 "Defence explores options for Space Electronic Warfare," Press release by the office of the Hon Peter Dutton MP, Minister of Defence, July 29, 2021, <https://www.minister.defence.gov.au/minister/peter-dutton/media-releases/defence-explores-options-space-electronic-warfare>.
- 2 Colin Clark, "Aussie Space Command looks to electronic warfare, other tech to deter attacks on satellites," *Breaking Defense*, March 2, 2023, <https://breakingdefense.com/2023/03/aussie-space-command-looks-to-electronic-warfare-other-tech-to-deter-attacks-on-satellites/>.
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- 4 Sandra Erwin, "US Space Force seeks to work closer with allies in face of shared threats," *SpaceNews* October 19, 2023, <https://spacenews.com/u-s-space-force-seeks-to-work-closer-with-allies-in-face-of-shared-threats/>.
- 5 "2024 National Defence Strategy and 2024 Integrated Investment Program," Australian Government, April 2024, <https://www.defence.gov.au/about/strategic-planning/2024-national-defence-strategy-2024-integrated-investment-program>.
- 6 "DIU Partners With AUKUS Pillar II for International Prize Challenge," US Department of Defense, March 26, 2024, <https://www.defence.gov/News/Releases/Release/Article/3718379/diu-partners-with-aukus-pillar-ii-for-international-prize-challenge/>.
- 7 Nigel Pittaway, "JP9360 to provide a sharp focus on space," *Australian Defence Magazine*, December 16, 2021, <https://www.austliandefence.com.au/defence/cyber-space/jp9360-to-provide-a-sharp-focus-on-space>.
- 8 Gregor Ferguson, "Unified space strategy update to shape defence space R&D," *The Australian*, April 8, 2022, <https://www.theaustralian.com.au/special-reports/unified-space-strategy-update-to-shape-defence-space-rd/news-story/ad45871956260afd722583d6001ddf54>.
- 9 Nigel Pittaway, "JP9360 to provide a sharp focus on space," *Australian Defence Magazine*, December 16, 2021, <https://www.austliandefence.com.au/defence/cyber-space/jp9360-to-provide-a-sharp-focus-on-space>.
- 10 Pittaway, "JP9360 to provide a sharp focus on space," *ibid*.
- 11 Steve Kotecki, "C-band Radar Reaches Full Operational Capability in Australia," Peterson Air Force Base, March 15, 2017, <https://www.peterson.af.mil/News/Article/1114478/c-band-radar-reaches-full-operational-capability-in-australia/>.

- 12 Sandra Erwin, "US Space Force Deploying Surveillance Telescope In Australia," *SpaceNews*, April 23, 2020, <https://spacenews.com/u-s-space-force-deploying-surveillance-telescope-in-australia/>; Sandra Erwin, "Space surveillance telescope developed by the US begins operations in Australia," *SpaceNews*, September 30, 2022, <https://spacenews.com/space-surveillance-telescope-developed-by-the-u-s-begins-operations-in-australia/>.
- 13 "Joint US-Australian Space Surveillance Telescope To Be Improved," *Australian Defence Magazine*, July 16, 2020, <https://www.australian-defence.com.au/defence/cyber-space/joint-us-australian-space-surveillance-telescope-to-be-improved/>; Erwin, "Space surveillance telescope developed by the US begins operations in Australia," *ibid*.
- 14 Nessa, "1SSU Launches: Australia's First Joint Space Surveillance Unit," *The Sign*, September 19, 2023, <https://www.thesign.media/blog/1s-su-launches-australias-first-joint-space-surveillance-unit>.
- 15 "Space Command shines on the Top End," Australian Defence Force, August 5, 2024, <https://www.defence.gov.au/news-events/news/2024-08-05/space-command-shines-top-end>.
- 16 "Space Command shines on the Top End," *ibid*.
- 17 Theresa Hitchens, "Australian Space Command considers 'space control' options: Senior officer," *Breaking Defense*, October 9, 2025, <https://breakingdefense.com/2025/10/australian-space-command-considers-space-control-options-senior-officer/>; "Space Command shines on the Top End," *ibid*.
- 18 "Space Machines to develop threat detection system," *Asia-Pacific Defense Reporter*, January 28, 2026, <https://asiapacificdefencereporter.com/space-machines-to-develop-threat-detection-system/>.
- 19 "Space Machines to develop threat detection systems," *ibid*.
- 20 "Space Machines to develop threat detection systems," *ibid*.
- 21 "Space Machines to develop threat detection systems," *ibid*.
- 22 "US, UK, Australia announce trilateral Deep Space Advanced Radar Capability Initiative," *United States Space Force*, December 2, 2023, <https://www.spaceforce.mil/News/Article-Display/Article/3604036/us-uk-australia-announce-trilateral-deep-space-advanced-radar-capability-initia/>.
- 23 "US, UK, Australia announce trilateral Deep Space Advanced Radar Capability Initiative," *ibid*.
- 24 Lisa Sadders, "Deep Space Advanced Radar Capability makes tremendous progress in first year," *Space Systems Command*, February 20, 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4072069/deep-space-advanced-radar-capability-makes-tremendous-progress-in-first-year/>.

to be jointly operated by the USSF's Space Delta 2 unit and the Royal Australian Air Force (RAAF).¹² It imaged its first objects in March 2020 and was declared operational in September 2022.¹³ Australia's first joint space unit, the No. 1 Space Surveillance Unit (1SSU), began operations in January 2023 and is in charge of the C-band radar and the SST.¹⁴

The Australian Defence Force (ADF)'s Space Command held Exercise Pitch Black 24 in August 2024 to strengthen its SSA capabilities.¹⁵ This was completed through partnership with the US Space Force's Joint Commercial Operations (JCO) network, which is striving to provide 24 hour space surveillance.¹⁶ This exercise consisted of the following actors: ADF, New Zealand Defence Force, Japan Air Self-Defense Force, and the Australian Bureau of Meteorology.¹⁷ Chief of Joint Capabilities Lieutenant General Susan Coyle said, "Investment in space capabilities that enhance intelligence, surveillance and reconnaissance is a top priority under our National Defence Strategy."¹⁸

In January 2026, Australia's DoD announced a \$2.9 million AUS contract with Space Machines to create a threat detection system, Space Threat Analysis and Response System (STARS).¹⁹ This 24 month-long project aims to create technology capable of ingesting data from ground-based SSA systems, along with commercial providers, in order to predict RPOs, close fly-bys, or other potential sources of interference to Australian and allies' satellites in LEO. Following the completion of this project, the Space Machines Company plans to incorporate this capability into their Solstice OS system, which Australia plans to eventually offer allies access to.²⁰ The STARS project is intended to strengthen Australian SSA capabilities, through integration into command and control systems, with the goal of streamlining spacecraft fleet operations and on-demand orbital services.²¹

Deep Space Advanced Radar Capability (DARC) Program

In December 2023, the United States announced that Australia and the United Kingdom had officially joined the Deep Space Advanced Radar Capability (DARC) program.²² DARC is an effort to develop a new set of radars to detect, track, and identify objects in deep space and consists of three geographically distributed sites that each have multiple transmit and receive radars meshed together (see US Space Situational Awareness Capabilities, Section 1.5). Australia was assigned the first operational site, "Site 1."²³ In September 2022, Northrop Grumman was awarded the contract to build Site 1 in Western Australia and began this work in October 2023; the first of twenty-seven antennas was completed in February 2024.²⁴

DARC has been having issues maintaining its set schedule. USSF's Gen. Stephen Purdy said in February 2025 that DARC might be one of the “slow” and “expensive” legacy systems that might be better replaced by commercial providers.²⁵ A June 2025 report by the US Government Accountability Office (GAO) noted that delays in the build of Site 1 because of issues in creating the site's systems integration lab were “due to the contractor's lack of expertise in building such a lab” and that seven-month delay had created follow-on delays.²⁶ For example, “the program delayed Site 2 construction by 9 months to April 2027 and deferred operational acceptance by 13 months to November 2029. Similarly, for Site 3, the program postponed both construction start and operational acceptance by 26 months, to September 2029 and January 2032, respectively.”²⁷

In August 2025, Northrop Grumman reported that Site 1's “calibrated antenna arrays operated as a single system to successfully characterize the movement of multiple satellites and demonstrate the effectiveness of the system's precision radar tracking technology” and is scheduled to be completed in 2027.²⁸ Despite delays in the sites' construction, the entire DARC system is still scheduled to be operational by 2032.²⁹

6.3 – AUSTRALIAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

In the July 2020 *Defence Strategic Update*, the Australian government identified several key issue areas it wanted to focus on in space. These include assured access to space, a satellite network to allow for independent communications, SSA capabilities (sensors and tracking), and “an enhanced space control program.” On the same day, Australia's *Force Structure Plan 2020* included a chapter on the space domain, and noted that “Continued investment and development of space capabilities will be required to further improve Defence's resilience and enhance a large number of space-dependent capabilities across the Joint Force.” In the section about space control, it calls for a focus on space domain awareness but also notes that its plans include “the development of options to enhance ADF space control through capabilities to counter emerging space threats to Australia's free use of the space domain and that assure our continued access to space-based intelligence, surveillance and reconnaissance.”

Australia's DoD was reported to have been undertaking a “space domain review” as part of its efforts to recognize space as a full operational warfighting domain. It was intended to be completed in March 2023, but as of February 2026, it is not known to have been completed.

Australia announced in May 2021 that it would be establishing an ADF space command that will be housed within the RAAF. It is intended to bring together the three branches of the Australian military with representatives of the Australian government with the goal of creating “an organisation to sustain, force-generate, operate space capabilities, and assign them to a joint operation command if needed.”³⁰ Air Marshall Mel Hupfeld, chief of the Australian Air Force, clarified that while there were concerns about space being contested, “this does not mean that defence encourages the militarisation of space,” and that “All space operations are conducted consistent with international and domestic legal obligations.”³¹ In March 2022, Air Vice-Marshal Catherine Roberts, the head of the ADF's new space command, stated, “I think the activities by China and Russia, which have been fairly well documented in the public domain, scare me... We need to accelerate the capabilities so we can deal with

25 Theresa Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *Breaking Defense*, March 11, 2025, <https://breakingdefense.com/2025/03/ssc-reviewing-expensive-legacy-programs-for-possible-commercial-shift/>.

26 “*Weapon Systems Annual Assessment: DOD Leaders Should Ensure That Newer Programs Are Structured for Speed and Innovation*,” Government Accountability Office Report GAO-25-107569, p. 158, June 2025, <https://www.gao.gov/assets/gao-25-107569.pdf>.

27 Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *ibid*.

28 Sandra Erwin, “Deep-space radar in Australia begins tracking satellites for AUKUS partners,” *SpaceNews*, August 12, 2025, <https://spacenews.com/deep-space-radar-in-australia-begins-tracking-satellites-for-aukus-partners/>.

29 Theresa Hitchens, “Northrop Grumman says first DARC test validates radar tracking capability,” *Breaking Defense*, August 15, 2025, <https://breakingdefense.com/2025/08/northrop-grumman-says-first-darc-test-validates-radar-tracking-capability/>; Erwin, “Deep-space radar in Australia begins tracking satellites for AUKUS partners,” *ibid*.

30 Malcolm Davis, “ADF space command is the right next step for Australian space power,” *ASPI The Strategist*, May 5, 2021, <https://www.aspi-strategist.org.au/adf-space-command-is-the-right-next-step-for-australian-space-power/>.

31 “Australian military to set up space division with \$7bn budget,” *Australian Associated Press*, May 19, 2021, <https://www.theguardian.com/australia-news/2021/may/19/australian-military-to-set-up-space-division-with-7bn-budget>.

- 32 Jack Norton, "Russia and China give Australia's space commander the need for speed," *ASPI The Strategist*, March 23, 2022, <https://www.aspistrategist.org.au/russia-and-china-give-australias-space-commander-the-need-for-speed/>.
- 33 Norton, March 23, 2022, *ibid*; Daniel Hurst, "Peter Dutton says space command needed as some countries 'see space as a territory for their taking,'" *The Guardian*, March 21, 2022, <https://www.theguardian.com/australia-news/2022/mar/22/peter-dutton-says-space-command-needed-as-some-countries-see-space-as-a-territory-for-their-taking>.
- 34 Colin Clark, "Dancing with the gorilla: Aussies launch space strategy," *Breaking Defense*, March 4, 2022, <https://breakingdefense.com/2022/03/dancing-with-the-gorilla-aussies-launch-space-strategy/>.
- 35 Malcom Davis, "Australia needs to aim high with space strategic update," *ASPI The Strategist*, March 11, 2022, <https://www.aspistrategist.org.au/australia-needs-to-aim-high-with-space-strategic-update/>.
- 36 Malcolm Davis, "The Australian Defence Strategic Review and space," *Australia in Space Magazine*, October 27, 2022, https://issuu.com/apsm/docs/australia_in_space_magazine_issue_4_digital/s/17159395.
- 37 Andrew Greene, "NASA boss Bill Nelson visits Canberra, amid concerns for Australian space industry's failure to launch," *Australia Broadcasting Corporation*, March 22, 2023, <https://www.abc.net.au/news/2023-03-23/nasa-boss-visits-amid-concerns-australia-lost-in-space/102132070>.
- 38 David Fawcett, "Investing in a Homegrown Australian Space Industry," Committee Speech, August 13, 2024, <https://senatorfawcett.com.au/speeches/investing-in-a-homegrown-australian-space-industry/>.
- 39 "Australian military to set up space division with \$7bn budget," *Australian Associated Press*, May 19, 2021, <https://www.theguardian.com/australia-news/2021/may/19/australian-military-to-set-up-space-division-with-7bn-budget>.
- 40 Rami Mandow, "Govt. Defence Strategy Invest \$7 Billion in Space," *Space Australia*, July 7, 2020, <https://spaceaustralia.com/news/govt-defence-strategy-invest-7-billion-space>.
- 41 Gregor Ferguson, "Australia stands up Defence Space Command, publishes Space Strategy," *EX2*, March 22, 2022, <https://www.ex2.com.au/news/australia-stands-up-defence-space-command-publishes-space-strategy/>; *Defence soars into space*, Australian Government-Department of Defense, March 23, 2022, <https://www.defence.gov.au/news-events/news/2022-03-23/defence-soars-into-space>; *Australia's Defence Space Strategy*, Australian Government-Department of Defense, March 2022.
- 42 "Space Power eManual," Defence Space Command, 2022, https://www.airforce.gov.au/sites/default/files/2022-09/213304_space_power_e_manual_v1.0a%5B1%5D.pdf.
- 43 "Space Power eManual," *ibid*.
- 44 "Space Power eManual," *ibid*.

the threats."³² The space command, officially established in March 2022 with about 100 personnel, is reported to be investigating irreversible and reversible ways in which to disable enemy satellites (via lasers or jamming) but will not use counterspace capabilities that create debris.³³

In March 2022, Australia announced the head of its space agency had begun working on a national space strategy, its "Space Strategic Update" (SSU), which was intended to guide the country's space activities and priorities to the 2040s and integrate its military, commercial, and civil space efforts.³⁴ It was intended to take 18 months to be completed.³⁵ Australia's SSU was renamed to the *National Space Policy* in 2022,³⁶ but the report has not been published as of February 2026. Australian Industry and Science Minister Ed Husic stated in March 2023 that he did not intend to "automatically" progress work on the *National Space Policy*, as the project was announced by the former Australian government.³⁷ In August 2024, Australian Senator David Fawcett noted that \$9.5 million had been committed toward the development of this report.³⁸

Australia's Department of Defence intends to invest \$7 billion AUD in space over the next decade.³⁹ This was announced in July 2020 as part of its 2020 *Defence Strategic Update and 2020 Force Structure Plan* and is planned to be used on developing space services and emerging space technologies.⁴⁰

Also in March 2022, Australia released its *Defence Space Strategy*, reaffirming its \$7 billion AUD planned to be spent on space capabilities by 2036. The strategy declared that the mission of the Australian military forces in space was to shape the space domain, deter competitor actions, and respond as necessary to assure access to space capabilities. The document lists five "lines of effort" to meet that vision:

- "Enhance space capability to assure Joint Force access in a congested, contested and competitive space environment;
- "Deliver military effects integrated across Whole of Government and with allies and partners in support of Australia's national security;
- "Increase the national understanding of the criticality of space;
- "Advance Australian sovereign space capability to support the development of a sustainable national space enterprise; and
- "Evolve the Defence Space Enterprise to ensure a coherent, efficient and effective use of the space domain."⁴¹

The strategy also discussed Department of Defence's role in continuing to "identify Space Control gaps and opportunities to develop a credible Space Control capability, and space capability developers will actively seek to improve resilience of the space capabilities," noting as well, "Defence will explore options consistent with its commitment to be a responsible actor in space."

In March 2022, Australia's Defence Space Command released a *Space Power eManual*.⁴² It describes itself as "the foundational Defence reference on the employment of space power, complementing and supporting all levels of Defence education and doctrine," and space power is further defined as "the total strength of a nation's ability to conduct and influence activities to, in, through and from space to achieve its objectives."⁴³ Space control is described as involving "offensive and defensive operations to ensure freedom of action in space by defeating efforts to interfere with or attack Australian or allied space systems and, when directed, deny space services to a competitor," and that those activities may happen in any operating domain, and is made up of "offensive space control, defensive space control, space electronic warfare and the aspects of navigation warfare that deal with space based PNT."⁴⁴

In October 2022, Australia formally pledged not to conduct destructive DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.⁴⁵

In April 2023, Australia released the public version of its *Defence Strategic Review* (DSR), which is a periodic assessment of defense capabilities and status that has only been done twice previously (in 1986 and 2012).⁴⁶ The review was prompted by recent changes in the strategic environment, largely driven by the continued rise of China, and political dissatisfaction with how previous Australian defense policy addressed emerging challenges. This 2023 review included significant attention to space as a new domain of operations and recommended moving space into the Joint Capabilities Group (JCG), creating a centralized development and management function for space, and building a career path for space professionals.⁴⁷ The Australian Department of Defence manages the JCG, along with components of their work including cyber operations and satellite communications.⁴⁸

The Australian Department of Defence revealed multiple initiatives in July 2023, focused on increasing their space defense capabilities and lining up with key components of the 2023 DSR.⁴⁹ One of these included the Defence Space Command's transfer to the RAAF, along with the creation of the ADF's first joint space unit.⁵⁰ According to Lieutenant General John Frewen, Chief of Joint Capabilities, the DSR focused on the importance of better coordination between space, cyber, and information warfare.⁵¹

Australia's Department of Defence intends to invest in AUD \$9-12 billion in space over the next decade.⁵² This was announced in April 2024 as part of its *2024 Defence Integrated Investment Plan*, which was jointly released with the *2024 National Defence Strategy*. The 2024 Integrated Investment Program is expected to focus on resilient communications, surveillance, reconnaissance, and space domain awareness.⁵³ The Australian DoD is currently updating their *2024 National Defence Strategy*, aiming to publish this update sometime in 2026.⁵⁴ Australian officials in October 2025 spoke about their interest in developing space control capabilities, citing their space operations framework, concept SELENE.⁵⁵ While that concept is not available online, Australian military writing has discussed it, including stating what is described to be its core tenant, "The ADF will seek space advantage to enable freedom of action by temporally assuring access and disrupting or denying an adversary use of the space domain, as required."⁵⁶

Australia participated in US Space Command's exercise Global Sentinel 2025 in April 2025 (See US Counterspace Policy, Doctrine, and Organization, Section 1.6).⁵⁷ This event included nearly 30 partner nations, including NATO, aiming to strengthen international partnerships, collaboration, and responsible space behaviors.⁵⁸ The Global Sentinel used a dedicated Global sentinel version of Space-Track.org for capstone modeling and simulation, replicating the actual platform.⁵⁹

In May 2025, former Australian Prime Minister Scott Morrison called for a third pillar of AUKUS cooperation to include the development of satellites and other space technology as a counter to Chinese and Russian counterspace capabilities, emphasizing the need to "recognize and elevate the strategic importance of the space domain to address the shared security objectives of AUKUS partners."⁶⁰

In February 2026, the ADF announced the creation of two space-oriented roles within the organization: "Space Operations Operations Officer" and a

45 "Australia advances responsible action in space," Australia Ministry for Foreign Affairs, October 22, 2022, <https://www.foreignminister.gov.au/minister/penny-wong/media-release/australia-advances-responsible-action-space>.

46 Lam Tran, "Unpacking Australia's 2023 Defence Strategic Review," *Center for Strategic and International Studies*, September 11, 2023, <https://www.csis.org/blogs/new-perspectives-asia/unpacking-australias-2023-defence-strategic-review>.

47 National Defence Strategic Review, *Australian Government*, April, 2023, <https://www.contactairlandandsea.com/wp-content/uploads/2023/04/NationalDefence-DefenceStrategicReview.pdf>.

48 Nessa, "1SSU Launches: Australia's First Joint Space Surveillance Unit," *The Sign*, September 19, 2023, <https://www.thesign.media/blog/1ssu-launches-australias-first-joint-space-surveillance-unit>.

49 Nessa, "1SSU Launches: Australia's First Joint Space Surveillance Unit," *ibid*.

50 Nessa, "1SSU Launches: Australia's First Joint Space Surveillance Unit," *ibid*.

51 Nessa, "1SSU Launches: Australia's First Joint Space Surveillance Unit," *ibid*.

52 "Australian military to set up space division with \$7bn budget," *Australian Associated Press*, May 19, 2021, <https://www.theguardian.com/australia-news/2021/may/19/australian-military-to-set-up-space-division-with-7bn-budget>.

53 "2024 National Defence Strategy and 2024 Integrated Investment Program," *Australian Government*, April 2024, <https://www.defence.gov.au/about/strategic-planning/2024-national-defence-strategy-2024-integrated-investment-program>.

54 Theresa Hitchens, "Australian Space Command considers 'space control' options: Senior officer," *Breaking Defense*, October 9, 2025, <https://breakingdefense.com/2025/10/australian-space-command-considers-space-control-options-senior-officer/>. It should be noted that the 2024 National Defence Strategy has been taken off-line as it is being updated.

55 Hitchens, "Australian Space Command considers 'space control' options," *ibid*.

56 Lt. Baldwin, "Cert Cito Ex Astris: Workforce," *The Cove*, July 8, 2025, <https://cove.army.gov.au/article/cert-cito-ex-astris-workforce>.

57 LaDonna Davis, "US Space Command hosts Global Sentinel 2025 exercise," *United States Space Force*, May 6, 2025, <https://www.space-force.mil/news/article-display/article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.

58 Davis, "US Space Command hosts Global Sentinel 2025 exercise," *ibid*.

59 Davis, "US Space Command hosts Global Sentinel 2025 exercise," *ibid*.

60 James Massola, "Trump's 'golden dome' a golden opportunity for AUKUS in space, says Morrison," *The Sydney Morning Herald*, May 27, 2025, <https://www.smh.com.au/politics/federal/morrison-calls-for-aukus-space-pillar-to-combat-china-russia-rise-20250527-p5m2hc.html>.

- 61 Nathan Schmidt, "New Frontier": ADF hiring space roles amid strategic challenges," *News.com.au*, February 9, 2026, <https://www.news.com.au/technology/science/space/new-frontier-adf-hiring-space-roles-amid-strategic-challenges/news-story/0146429ee-1905154a403dd19cf5290df>.
- 62 Schmidt, "New Frontier": ADF hiring space roles amid strategic challenges," *ibid*.

"Space Operations Specialist."⁶¹ According to Australian Defence Personnel Minister Matt Keogh, this was to "grow the ADF's capabilities in space operations" and is a step s in building "Australians sovereign space workforce," which will eventually include positions focusing on missile warning, space control, and space surveillance.⁶²

Potential Military Utility /

Australia has made significant policy changes aimed at developing more of a national security space capability and dealing with space threats. Between creating a project to develop a ground-based EW counterspace capability and statements from Australian military officials about the importance of Australia developing that capability, it is likely that Australia will have at least an initial EW counterspace capability in the near future. Furthermore, given the amount of policy documents being generated for defense space purposes, it would appear that Australia is serious about having the option to use its nascent EW counterspace capability, so it is most likely going to be operational in some capacity. Additionally, given the investment in its SSA capabilities and physical possession of some SSA radars already, should Australia decide to target space assets for offensive measures, it is likely to have at least some inherent capacity to do so.

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07

FRANCE

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While France has long had a civil space program, as well as military satellites, it was not until recently that France had an explicit focus on offensive and defensive counterspace activities. The major change occurred in July 2019 with the release of the first French Space Defense Strategy, which elevated French military space efforts and control of French military satellites. While some French officials initially suggested machine guns on satellites, the actual plan calls for ground-based lasers for dazzling and satellites equipped for on-orbit inspections and also with lasers used for what has been described as self-defense, but could suggest the potential for enabling counterspace capability. Subsequently, new demonstration assets are slated for deployment, including “patrol-guard” satellites and in-orbit lasers. Since 2021, France has carried out annual military exercises, codenamed “ASTERX,” in outer space, testing the capabilities of its Space Command, as part of France’s evolving goal to be the world’s third-largest spatial power.¹ France and the United States conducted two RPO engagements in 2025.

7.1 – FRENCH CO-ORBITAL ASATs

In July 2019, when announcing France’s interest in developing active counterspace capabilities, French Minister of Defense Florence Parly reportedly offered the option of including machine guns on satellites that would theoretically target enemy satellites’ solar panels. This was part of a larger discussion about how “our allies and adversaries are militarising space...we need to act.”³ However, in private discussions with French officials, this was clarified as having been a poorly-used metaphor. Orbital mechanics severely limits the utility of projectile weapons in orbit. In the context of Operation ARES (Action et Résilience Spatiale), France has started the development of demonstration assets in GEO and LEO, to prepare the deployment of the Engin géodérivant d’intervention et de découragement (Geosynchronous Drift Intervention and Deterrence Vehicle, EGIDE) program to produce operational patrol satellites.⁴ To support this initiative, new demonstration assets are planned to be deployed, including the programming of patrol-guard satellites (Yeux en Orbite pour un Démonstrateur Agile, or YODA) and in-orbit lasers (FLAMHE project).⁵ These experiments will be complemented by the TOUTATIS (In-Orbit Test of Action Techniques against Attempted Spatial Interference) program that aims to implement a comprehensive chain of knowledge and response to attempted space interference.⁶ These YODA satellites are intended to be launched to GEO in 2026 or 2027, provided a launch slot is found, and are intended to be an RPO surveillance or inspection platform, similar to the United States’ GSSAP program (see US Co-Orbital ASAT, Section 1.1).⁷ The YODA program is also framed as an early technology demonstrator program of later and bigger versions of inspector satellites that would be able to protect French military satellites by 2030.⁸ In parallel with this program, the use of in-orbit laser technologies (FLAMHE project) is being considered as non-kinetic means to neutralize unfriendly satellites without creating any debris.⁹

- 1 “« AsterX 2024 » : nouvelle édition de l'exercice spatial militaire français,” Armée de l’Air et de l’Espace, March 4, 2024, <https://www.defense.gouv.fr/air/actualites/asterx-2024-nouvelle-edition-lexercice-spatial-militaire-francais>.
- 2 Adam Plowright and Daphne Benoit, “France to develop anti-satellite laser weapons: minister,” *Phys.org*, July 25, 2019, <https://phys.org/news/2019-07-france-unveil-space-defence-strategy.html>.
- 3 Plowright and Benoit, “France to develop anti-satellite laser weapons: minister,” *ibid*.
- 4 Andrew Parsonson, “DGA Selects Infinite Orbits for €50M PALADIN Satellite-Inspection Service,” *European Spaceflight*, August 12, 2025, <https://europeanspaceflight.com/dga-selects-infinite-orbits-for-e50m-paladin-satellite-inspection-service/>.
- 5 *LPM 2024-2030 Les grandes orientations*, Ministère des Armées, Délégation à l’information et à la communication de la Défense, April 2023.
- 6 Spatial : l’Agence de l’innovation de défense notifie à U-Space la réalisation d’une démonstration d’actions en orbite basse au profit du Commandement de l’espace, *Agence de l’innovation de défense*, September 16, 2024, <https://www.defense.gouv.fr/aid/actualites/spatial-l'agence-l'innovation-defense-notifie-u-space-realisation-d'une-demonstration-d'actions-orbite>.
- 7 “France’s Space Commander shares lessons learned from Ukraine and future plans,” *Satellite Observation*, February 6, 2023, <https://satelliteobservation.net/2023/02/06/frances-space-commander-shares-lessons-learned-from-ukraine-and-future-plans/>; *Projet annuel de performances, Annexe au projet de loi de finances pour 2025*, Budget général - Mission ministérielle, Défense, 2025, p. 148; Rudy Ruitenberg, “France plans low-orbit demonstrator that can target other satellites,” *DefenseNews.com*, September 17, 2024, <https://www.defensenews.com/global/europe/2024/09/17/france-plans-low-orbit-demonstrator-that-can-target-other-satellites/>.
- 8 Comité Rochefort, “The ‘Non-Identical’ Twins of European Military Space (Part 1),” *Defense-Aerospace.com*, April 20, 2022, <https://www.defense-aerospace.com/europes-non-identical-military-space-twins-1/>.
- 9 *Avis no. 527 de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2025 (n°324)*, Tome VI, Défense, Préparation et emploi des forces : Air, October 30, 2024.

10 Photograph taken by Victoria Samson, October 17, 2024, at the International Astronautical Congress in Milan, Italy.

11 "Il y a cinq ans, la France lançait son Commandement de l'espace," *Ministère des Armées*, November 21, 2024, <https://www.defense.gouv.fr/actualites/il-y-cinq-ans-france-lancait-son-commandement-lespace>.

12 *Spatial : l'Agence de l'innovation de défense notifie à U-Space la réalisation d'une démonstration d'actions en orbite basse au profit du Commandement de l'espace*, Agence de l'innovation de défense, September 16, 2024, <https://www.defense.gouv.fr/aid/actualites/spatial-l'agence-l'innovation-defense-notifie-u-space-realisation-dune-demonstration-dactions-orbite>.

13 *Spatial : l'Agence de l'innovation de défense notifie à U-Space la réalisation d'une démonstration d'actions en orbite basse au profit du Commandement de l'espace*, *ibid*.

14 *Avis no. 527 de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2025 (n°324)*, Tome VI, Défense, Préparation et emploi des forces : Air, October 30, 2024; Robert Wall, "MaiaSpace To Launch French Toutatis Space Defense Demo," *Aviation Week & Space Technology*, November 28, 2025, <https://aviationweek.com/space/launch-vehicules-propulsion/maiaspace-launch-french-toutatis-space-defense-demo>.

15 Theresa Hitchens, "France announces almost \$5B in new military space funding," *Breaking Defense*, November 13, 2025, <https://breaking-defense.com/2025/11/france-announces-almost-5b-in-new-military-space-funding/>.

16 "France's Defence Innovation Agency launches Salazar project to study space object interception," *Defense Industry Europe*, November 20, 2024, <https://defence-industry.eu/frances-defence-innovation-agency-launches-salazar-project-to-study-space-object-interception/>.

17 Andrew Parsonson, "Orbital Defense Company Dark Completes Hot Fire Test Campaign," *European Spaceflight LTD*, "European Spaceflight," July 8, 2024, <https://europeanspaceflight.com/orbital-defense-company-dark-completes-hot-fire-test-campaign/>.

FIGURE 7-1 — FULL-SIZE MODEL OF YODA (2024)



Image credit: Victoria Samson¹⁰

In September 2024, French Space Command leader Major General Philippe Adam, and company executives from U-SPACE and MBDA kicked off a demonstration program aiming to provide France with active space defense capabilities.¹¹ This will start with TOUTATIS, a LEO demonstration, that aims to complement the experiments that will be carried out in geostationary orbit by the YODA satellites. As the first building block of the ARES operation, led by the French Procurement agency (Direction générale de l'armement), the TOUTATIS experiment involves two demonstration nanosatellites.¹² SPLINTER, a "low-orbit action" satellite, will have a high maneuvering capability and a set of subsystems enabling autonomous approach and actions. LISA-1, a "spotter" satellite, will be deployed to provide enhanced observation capabilities for space surveillance from orbit.¹³ Carried out by U-SPACE, in partnership with MBDA, the TOUTATIS experiment is intended to start in 2026.¹⁴

While announcing a major increase in French military space spending, President Emmanuel Macron said in November 2025, "[W]e will deploy our first patrol satellites... starting in 2027 to monitor, inspect, and, if necessary, counter threats in orbit. These will be complemented by our first space-based action capabilities based on lasers and jammers."¹⁵

The French Defense Innovation Agency is launching a preliminary study named "Salazar" to simulate the capture of dangerous space objects in LEO using a set of numerical models and missions. In November 2024, this study was awarded to the French start-up Dark to prove the feasibility of using a multi-stage space access system, capable of rapidly reaching a specific point in orbit, while bypassing meteorological constraints and certain types of orbital transfer. Its final stage is equipped with a robotic module dedicated to target capture.¹⁶ Founded in 2021, Dark developed an interceptor system and announced in July 2024 the completion of the first test campaign of its Sheitan rocket engine that would power its Interceptor vehicle, before a first demonstration of orbital defence capabilities by 2026.¹⁷ As part of the Salazar preliminary study, the Defense Innovation Agency was going to supply to Dark a fictitious target equipped with evasion or warning systems, which in turn would present several

possible scenarios. During the simulation, Dark was supposed to propose the best interception scenario, based on a target's orbital parameters, taking into account mission strategy, performance and timing.¹⁸ However, in October 2025, Dark closed; it is unclear as to who will continue the Salazar study.¹⁹

French interest in possessing their own spaceplane has grown in recent years.²⁰ Figures like French MP Bastien Lachaud stated that, "France cannot afford to fall behind in this field, at the risk of having to buy an off-the-shelf solution or fraying technological relegation."²¹ Additionally, Major General Philippe Koffi, DGA's Air, Land, and Naval Combat Lead, stated, "A spaceplane is maneuverable, reusable and flexible, so it can deliver payload in orbit, recover critical assets, conduct reconnaissance and intervene against threats in orbit... (spaceplanes) could deploy satellites, sensors, and even weapons in orbit within hours or days and not months...(and offer) rapid transportation, spacecraft servicing, and even recovery of critical assets."²² In May 2025, French company AndroMach received a Centre national d'études spatiales (CNES) contract to test Banger v1 rocket engines, emphasizing the importance of testing the propane-fueled engine, evaluating its thermodynamic performance, which could contribute to eventual French spaceplane technology.²³ The following June, a contract between DGA and Dassault Aviation was announced to develop Véhicule Orbital Réutilisable de Transport et d'Exploration (Reusable Orbital Transport and Exploration Vehicle, VORTEX), a spaceplane demonstrator.²⁴ VORTEX is scheduled to be launched on a small rocket in 2028, aiming to validate key technologies and perform atmospheric reentry.²⁵

France and the United States held their first bilateral RPO engagement in April 2025, which involved a US and a French military satellite approaching each other near a "strategic competitors" spacecraft; it is unclear which country that spacecraft belonged to.²⁶ In September 2025, a USSF official said that France and the United States would be engaging in a second RPO mission.²⁷ This ended up happening as part of Operation Olympic Defender in November 2025.²⁸ While both countries acknowledged the maneuvers, they did not provide specifics. However, US commercial SSA company COMSPOC monitored the RPOs and identified the participating satellites as USA 324 (2022-006A, 51280, part of the United States' GSSAP program) and France's SYRACUSE 3A (2005-041B, 28885); there were three sets of maneuvers observed (November 11-14, November 22-23, and November 28-29), and, according to a COMSPOC spokesperson, "In all these movements, SYRACUSE 3A seems to lead and USA 324 seems to follow as the maneuvers performed by USA 324 is lagged by a day."²⁹ The closest the two satellites got to each other was just a little over 25 km.³⁰

7.2 – FRENCH DIRECT-ASCENT ASATs

There are no known plans for France to have a DA-ASAT capability. France does have a jointly fielded missile defense system with Italy called Surface-to-Air Missile Platform/Terrain (SAMP/T); however, its interception altitude is at best 120 km and is thus not of much military utility as an ASAT weapon.³¹ France maintains significant expertise in space launch vehicle and ballistic missile technology that could be the basis for a future DA-ASAT program.

7.3 – FRENCH ELECTRONIC WARFARE

While France has terrestrial-based EW capabilities, there are scant details available in the public domain and it is unclear how effective or operational

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19 Rachel Jewett, "French Space Defense Startup Dark Shuttles Operations," *Via Satellite*, October 9, 2025, <https://www.satellitetoday.com/finance/2025/10/09/french-space-defense-startup-dark-shuttles-operations/>.

20 Clement Charpentreau, "Dassault CEO warns France risks falling behind in military spaceplane race," *AeroTime*, April 15, 2025, <https://www.aerotime.aero/articles/france-space-plane-gap-trappier-warning>.

21 Charpentreau, "Dassault CEO warns France risks falling behind in military spaceplane race," *ibid*.

22 Debra Werner, "Does Europe need a spaceplane?" *SpaceNews*, September 17, 2025, <https://spacenews.com/does-europe-need-a-spaceplane/>.

23 Stephen Clark, "Rocket Report: SpaceX's expansion at Vandenberg; India's PSLV fails in flight," *Ars Technica*, May 23, 2025, <https://arstechnica.com/space/2025/05/rocket-report-spacexs-expansion-at-vandenberg-indias-pslv-fails-in-flight/>.

24 Debra Werner, "Does Europe need a spaceplane?" *SpaceNews*, September 17, 2025, <https://spacenews.com/does-europe-need-a-spaceplane/>.

25 Werner, "Does Europe need a spaceplane?" *ibid*.

26 Sandra Erwin, "US Space Command chief calls for new capabilities for combat while emphasizing deterrence," *SpaceNews*, April 8, 2025, <https://spacenews.com/u-s-space-command-chief-calls-for-new-capabilities-for-combat-while-emphasizing-deterrence>.

27 Joey Roulette and Cassell Bryan-Low, "US, France step up joint military satellite moves to counter China in Space," *Reuters*, September 30, 2025, <https://www.reuters.com/business/aero-space-defense/us-france-step-up-joint-spy-satellite-moves-counter-china-space-2025-09-30/>.

28 Theresa Hitchens, "France, US practices up-close satellite maneuvers under joint space war plan," *Breaking Defense*, December 15, 2025, <https://breakingdefense.com/2025/12/france-us-military-space-satellites-operation-olympic-defender/>.

29 Hitchens, "France, US practices up-close satellite maneuvers under joint space war plan," *ibid*.

30 Hitchens, "France, US practices up-close satellite maneuvers under joint space war plan," *ibid*.

31 "SAMP/T Air Defense System (France & Italy)," *Missile Defense Advocacy Alliance*, <https://missiledefenseadvocacy.org/defense-systems/sampt-air-defense-system/>.

- 32 AzurX, "Middle East Space Roundup: 23 to 29 July, 2023," *Middle East Space Monitor*, <https://mideastspace.substack.com/p/middle-east-space-roundup-23-to-29-18b>.
- 33 Candice Clark, "ANFR Fighting against jammers," *Resilient Navigation and Timing Foundation*, July 18, 2023, <https://rntfnd.org/2023/07/21/lots-of-jammers-near-french-airport/>.
- 34 *Commission de la défense nationale et des forces armées*, Audition du général d'armée aérienne Jérôme Bellanger, chef d'état-major de l'armée de l'Air et de l'Espace, sur le projet de loi de finances 2025, Compte rendu no. 8, October 16, 2024.
- 35 Adam Plowright and Daphne Benoit, "France to develop anti-satellite laser weapons: minister," *Phys.org*, July 25, 2019, <https://phys.org/news/2019-07-france-unveil-space-defence-strategy.html>.
- 36 Theresa Hitchens, "Space Lasers for Satellite Defense Top New French Space Strategy," *Breaking Defense*, July 26, 2019, <https://breakingdefense.com/2019/07/france-envisions-on-orbit-lasers-for-satellite-defense/>.
- 37 Taylor Mahlandt, "France is Getting Serious About Its 'Space Command,'" *SpaceWatchGlobal*, August 1, 2019, <https://spacewatch.global/2019/09/cnes-supports-french-armed-forces-in-implementing-military-space-strategy/>.
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- 40 *Rapport no. 1234 fait au nom de la Commission de la Défense Nationale et des Forces Armées sur le Projet de Loi (no. 1033) relatif à la programmation militaire pour les années 2024 à 2030 et portant diverses dispositions intéressant la Défense*, May 12, 2023, page 61 https://www.assemblee-nationale.fr/dyn/17/rapports/cion_def/17b0527-tvi_rapport-avis.
- 41 Julien Lausson, "Le laser, future arme de la France pour neutraliser les satellites adverses?," *Numerama*, June 11, 2019, <https://www.numerama.com/politique/525203-le-laser-future-arme-de-la-france-pour-neutraliser-les-satellites-adverses.html>.
- 42 *Commission de la défense nationale et des forces armées*, Audition du général d'armée aérienne Jérôme Bellanger, chef d'état-major de l'armée de l'Air et de l'Espace, sur le projet de loi de finances 2025, Compte rendu no. 8, October 16, 2024.
- 43 Nathan Gain, "From Nostradamus to the SAMP/T NG, mastery of very high altitude will also be achieved from the ground," *Forces Operations Bloc*, June 25, 2025, <https://www.forcesoperations.com/de-nostradamus-au-samp-t-ng-la-maitrise-de-la-tres-haute-altitude-sarticulera-aussi-depuis-la-terre-ferme/>; "French DGA orders SYDERAL high-power laser demonstrator for anti-drone warfare," *Naval News*, September 4, 2025, <https://www.navalnews.com/naval-news/2025/09/french-dga-orders-syderal-high-power-laser-demonstrator-for-anti-drone-warfare/>.

they are against space capabilities. French officials have also expressed their willingness to share technology on counterspace EW capabilities with Saudi Arabia, but there has been no public concrete action announced in this area.³²

French authorities have also discovered multiple Global Navigation Satellite System (GNSS) jammers operating near the Merville airport in March 2023, operated by unknown entities.³³ During his hearing on the 2025 Finance Bill, Air Force General Jérôme Bellanger declared that France is "continuing to study jamming" technologies.³⁴

7.4 – FRENCH DIRECTED ENERGY WEAPONS

In July 2019, French Minister of Defense Florence Parly indicated the potential for placing lasers on satellites with the goal of protecting them from attack, saying, "If our satellites are threatened, we intend to blind those of our adversaries... We reserve the right and the means to be able to respond: that could imply the use of powerful lasers deployed from our satellites or from patrolling nano-satellites."³⁵ These lasers would "dazzle those who would be tempted to approach too close."³⁶ At the time of her statement, the plan was to have the first capabilities ready by 2025 with the completion being achieved by 2030, yet this timeline no longer appears to be accurate.³⁷ Further information about these efforts was revealed in April 2023 as part of the French military programming law for 2024-2030. One of the initiatives is BLOOMLASE, a program to develop ground-based lasers used from the ground to dazzle an observation satellite.³⁸ Another initiative is FLAMHE, a project aiming to develop space-based capabilities to neutralise in-orbit satellites using directed energy weapons. The technology is currently being developed by companies, including ArianeGroup, and is intended to eventually provide France with an operational capability.³⁹ The French Navy's Chief of Staff stated in front of the French National Assembly that "lasers can also be used as a space warfare weapon operated from boats: they can blind observation satellites to ensure the concealment of naval forces in conflict situations."⁴⁰ France has also conducted tests of the effectiveness of existing ground-based lasers against their Spot remote sensing satellites in LEO.⁴¹ When addressing the Commission de la Défense nationale et des Forces Armées (National Defence and Armed Forces Committee) on the 2025 Finance Bill, Air Force General Jérôme Bellanger, Chief of Staff of the Armée de l'air et de l'espace (French Air and Space Force), stated that France is studying directed-energy laser technologies.⁴² The French Defence Procurement Agency (DGA) is reported to be working on ground-based lasers as part of its anti-drone and area defense laser program, Syderal (Système Laser de Défense de Nouvelle Génération or New Generation Laser Defence System); this system is planned to result in a 50kW laser by 2030 that could be used against satellites as well.⁴³

It is unclear whether these are meant to be destructive laser weapons or those used as countermeasures against the targeting systems of an attacker. A nanosatellite is very unlikely to have sufficient on-board power to generate a destructive laser, although it may be possible to have lower power directed energy systems that could be used to blind, dazzle, or confuse electro-optical targeting systems of approaching co-orbital ASATs or inspection satellites. These systems could operate in a similar manner to the directional infrared countermeasures systems mounted on some modern aircraft to confuse or jam infrared seekers on anti-aircraft missiles. However, successfully aiming such a laser at an approaching satellite or interceptor is a non-trivial challenge.

7.5 – FRENCH SPACE SITUATIONAL AWARENESS CAPABILITIES

France's Space Command (CDE) is charged with coordinating SSA for the country as a whole. It operates the Grand Réseau Adapté à la Veille Spatiale (Large Network Adapted for Space Surveillance, GRAVES) radar (see Imagery Appendix, p. 17-53 and p. 17-54), which can see objects with radar cross sections, initially down to 1 meter at an altitude of 400-1000 km.⁴⁴ Following two major upgrades, the GRAVES radar monitors objects in low Earth orbit, from 200 to 2000 km from three sites in France: the transmission center near Dijon, the reception center near Orange, and the operations center, which opened in Toulouse in June 2024. The system can detect and determine the orbits of satellites crossing its coverage zone 24/7.⁴⁵ France also has three Système d'Acquisition et de Trajectographie des Avions et des Munitions (SAT-AM) C-band radars that are not primarily SSA sensors but do have a secondary mission to track space debris.⁴⁶ Another asset which contributes to French SSA capabilities (but does so in the capacity of it being its secondary mission) is the Bâtiment d'Essais et de Mesures (BEM) Monge tracking ship.⁴⁷ France also has the Système Probatoire d'Observation du Ciel (Experimental Earth Observation System, SPOC) telescope, which can do initial orbit determinations, and the Télescope à Action Rapide pour les Objets Transitoires (TAROT) system of two 25-centimeter telescopes located at the Calern Observatory (see Imagery Appendix, pg 17-55) and an 18 cm telescope at the Les Makes Observatory, which, along with the Radiometry for Ocean colour Satellites Calibration and Community Engagement (ROSACE) telescope, can track objects at GEO.⁴⁸ All of these capabilities contribute to France's Centre Opérationnel de Surveillance Militaire des Objets Spatiaux (COSMOS), its Operational Center for Military Surveillance of Space Objects.⁴⁹ COSMOS operators visited the US 18th Space Defense Squadron, which is charged with running the USSF's space situational awareness mission, in October 2022 as part of an exchange to improve SSA data sharing and operational best practices.⁵⁰

France participates in and hosts NATO's Space Centre of Excellence, which was created in July 2023 and reached full operational status in January 2026.⁵¹ According to NATO, the Centre - which is based in Toulouse - "develops space operations concepts, strengthens staff readiness, supports major exercises, and feeds operational lessons back into NATO's adaptation cycle."⁵²

In her July 2019 announcement about France's interest in counterspace capabilities, French Minister of Defense Florence Parly noted that while France has some existing SSA capabilities, it wished to work with other European Union countries on shoring those up. She specifically said, "France has her independence and is attached to it. But she does not want to be isolated in this new zone of conflicts...I am counting particularly on Germany to become the beating heart of surveillance in space."⁵³ The Franco-German Space and Defence Council in 2017 approved a joint SSA project, which is hoped to be able to provide clarifying information about unfriendly or hostile actions in space.⁵⁴ Minister Parly also said that they plan to use Ariane Group's Geotracker network in order to capture pictures of objects in GEO.⁵⁵

During discussions in the Commission de la Défense Nationale et des Forces Armées (National Defence and Armed Forces Committee) on the Draft Budget Bill for 2025, it was pointed out that the law's priority is to develop the successor to the GRAVES space surveillance radar, with a view to its entry into service as of 2030. A single GRAVES-Next Generation space surveillance radar has been included in the programming law, but has not yet been developed.⁵⁶

Another capability currently discussed is onboard cameras for future Syracuse

44 Andrea Console, "Command and Control of a Multinational Space Surveillance and Tracking Network," NATO Joint Air Power Competence Centre, June 2019, p. 33, https://www.japcc.org/wp-content/uploads/JAPCC_C2SST_2019_screen.pdf.

45 "Les données GRAVES sont désormais exploitées depuis Toulouse!," Commandement de l'Espace, Ministère des Armées, June 24, 2024, <https://www.defense.gouv.fr/cde/actualites/donnees-graves-sont-desormais-exploitees-toulouse>.

46 "Les données GRAVES sont désormais exploitées depuis Toulouse!," *ibid*.

47 "Les données GRAVES sont désormais exploitées depuis Toulouse!," *ibid*, p. 34.

48 Michael Boer, Alain Klotz, Romain Laugier, Pascal Richard, Juan-Carlos Dolado Perez, Laurent Lappasset, Agnes Verzeni, Sebastien Theron, David Coward, and J.A. Kennewell, "TAROT: A network for space surveillance and tracking operations," *ESA Space Debris Office*, proceedings of the 78th European Conference on Space Debris, Darmstadt Germany, April 18-21, 2017, June 2017, <https://conference.sdo.esoc.esa.int/proceedings/sdc7/paper/382/SDC7-paper382.pdf>.

49 Andrea Console, "Command and Control of a Multinational Space Surveillance and Tracking Network," NATO Joint Air Power Competence Centre, June 2019, p. 33, https://www.japcc.org/wp-content/uploads/JAPCC_C2SST_2019_screen.pdf, p. 33.

50 Luke Kitterman, "18 SDS, France's COSMOS integrate SDA knowledge during 'Operator Exchange'," *Combined Force Space Component Command Public Affairs*, October 24, 2022, <https://www.spoc.spaceforce.mil/News/Article-Display/Article/3197664/18-sds-frances-cosmos-integrate-sda-knowledge-during-operator-exchange>.

51 "Lift-off, NATO Launches New Space Centre of Excellence," NATO, July 17, 2023, <https://www.act.nato.int/article/space-newest-coe/>; "NATO Space Centre of Excellence Reaches Full Operational Capability, Reinforcing Alliance Readiness in the Space Domain," NATO, January 26, 2026, <https://www.act.nato.int/article/space-coe-reinforces-nato-readiness/>.

52 "NATO Space Centre of Excellence Reaches Full Operational Capability," *ibid*.

53 Adam Plowright and Daphne Benoit, "France to develop anti-satellite laser weapons: minister," *Phys.org*, July 25, 2019, <https://phys.org/news/2019-07-france-unveil-space-defence-strategy.html>.

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55 Theresa Hitchens, "Space Lasers for Satellite Defense Top New French Space Strategy," *Breaking Defense*, July 26, 2019, <https://breakingdefense.com/2019/07/france-envisions-on-orbit-lasers-for-satellite-defense/>.

56 Avis no. 527 de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2025 (n°324), Tome VI, Défense, Préparation et emploi des forces : Air, October 30, 2024.

- 57 Arthur Laudrain, "France's 'strategic autonomy' takes to space," *IJSS Military Balance Blog*, August 14, 2019, <https://www.ijss.org/blogs/military-balance/2019/08/france-space-strategy>.
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- 62 "New EU SST Service Portfolio now available," EU SST, September 30, 2024, <https://www.eusst.eu/newsroom/new-eu-sst-service-portfolio-now-available/>.
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- 65 Theresa Hitchens, "European Defense Fund invests in 'Bodyguard' satellite development to 'counteract' orbital threats," *Breaking Defense*, May 30, 2024, <https://breakingdefense.com/2024/05/european-defense-fund-invests-in-bodyguard-satellite-development-to-counteract-orbital-threats/>.
- 66 "Celestia TTI takes big steps forward on the NAUCRATES project," *Celestia TTI*, April 9, 2024, <https://www.ttinorte.es/celestia-tti-takes-big-steps-forward-on-the-naucrates-project/>.
- 67 Rachel Jewett, "Arianespace consortium to lead French space situational awareness project," *Satellite Today*, April 24, 2023, <https://www.satellitetoday.com/government-military/2023/04/24/arianegroup-consortium-to-lead-french-space-situational-awareness-project/>.

military communications satellites, which could alert satellites to oncoming threats so that the satellites can take defensive actions or maneuvers.⁵⁷ A strategy of maintaining competitiveness and autonomy internationally in the SSA domain is also being pursued by the European Union Space Surveillance and Tracking (EU SST), of which France is a prominent member. The EU SST increased the budget contracted to European Industry in R&D and capabilities by 205 percent in 2020-2022 compared to the 2018-2019 budget.⁵⁸ In February 2024, the European Health and Digital Executive Agency completed a set of grant agreements under the Horizon Europe projects to support research and development for EU SST services.⁵⁹ The total budget made available by the EU for the five projects is €52 million for the 2023-2025 period.⁶⁰ In September 2024, the network of sensors contributing to EU SST has started growing with the integration of new commercial sensors, resulting from a public procurement procedure led by the CNES for the acquisition of commercial data for a total maximum amount of €13.2 million that was launched in 2023.⁶¹ The new sensors aim to enhance the provision of the EU SST services, such as collision avoidance, re-entry analysis, and fragmentation analysis.⁶²

In January 2023, it was announced that the European Defence Fund had awarded a contract to a consortium for the creation of a satellite, Naucrates, that could be placed in GEO in order to do close approaches to other spacecraft there and take centimeter-level resolution images.⁶³ Described as a "Microsatellite for Geostationary Orbit Surveillance and Intelligence" with less than 100 kg mass, the estimated cost for the design and demonstration of the project amounts to around €5 million.⁶⁴ Naucrates should have a lifespan of 3 to 5 years.⁶⁵ Celestia TTI, one of the firms involved in the project, announced in April 2024 that the initiative had successfully cleared its critical design review and is on track for delivery by the end of 2025.⁶⁶ Presumably France, as a member of the European Commission, could get access to the SSA data generated by this satellite. In April 2023, CNES announced that it had selected a consortium led by ArianeGroup to develop a network of ground telescopes and a space-based sensor to augment its existing SSA capabilities.⁶⁷ As of February 2026, there have been no updates on their progress.

The French military programming law for 2024-2030 includes the creation, by 2028, of an operational command and control capability of space operations named “Astreos”, based on the capabilities of a high-performance computer adapted to the massive processing of space surveillance data, as part of Operation ARES.⁶⁸ French company Infinite Orbits won a contract from France’s Directorate General of Armament in August 2025 for the €50M (Positioning and Autonomous Laser Assisted Detection in Near-space) PALADIN framework agreement, which is a part of the ARES program.⁶⁹ Infinite Orbits will be responsible for the creation of a GEO inspection and monitoring service for the French Space Command, which includes a desired launch date of 2027.⁷⁰ It is intended to be able to get within 1 km of other satellites.⁷¹

In 2011, France and the United States reached an agreement to exchange information on space debris in orbit, with the aim of strengthening the protection of satellites operated by their respective armed forces.⁷² In 2020, France and Germany joined the Combined Space Operations (CSpO) initiative to develop coordination and interoperability of their efforts, increase resilience and encourage responsible behavior in outer space.⁷³ After having rejected in 2021 a first offer to join,⁷⁴ France joined the Multinational Force Operation Olympic Defender (MNF-OOD) in October 2024, an initiative launched in 2013 by the United States to foster international cooperation in space defense.⁷⁵ MNF-OOD aims to optimize space operations, build resilience in space systems, synchronize efforts to strengthen deterrence against hostile actors, and reduce the spread of on-orbit debris. Participants commit to improve data and information sharing, contribute to the deterrence of competitors and create a common operational culture in outer space, by refining their understanding of the space environment, including the training of national operators.

DGA issued a contract as part of the ARES program to Thales in October 2025 to develop, deliver, and deploy the ground-based LEO space surveillance radar system, AURORE.⁷⁶ AURORE will provide uninterrupted monitoring and tracking of multiple objects at the same time, through a software-defined radar system within an Ultra High Frequency (UHF) band.⁷⁷

7.6 – FRENCH COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

In September 2018, Parly surprised some by openly calling out the Russians for using their Luch Olymp satellite to allegedly attempt to spy on France’s Athena-Fidus satellite (2014-006B, 39509) (see Russian Co-Orbital ASAT, Section 2.1). She said, “It got so close that we might have imagined it was trying to intercept our communications,” and commented, “Trying to listen to your neighbors is not only unfriendly. It’s an act of espionage.”⁷⁸ It should be noted that surveillance of this type does not violate any existing international laws.

68 *Avis no. 527 de la commission de la défense nationale et des forces armées sur le projet de loi de finances pour 2025 (n°324)*, Tome VI, Défense, Préparation et emploi des forces : Air, October 30, 2024.

69 Andrew Parsonson, “DGA Selects Infinite Orbits for €50M PALADIN Satellite-Inspection Service,” *European Spaceflight*, August 12, 2025, <https://europeanspaceflight.com/dga-selects-infinite-orbits-for-e50m-paladin-satellite-inspection-service/>; Rachel Jewett, “French Space Commands Orders Micro GEO Surveillance Satellite from Infinite Orbits,” *Via Satellite*, August 12, 2025, <https://www.satellitetoday.com/government-military/2025/08/12/french-space-command-orders-micro-geo-surveillance-satellite-from-infinite-orbits/>.

70 Parsonson, “DGA Selects Infinite Orbits for €50M PALADIN Satellite-Inspection Service,” *ibid*.

71 Jewett, “French Space Commands Orders Micro GEO Surveillance Satellite from Infinite Orbits,” *ibid*.

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78 Christina Maza, “Russian Spy Satellite Tried to Steal Military Information from France, Defense Minister Says,” *Newsweek*, September 17, 2018, <https://www.newsweek.com/russian-spy-satellite-tried-steal-military-information-france-1112072>.

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- 84 "France to create space command within air force: Macron," *Reuters*, July 13, 2019, <https://www.reuters.com/article/us-france-national-day-defence/france-to-create-space-command-within-air-force-macron-idUSKCN1U80LE>.
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- 86 Arthur Laudrain, "France's 'strategic autonomy' takes to space," *IJSS Military Balance Blog*, August 14, 2019, <https://www.ijss.org/blogs/military-balance/2019/08/france-space-strategy>.
- 87 Theresa Hitchens, "Space Lasers for Satellite Defense Top New French Space Strategy," *Breaking Defense*, July 26, 2019, <https://breaking-defense.com/2019/07/france-envisions-on-orbit-lasers-for-satellite-defense/>.
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- 89 *Space Defence Strategy*, *ibid*.
- 90 *Space Defence Strategy*, *ibid*. p. 26.
- 91 *Space Defence Strategy*, *ibid*., p. 27.

In July 2019, French President Emmanuel Macron announced that by September 1 of that year, France would be elevating the existing Joint Space Command within the French Air Force to be a full Space Command and renaming the French Air Force to be the Air and Space Force, or the Armée de l'Air et de l'Espace. He said that this was to, "ensure the development and reinforcement of our space capabilities."⁷⁹ France's Space Command or Commandement de l'espace (CDE) is starting off with 220 people as its staff and will grow eventually to 500 when it reaches full operational capacity in 2030.⁸⁰ According to Parly, "Eventually, this command will be responsible for all our space operations, under the orders of the Chief of Staff of the Armed Forces." She noted the importance of the Ministry of Armed Forces becoming a space operator, as "If we want to be able to carry out real military space operations, we must develop autonomy of action."⁸¹ CDE moved in November its offices to Toulouse to be co-located, near CNES, France's civil space agency.⁸² The French military had originally put aside €3.6-billion (roughly \$4 billion USD) to invest in its satellites from 2019-2025.⁸³ Parly announced in July 2019 an additional €700 million for this effort.⁸⁴ This €4.3 billion includes funds for refreshing France's military space infrastructure (reconnaissance, signals intelligence, and communications satellites, as well as the GRAVES radar used for space surveillance). Parly also noted that France will be testing a long-range radar as a result of increased missile threats.

In July 2019, France also announced its first *Stratégie Spatiale de Défense (Space Defence Strategy)*.⁸⁵ It has two goals: to increase and strengthen SSA for there to be better decision-making and to protect French and selected European space assets. This strategy is intended to be defensive in nature, with Parly noting in her July 2019 speech that this was "not an arms race."⁸⁶ According to Parly, "active defense is not an offensive strategy, it's all about self-defense... That is, when a hostile act has been detected, characterized and attributed, to be able to respond in an appropriate and proportionate way, in conformity with the principles of international law."⁸⁷

The *Space Defence Strategy* noted that the renewed doctrine for military space operations will have the following four functions: "support for space capabilities, situational awareness, support for operations and action in space."⁸⁸ It also stated that a "consolidated assessment of threats affecting our capabilities" will be needed.⁸⁹ The Agence de l'Innovation de Défense (Defense Innovation Agency, AID) is intended to take part in space research and development guidelines.

The strategy talks about the need to be able to respond to "unfriendly, illegal or aggressive acts, in accordance with international law."⁹⁰ It gives the following guidelines for responses in these cases:

- In the face of an unfriendly act in space, France reserves the right to take retaliatory measures;
- in response to an unlawful act committed against it, it may take countermeasures with the sole purpose of putting an end to it, in accordance with its obligations under international law; these countermeasures will be strictly necessary and proportionate to the objective;
- in the event of armed aggression in space, France can make use of its right to self-defence.⁹¹

The strategy recommends France continue to participate in multilateral fora, especially so it can "focus on behavioural standards to ensure strategic stability

and avoid opportunities for misunderstandings or escalations.”⁹² As part of this overhaul of France’s military space capabilities, the Ministère des Armées would now be allowed to conduct activities in space. To allow for this shift toward military space, France’s National Space Law will have to go through inter-ministerial discussions to be adapted to reflect this new set-up. Published in June 2008, the *Space Operations Act* (LOS) encourages space activity to be primarily commercial and/or civil in nature.⁹³ It was created in order to meet France’s Article VI obligations of the 1967 *Outer Space Treaty*, which requires continuing supervision of national space activities. In February 2022, France’s Space Operations Law was modified to reflect its military space strategy, allowing civilian assets to be transferred to the Ministère des Armées (Ministry of the Armed Forces) designated the Ministère des Armées to be liable if those assets caused any damage, and permitted the Ministère des Armées to commandeer civilian assets.⁹⁴

Stratégie Nationale Spatiale 2025-2040

France released its new national space policy in November 2025. The *Stratégie Nationale Spatiale 2025-2040* consists of “Pillars” and “Strategic Objectives,” which focus on ensuring strategic autonomy, industrial strength, and security in space for the French.⁹⁵ Pillar 3, “Strengthening the Resilience and Responsiveness of the Military Space Architecture and Accelerate the Deployment of Capabilities in and towards Space,” states as its mission to “Guarantee the security, continuity, and resilience of space infrastructure in a contested, congested, and vulnerable orbit environment, by combining protection, capability autonomy, defensive action, and situational awareness.”⁹⁶ Below Pillar 3 are four strategic objectives:

- Strategic Objective 6, “Strengthen the resilience of critical civil and military space infrastructure,” outlines improving resiliency by “redundancy of components (orbital, ground, cyber), diversification of suppliers, use of dual-use solutions, ability to operate in degraded mode, rapid response procedures in the event of failure, etc.”
- Strategic Objective 7, “Guarantee the operational autonomy of sovereign space assets,” details how France plans to improve its freedom of action by focusing on “the sovereignty of space capabilities in three critical areas: intelligence, military telecommunications and early warning.”
- Strategic Objective 8, “Strengthen French and European space surveillance capabilities to ensure autonomous assessment and decision-making in the face of orbital threats,” discusses how France wants to “strengthen the entire SSA chain in order to build a sovereign, precise, reliable, responsive, and resilient SSA capabilities.”
- Strategic Objective 9, “Possess a national capability for active defense in and towards space,” calls for France “to protect and defend national interests, prevent and deter hostile acts, ensure the continuity of strategic missions and, where necessary, act directly in and towards space, while guaranteeing strict compliance with the core principles of the international space law applicable to outer space.” Along these lines, it notes that this depends “on the development of detection, characterisation and attribution capabilities. These capabilities will be complemented by capabilities to disrupt, degrade or even neutralise, if necessary, an adversary’s capabilities, in accordance with international law and based on a logic of gradation and proportionality.” Finally, priority is given to the ground segment of space systems, as it is “the most vulnerable.”¹⁰⁰

During a December 2021 hearing, French military officials announced their plans to spend €646 million on space in 2022, and that they earmarked €5.3 billion for military space capabilities and services to be spent between 2019

⁹² *Space Defence Strategy*, *ibid.*

⁹³ Philippe Clerc, “Can national space law offer solutions? The French Space Operations Act’s contribution,” presentation to the *Toulouse Space Show 2012*, June 26, 2012, https://iislweb.space/wp-content/uploads/2020/01/2012_Clerc.pdf.

⁹⁴ Stromgade on Twitter, March 9, 2022, <https://twitter.com/stromgade/status/1500407634192654337?s=21>; Ordinance No. 2022-232 of February 23, 2022 on the protection of national defense interests in the conduct of space operations and the use of data of space origin, Government of France, taken from the official journal *Lois et Décrets vol. 47*, published February 25, 2022, <https://www.legifrance.gouv.fr/jorf/id/JORF-TEXT000045222114>.

⁹⁵ *National Space Strategy 2025-2040*, Government of France, November 12, 2025, https://www.sgdsn.gouv.fr/files/files/Publications/National%20space%20strategy_ENG.pdf.

⁹⁶ *National Space Strategy 2025-2040*, *ibid.*

⁹⁷ *National Space Strategy 2025-2040*, *ibid.*

⁹⁸ *National Space Strategy 2025-2040*, *ibid.*

⁹⁹ *National Space Strategy 2025-2040*, *ibid.*

¹⁰⁰ *National Space Strategy 2025-2040*, *ibid.*

- 101 Vivienne Machi, "France puts space at top of national—and European—security priorities," *DefenseNews*, March 14, 2022, <https://www.defensenews.com/space/2022/03/14/france-puts-space-at-top-of-national-and-european-security-priorities/>.
- 102 "Objectifs LPM 2024-2030 : maîtriser les nouveaux espaces de conflictualité," *Ministère des Armées*, May 9, 2023, <https://www.defense.gouv.fr/actualites/objectifs-lpm-2024-2030-maitriser-nouveaux-espaces-conflictualite>.
- 103 Anna Desmarais, "France wants to bolster its space defenses. Here's what it could buy first," *Euronews*, November 14, 2025, <https://www.euronews.com/next/2025/11/14/france-wants-to-bolster-its-space-defences-heres-what-it-could-buy-first>.
- 104 "France's Macron announces new funding to prepare for militarization of space," *Le Monde with AFP*, November 12, 2025, https://www.lemonde.fr/en/international/article/2025/11/12/france-s-macron-announces-new-funding-to-prepare-for-militarization-of-space_6747393_4.html.
- 105 "France conducts first military exercises in space," *Deutsche Welle (DW)*, March 10, 2021, <https://www.dw.com/en/france-conducts-first-military-exercises-in-space/a-56821868>.
- 106 Murielle Delaporte, "ASTERX 2021: French Space Forces Reach for Higher 'Orbit,'" *Breaking Defense*, April 9, 2021, <https://breakingdefense.com/2021/04/asterx-2021-french-space-forces-reach-for-higher-orbit/>.
- 107 "ASTERX 22: France's annual military space exercise," *SatelliteObservation.net*, March 6, 2022, <https://satelliteobservation.net/2022/03/06/asterx-22-frances-annual-military-space-exercise/>.
- 108 "ASTERX 22: France's annual military space exercise," *ibid.*
- 109 "French Space Exercise Asterx Builds on Realistic Scenario and Integration," *NATO*, March 9, 2023, https://ac.nato.int/archive/2023/FRA_AsterX23.
- 110 Joshua Posaner, "More Tetris than Dune: Inside French Space Command's war game," *POLITICO*, March 8, 2024, <https://www.politico.eu/article/tetris-dune-france-space-command-war-game-asterx/>; Rudy Ruitenberg, "France prepares for space wars in 'AsterX' European exercise," *C4ISRNET*, March 8, 2024, <https://www.c4isrnet.com/battlefield-tech/space/2024/03/08/france-prepares-for-space-wars-in-asterx-european-exercise/>.
- 111 "5th edition of the exercise comes to an end," *Ministère des Armées et des Anciens Combattants*, March 31, 2025, <https://www.defense.gouv.fr/en/asterx/news/5th-edition-exercise-comes-end>.
- 112 "5th edition of the exercise comes to an end," *ibid.*
- 113 "Space-France's commitment not to conduct destructive direct-ascent anti-missile tests (29 November 2022)," *Ministère de l'Europe et des Affaires Étrangères*, November 29, 2022, <https://www.diplomatie.gouv.fr/en/french-foreign-policy/security-disarmament-and-non-proliferation/news/2022/article/space-france-s-commitment-not-to-conduct-destructive-direct-ascent-anti>.

and 2025.¹⁰¹ In 2023, France adopted its military programming law for 2024-2030, amounting to €400 billion, including €6 billion dedicated to the space domain with a threefold ambition: to increase both the observation and intelligence capabilities and the defense capabilities of satellites.¹⁰²

In November 2025, while announcing France's new space strategy, Macron pledged a €4.2 billion investment in military space activities up to 2030, with an eventual investment in space weapons likely to be over €10 billion by 2030.¹⁰³ While making the announcement, Macron said, "The war of today is already being fought in space, and the war of tomorrow will begin in space...Space is no longer a sanctuary, it has become a battlefield."¹⁰⁴

In 2021, the Ministère des Armées legally conducted its first military exercises in outer space.¹⁰⁵ The exercise was codenamed "ASTERX," and it tested the capabilities of CDE in tackling 18 different space events and threats to its satellites and defense equipment.¹⁰⁶ Since then, ASTERX has been held annually; the 2022 version simulated 16 events and an orbital population of 10,000 objects.¹⁰⁷ It was broader in terms of scope from the previous year's exercise in that it included the European External Action Service (EEAS) plus four other countries; it also incorporated commercial data via the Commercial Integration Cell (CIC).¹⁰⁸ The 2023 version proposed 23 space events, including one in the cyber domain,¹⁰⁹ and the 2024 version involved 23 events, including 14 different types of threats, ranging from a satellite rendezvous to an attack on a military satellite.¹¹⁰ CDE held the 2025 edition of ASTERX in March, emphasizing various frameworks of cooperation in all domains including space: tactical, strategic, political, and diplomatic.¹¹¹ This exercise had two phases; the first focused on the French national response to a threat and the second broadened it to international partnerships.¹¹²

In November 2022, France formally pledged not to conduct destructive DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.¹¹³

In November 2024, French General Philippe Adam, Commander of CDE, pointed out that, faced with the prospect of a conflict in space, the CDE has several missions: to maintain space support for military operations, and to plan and conduct military operations to control space in order to protect satellites up to 36,000 km above Earth.¹¹⁴ Furthermore, speaking to the Commission de la Défense Nationale et des Forces Armées on the Draft Budget Bill for 2025, Air Force General Jérôme Bellanger, Chief of Staff of the French Air Force and Space Ministry, said that France “sticks to an active defense approach, excluding any offensive mindset” and added it “does not develop missiles designed to destroy certain satellites.”¹¹⁵

The United States started its Schriever Wargame in 1998 as a biennial tabletop exercise to look at how advanced space technologies influenced future conflicts in space. In recent years, the Schriever Wargame has become an annual event that also explored policy and strategy issues, diplomatic, economic, military, and information activities, and included participation from a growing number of allied military and commercial partners. France has been participating in it since 2012.¹¹⁶ The 17th and most recent iteration of the Schriever Wargame was held in August 2025, included policy-makers from Australia, Canada, France, Germany, Italy, Japan, New Zealand, Norway, and the United Kingdom, and had an Indo-Pacific focus.¹¹⁷ It included a special access cell so that the participants could share information about special access programs.¹¹⁸ The next version of the wargame will be in 2027 and for the first time, will have allies involved in its creation and planning, as opposed to the United States doing all of it.¹¹⁹

France participated in US Space Command’s Global Sentinel 2025 in April 2025 (See US Counterspace Policy, Doctrine, and Organization, Section 1.6).¹²⁰ This event included nearly 30 partner nations, including NATO, aiming to strengthen international partnerships, collaboration, and responsible space behaviors.¹²¹ The Global Sentinel exercised a dedicated Global Sentinel version of Space-Track.org for capstone modeling and simulation gameplay, replicating potential real world events through this usage.¹²² Building on this international cooperation, South Korea’s Defense Acquisition Program Administration (DAPA) announced their agreement with the DGA to build upon bilateral defense cooperation in space in September 2025, specifically focusing on research and development and intelligence sharing.¹²³

In October 2025, DGA launched a “Space Pact”, aimed to address space sector challenges through engagement with 50+ companies.¹²⁴ This is an effort by the Ministère des Armées to align industrial capacity with military requirements and includes other government agencies like CNES and the French Aerospace Lab; it will be carried out with the support of the New Space France Alliance and the French Aerospace Industries Association.¹²⁵

114 *Commandement de l'Espace : les enjeux de la sécurité spatiale*, Ministère des Armées, November 21, 2024, <https://www.defense.gouv.fr/actualites/commandement-lespace-enjeux-securite-spatiale>.

115 *Audition du général d'armée aérienne Jérôme Bellanger, chef d'état-major de l'armée de l'Air et de l'Espace, sur le projet de loi de finances 2025*, *Compte rendu no. 8*, Commission de la défense nationale et des forces armées, October 16, 2024.

116 Julian Hale, “7 NATO Countries To Join US in Schriever Wargame,” *DefenseNews*, April 18, 2012, <http://www.defensenews.com/print/article/20120418/DEFREG02/304180009/7-NATO-Countries-Join-U-S-Schriever-Wargame>.

117 Sandra Erwin, “Schriever Wargame to give allies bigger role as US shifts toward coalition-led space strategy,” *SpaceNews*, August 18, 2025, <https://spacenews.com/schriever-wargame-to-give-allies-bigger-role-as-u-s-shifts-toward-coalition-led-space-strategy/>; Christopher W. Chang & Daniel P. Burns, “Schriever Wargame 2025: Space Planning For Future Operations,” Space Systems Command Warfighter Integration Office, August 29, 2024, <https://www.ssc.spaceforce.mil/Newsroom/Article-Display/Article/3890751/schriever-wargame-2025-space-planning-for-future-operations>.

118 Courtney Albon, “Space Force wargame could inform framework for allied info sharing,” *DefenseNews*, August 7, 2025, <https://www.defensenews.com/space/2025/08/07/space-force-wargame-could-inform-framework-for-allied-info-sharing/>.

119 Erwin, “Schriever Wargame to give allies bigger role as US shifts toward coalition-led space strategy,” *ibid*.

120 LaDonna Davis, “US Space Command hosts Global Sentinel 2025 exercise,” *United States Space Force*, May 6, 2025, <https://www.spaceforce.mil/news/article-display/article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.

121 Davis, “US Space Command hosts Global Sentinel 2025 exercise,” *ibid*.

122 Davis, “US Space Command hosts Global Sentinel 2025 exercise,” *ibid*.

123 Kim Hyun-soo, “S. Korea, France reach agreement on defense space cooperation,” *Yonhap News Agency*, September 16, 2025, <https://en.yna.co.kr/view/AEN20250916002600315>.

124 Giulia Bernacchi, “France Launches ‘Space Pact’ to Strengthen Military Space Capabilities,” *The Defense Post*, October 13, 2025, <https://thedefensepost.com/2025/10/13/france-space-pact-strengthen-military/>.

125 Bernacchi, “France Launches ‘Space Pact’ to Strengthen Military Space Capabilities,” *ibid*.

Potential Military Utility /

France plans to have inspector satellites deployed by 2027; these satellites could provide France with a co-orbital counterspace capability, even though their stated mission is to defend French satellites. Between the SAMP/T missile defense system and its extensive space launch and ballistic missile expertise, France has the technological building blocks to develop a DA-ASAT capability if it chooses to do so, although there are no indications it has such plans. France is developing the initial capability for ground-based DEW and RPO satellites armed with DEW in both LEO and GEO that may enable a future co-orbital ASAT program, but it is unclear whether they will be capable of just temporary dazzling or doing more permanent damage to other satellites. France’s successful coordination of a bilateral RPO with the United States, along with planning future RPOs, demonstrates its growth in this technology area. Additionally, France’s indigenous SSA capabilities are fairly well-developed so they could potentially be used for targeting non-French satellites and could be of limited military utility as well. Finally, given the amount of policy documents and military space organization being generated for defense space purposes, it would appear that France is serious about using counterspace capabilities, once they are more solidly developed.

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08

GERMANY

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Germany historically has had a civil focus to its space program. However, its military, the Bundeswehr, is working to expand its presence in orbit. The combination of a significant planned investment in space and defense systems over the next five years, a new space strategy, and growing engagement in space surveillance points to an increase in German abilities to develop the necessary capabilities to potentially carry out attacks against space systems, should it choose to do so. Germany is changing rapidly from having no offensive counterspace capabilities, to soon having several options available to it.

8.1 – GERMAN CO-ORBITAL ASATS

Germany currently does not have a co-orbital counterspace capability but it is looking to develop one. Maj. Gen. Michael Traut, commander of the German Space Command, otherwise known as Weltraumkommando der Bundeswehr (WRKdoBw), said in September 2024 that Germany is considering creating a program called “German Inspector Satellite for Multiple Operations,” that could inspect satellites and have arms so it could have the option to respond to threat satellites.¹ Traut talked in May 2025 about having extremely maneuverable satellites: “What if we could launch or have some nice little satellites up there, which are agile and go after some satellites which we feel need to be inspected—some sort of space police?”² He also said he was “pretty much interested” in interfering with adversaries’ systems.³

In August 2025, the Deutsches Zentrum für Luft-und Raumfahrt or DLR (German Aerospace Center) released requests for information for two types of maneuvering satellites that can conduct close approaches to other spacecraft: one that can be an inspector satellite and one with active defense capabilities.⁴ The call states that the satellites are to be delivered eleven months after the contracts are signed and that they are to be launched via a “national launcher.”⁵

The *Space Safety and Security Strategy* released by Germany in November 2025 calls for developing and using “highly agile low-signal surveillance and bodyguard satellites and reusable spaceplanes.”⁶ (For a longer discussion of the strategy, see Section 8.6, German Counterspace Policy, Doctrine, and Organization below.)

8.2 – GERMAN DIRECT-ASCENT ASATS

In December 2025, Germany received its first Arrow 3 ballistic missile defense battery from Israel; this was a delivery on a \$4 billion contract signed in September 2023 between the two countries.⁷ Three batteries were originally planned for as part of the 2023 deal; the first is based at the Holzdorf military airfield about 40 miles south of Berlin, while eventually the other batteries are intended to be fielded in its northern territory (Schleswig-Holstein), and its southern territory (Bavaria).⁸ Shortly after the first battery was delivered, Germany and Israel signed an expansion deal worth an additional \$3.1 billion USD for more Arrow 3 interceptors and launchers.⁹

While the exact capabilities of the Arrow 3 in a counterspace role are unknown, it reportedly achieved an exoatmospheric intercept for the first time in November 2023 when it was used to intercept a long-range missile fired from Houthi-controlled Yemen.¹⁰ It is unclear at what altitude the intercept was made, only that it was likely above 100 km. The Arrow 3’s range suggests that it can theoretically intercept targets up to 1200 km but its manufacturer, Israeli Aerospace Industries (IAI), estimates that the system is able to intercept

1 Robert Wall, Thierry Dubois, “France Expands Active Space Defense Efforts As Threats Grow,” *Aviation Week & Space Technology*, September 25, 2024, <https://aviationweek.com/space/satellites/france-expands-active-space-defense-efforts-threats-grow>.

2 Robert Wall, “German Space Commander Wants Satellite Self-Protection, Resilience,” *Aviation Week & Space Technology*, May 7, 2025, <https://aviationweek.com/space/satellites/german-space-commander-wants-satellite-self-protection-resilience>.

3 Wall, “German Space Commander Wants Satellite Self-Protection, Resilience,” *ibid*.

4 Tereza Pultarova, “Analysts question Germany’s request for defensive and inspector satellites,” *SpaceNews*, October 21, 2025, <https://spacenews.com/analysts-question-germanys-request-for-defensive-and-inspector-satellites/>.

5 Pultarova, “Analysts question Germany’s request for defensive and inspector satellites,” *ibid*.

6 *Space Safety and Security Strategy*, Federal Ministry of Defence and Federal Foreign Office, November 2025, <https://www.bmvg.de/resource/blob/6042580/128d-bebd8cce8d7b8e61eb680edf91ad/weltraumsicherheitsstrategie-2025-en-data.pdf>.

7 Seth J. Frantzman, “Germany receives first Arrow 3 air defense system from Israel,” *Breaking Defense*, December 3, 2025, <https://breakingdefense.com/2025/12/germany-receives-first-arrow-3-air-defense-system-from-israel/>; Ralf Bosen, “Germany steps up missile defense with help from Israel,” *Deutsche Welle*, December 8, 2025, <https://www.dw.com/en/germany-steps-up-missile-defense-with-help-from-israel/a-75067175>.

8 Linus Höller, “Germany to activate Arrow 3 missile shield this week,” *DefenseNews*, December 2, 2025, <https://www.defensenews.com/global/europe/2025/12/02/germany-to-activate-arrow-3-missile-shield-this-week/>; Bosen, “Germany steps up missile defense,” *ibid*.

9 “Israel, Germany sign \$3.1 billion contract expansion for Arrow air defence system,” *Reuters*, December 18, 2025, <https://www.reuters.com/business/aerospace-defense/israel-germany-sign-31-billion-contract-expand-arrow-air-defence-system-2025-12-18/>; Emanuel Fabian, *The Times of Israel*, December 17, 2025, <https://www.timesofisrael.com/german-parliament-approves-3-5b-expansion-of-arrow-3-deal-with-israel/>.

10 Tzally Greenberg, “Israel announces first Arrow-3 operational intercept,” *C4ISRNet*, November 10, 2023, <https://www.c4isrnet.com/battlefield-tech/space/2023/11/10/israel-announces-first-arrow-3-operational-intercept/>.

- 11 Timur Kadyshv, "An Analysis [of] the Utility of Arrow 3 for European Missile Defense," *MIT Global Security Technical Webinar Series*, February 6, 2024, <https://lnsp.mit.edu/seminar-list/2024/2/6/an-analysis-the-utility-of-arrow-3-for-european-missile-defense>; Peter Wuetherich, "Germany okays \$4.3 billion purchase of Israel's Arrow 3 anti-missile system," *The Times of Israel*, June 14, 2023, <https://www.timesofisrael.com/germany-okays-4-3-billion-purchase-of-israels-arrow-3-anti-missile-system/>.
- 12 Sebastian Sprenger, "Israel's IAI shoots for land-based, space-based Golden Dome business," *DefenseNews*, October 29, 2025, <https://www.defensenews.com/global/mideast-afri-ca/2025/10/29/israels-iai-shoots-for-land-based-space-based-golden-dome-business/>.
- 13 Robert Wall, "German Space Commander Wants Satellite Self-Protection, Resilience," *ibid*; Tim Martin, "German space commander's 'Christmas wish'? Satellites with EW-infused defenses," *Breaking Defense*, May 7, 2025, <https://breakingdefense.com/2025/05/german-space-commanders-christmas-wish-satellites-with-ew-infused-defenses/>.
- 14 *Space Safety and Security Strategy*, Federal Ministry of Defence and Federal Foreign Office, November 2025, <https://www.bmvg.de/resource/blob/6042580/128d-bebd8cce8d7b8e61eb680edf91ad/weltraumsicherheitsstrategie-2025-en-data.pdf>.
- 15 Joe Brock, "Germany eyes lasers, space satellites in military space spending splurge," *Reuters*, February 6, 2026, <https://www.reuters.com/science/germany-eyes-lasers-spy-satellites-military-space-spending-splurge-2026-02-03/>.
- 16 Vivienne Machi, "Germany establishes new military space command," *DefenseNews*, July 13, 2021, <https://www.defensenews.com/space/2021/07/13/germany-establishes-new-military-space-command/>.
- 17 Uwe Wirt, "Space situational awareness centre," DLR, accessed March 8, 2026, <https://event.dlr.de/en/ila2022/weltraumlagezentrum/>.
- 18 "GESTRA," DLR, accessed March 9, 2026, <https://www.dlr.de/en/ar/topics-missions/space-safety/gestra>.
- 19 "GESTRA," *ibid*.
- 20 *Space Safety and Security Strategy*, Federal Ministry of Defence and Federal Foreign Office, November 2025, <https://www.bmvg.de/resource/blob/6042580/128dbebd8cce8d-7b8e61eb680edf91ad/weltraumsicherheitsstrategie-2025-en-data.pdf>.
- 21 "Space observation radar TIRA," Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR, accessed March 9, 2026, <https://www.fhr.fraunhofer.de/en/the-institute/technical-equipment/Space-observation-radar-TIRA.html>.

ballistic missiles fired from a distance of up to 2,400 kilometers.¹¹ However, its ability to track and target objects at that altitude is unknown and undemonstrated. IAI officials have acknowledged the need to upgrade their ability to differentiate targets in a crowded field.¹²

8.3 – GERMAN ELECTRONIC WARFARE

Maj. Gen. Michael Traut, commander of the German Space Command, told a society of electronic warfare specialists in May 2025, "I would really like to see every future or present space system—not only satellite but the whole system—be put up, including some self-protection efforts built in."¹³ Options he suggested include having fuel for maneuvers, building resiliency in a system so the loss of one satellite can be overcome, or having back-up laser communications payloads for redundancy since, "We need to protect and defend."

The *Space Safety and Security Strategy* released by Germany in November 2025 calls for "Establishing the capability for comprehensive cyber operations and electromagnetic spectrum operations in the space domain."¹⁴ (For a longer discussion of the strategy, see Section 8.6, German Counterspace Policy, Doctrine, and Organization below.)

8.4 – GERMAN DIRECTED ENERGY WEAPONS

In discussing how to spend the €35 billion on space defense systems that Germany has committed to spend through 2030, Maj. Gen. Michael Traut, commander of the German Space Command, said in February 2026 that one of the technologies could be lasers that could be used to interfere with adversary spacecraft but not create debris in orbit.¹⁵ However, laser technology for counterspace purposes was not listed in the options given in Germany's November 2025 "Space Safety and Security Strategy," so it is unclear if or how Germany's work on directed energy weapons would progress. (For a longer discussion of the strategy, see Section 8.6, German Counterspace Policy, Doctrine, and Organization below.)

8.5 – GERMAN SPACE SITUATIONAL AWARENESS CAPABILITIES

The German Space Situational Awareness Center, known as the Weltraumlagezentrum or GSSAC, has been used by the German Air Force since 2009 to monitor objects in orbit.¹⁶ It is a civil-military facility jointly operated by the DLR and the German Space Command, and is managed by the Federal Ministry for Economic Affairs and Climate Action and the Federal Ministry of Defence.¹⁷

The German Experimental Surveillance and Tracking Radar (GESTRA) tracks objects in LEO and contributes to both Germany's national catalogue and that of the European Union Space Surveillance and Tracking (EU SST).¹⁸ It operates in the microwave range and has been operational since 2024.¹⁹ The transmitting and receiving systems are each composed of 256 individual antennae; it is partially mobile and has separate reception and transmission systems.²⁰

The Fraunhofer Institute for High Frequency Physics and Radar Techniques (Fraunhofer FHR), a government-funded research institute, has TIRA (Tracking and Imaging Radar), which can track space objects.²¹ It has a tracking radar

that transmits in the L-band frequency and an imaging radar that transmits in the Ku-band frequency.²² Its antenna is 34 meters in diameter and can be turned.²³

DLR's Johannes Kepler Observatory (JKO) has a 1.75 m telescope (Ritchey-Chrétien design) in the Northern Black Forest that is used to detect and track objects in LEO.²⁴ Its calculated visual magnitude limit is ~23.²⁵

Germany and the United States signed a space situational awareness (SSA) sharing agreement in January 2015.²⁶

In 2019, Germany joined the Combined Space Operations (CSpO) initiative to develop coordination and interoperability of space operations, increase resilience, and encourage responsible behavior in outer space.²⁷

Germany and the Spanish company Indra signed a contract in February 2025 for an upgraded version of Indra's space surveillance S3TSR radar; this purchase is part of Germany's LEO – Groundbased Upscaled AESA Radar or "L-GUARD" program, which is under its Space Surveillance System.²⁸ This radar will be operated by the German Space Command via remote access from the GSSAC.²⁹

A strategy of maintaining competitiveness and autonomy internationally in the SSA domain is also being pursued by the EU SST, of which Germany is a prominent member. The EU SST increased the budget contracted to European industry in R&D and capabilities by 205% in 2020-2022, compared to the 2018-2019 budget.³⁰ In February 2024, the European Health and Digital Executive Agency completed a set of grant agreements under the Horizon Europe projects to support research and development for EU SST services.³¹ The total budget made available by the EU for the five projects is €52 million for the 2023-2025 period.³² In September 2024, the network of sensors contributing to EU SST started growing with the integration of new commercial sensors, resulting from a public procurement procedure led by the Centre national d'études spatiales (CNES) for the acquisition of commercial data³³ for a total maximum amount of €13.2 million that was launched in 2023.³⁴ The new sensors aim to enhance the provision of the EU SST services, such as collision avoidance, re-entry analysis, and fragmentation analysis.³⁵

22 "Space observation radar TIRA," *ibid.*

23 "Space observation radar TIRA," *ibid.*

24 Gerd A. Wagner, Christoph Huber, Frank Schramm, Wolfgang Riede, Thomas Dekorsy, "DLR's Johannes Kepler Observatory for LEO RSO Analysis and Technology Development," *2nd Orbital Debris Conf. Papers 2023* (2023), <https://www.hou.usra.edu/meetings/orbitaldebris2023/pdf/6062.pdf>.

25 Wagner, Huber, Schramm, Riede, and Dekorsy, "DLR's Johannes Kepler Observatory," *ibid.*

26 "USSTRATCOM, Germany make arrangement to share space services, data," US Strategic Command Public Affairs, January 28, 2015, <https://www.stratcom.mil/Media/News/News-Article-View/Article/983710/usstratcom-germany-make-arrangement-to-share-space-services-data/>.

27 "Combined Space Operations: First Vision Paper Presented," Federal Ministry of Defence, February 22, 2022, <https://www.bmvg.de/en/news/combined-space-operations-first-vision-paper-presented-5358016>.

28 "Indra Signs Contract to Provide a Low Space Orbit Surveillance Radar to the German Air Force," *SATNow*, February 22, 2025, <https://www.satnow.com/news/details/2887-indra-signs-contract-to-provide-a-low-space-orbit-surveillance-radar-to-the-german-air-force>.

29 "Indra wins the contract to equip the German Air Force with a space surveillance radar," Indra Group, February 10, 2025, <https://www.indra-group.com/en/news/indra-wins-contract-equip-german-air-force-space-surveillance-radar>.

30 "3rd EU SST Webinar: Building the future of SST," Webinar, European Union Space Surveillance and Tracking (EU SST), October 5, 2021, https://www.eusst.eu/wp-content/uploads/2021/10/3rd_EU_SST_Webinar_presentation.pdf.

31 "HaDEA funds 5 grant agreements to boost EU Space Surveillance and Tracking," EU Commission, European Health and Digital Executive Agency, February 9, 2024, https://hadea.ec.europa.eu/news/hadea-funds-5-grant-agreements-boost-eu-space-surveillance-and-tracking-2024-02-09_en.

32 "7. Digital, Industry and Space," in *Horizon Europe Work Programme 2023-2025*, European Commission Decision C(2024) 2371, April 17, 2024, https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-7-digital-industry-and-space_horizon-2023-2024_en.pdf.

33 *610633-2023 - Competition, EU tenders - Ted tenders electronic daily*, Supplement to the Official Journal of the EU, October 5, 2023, <https://ted.europa.eu/en/notice/-/detail/610633-2023>.

34 "EU SST expands its user community and sensors network," EU SST, December 20, 2024, <https://www.eusst.eu/newsroom/eu-sst-expands-user-community-sensors-network/>.

35 "New EU SST Service Portfolio now available," EU SST, September 30, 2024, <https://www.eusst.eu/newsroom/new-eu-sst-service-portfolio-now-available/>.

- 36 *Integrated Security for Germany: National Security Strategy*, Federal Foreign Office, June 2023, <https://www.nationalesicherheitsstrategie.de/National-Security-Strategy-EN.pdf>.
- 37 should read: *Integrated Security for Germany: National Security Strategy*, *ibid*.
- 38 *The German Federal Government's Space Strategy*, The German Federal Government, September 2023, <https://www.bundeswirtschaftsministerium.de/Redaktion/EN/Publikationen/Technologie/the-german-federal-governments-space-strategy.pdf>.
- 39 *The German Federal Government's Space Strategy*, *ibid*.
- 40 *The German Federal Government's Space Strategy*, *ibid*.
- 41 *The German Federal Government's Space Strategy*, *ibid*.
- 42 *The German Federal Government's Space Strategy*, *ibid*.
- 43 *Defense Policy Guidelines 2023*, Federal Ministry of Defense, November 2023, <https://www.bmvg.de/resource/blob/5702190/edabed-114d7856c8aa71ad666cbce8b3/download-defence-policy-guidelines-2023-data.pdf>.
- 44 *Defense Policy Guidelines 2023*, *ibid*.
- 45 *Defense Policy Guidelines 2023*, *ibid*.
- 46 Rudy Ruitenberg, "Space is the new frontier of war, officials say in change of tone," *DefenseNews*, September 17, 2025, <https://www.defensenews.com/global/europe/2025/09/17/space-is-the-new-frontier-of-war-officials-say-in-change-of-tone/>.
- 47 Ruitenberg, "Space is the new frontier of war," *ibid*.
- 48 Linus Höller, "Germany unveils \$40bn military-space investment, citing new threats," *DefenseNews*, September 25, 2025, <https://www.defensenews.com/global/europe/2025/09/25/germany-unveils-40bn-military-space-investment-citing-new-threats/>.
- 49 Höller, "Germany unveils \$40bn military-space investment," *ibid*.
- 50 Höller, "Germany unveils \$40bn military-space investment, *ibid*; Speech by the Federal Minister of Defense Boris Pistorius at the 3rd BDI-Space Congress in Berlin, September 25, 2025, <https://www.bmvg.de/de/presse/rede-pistorius-3-bdi-weltraumkongress-berlin-5997822>.
- 51 Speech by the Federal Minister of Defense Boris Pistorius at the 3rd BDI-Space Congress in Berlin, *ibid*.
- 52 Tereza Pultarova, "What Germany's \$41B investment in space could mean for Europe," *SpaceNews*, October 1, 2025, <https://spacenews.com/what-germanys-41b-investment-in-space-could-mean-for-europe/>.

8.6 – GERMAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Policy and Doctrine

Germany's *National Security Strategy*, published in June 2023, talks about the importance of space in regards to national security and daily lives and goes on to state, "The Federal Government will therefore place a stronger focus on space as a strategic dimension and expand its capabilities in this domain."³⁶ In discussing partnerships, it says, "Allied defence also encompasses cyberspace and space. Attacks in or from these dimensions can have the magnitude and impact of an armed conflict and thus necessitate collective action. The Federal Government will promote the development and introduction of highly advanced capabilities."³⁷

The *German Federal Government's Space Strategy*, released in September 2023, has a section on "Security, strategic options and global stability."³⁸ It says that building off of the *National Security Strategy*, the EU, and NATO provide "the central framework for addressing space security issues" and that "space plays an important role in national security."³⁹ It talks about the importance of a rules-based order, noting, "We are calling for use of space to be based on rules, and to be secure."⁴⁰ It brings up that the "intentional destruction of objects in space, in tests of ground-based, destructive anti-satellite weapons, has also added to the debris" and that Germany and its allies have made commitments not to conduct those types of tests.⁴¹ The strategy indicates that the German government is going to prioritize "the development and expansion of additional capabilities for space situational awareness."⁴²

Germany released its *Defense Policy Guidelines* in November 2023.⁴³ In it, space is described as being of "strategic relevance" and one permanent mission of the German armed forces is "contributing to the national situation picture in space."⁴⁴ As well, it says "the nature of the threat environment," means that it is "necessary to operate beyond geographically defined areas, namely in the cyber and information domain, and in space."⁴⁵

In September 2025, Brig. Gen. Jürgen Schrödl, of the German Ministry of Defence, stated, "We have to accept that space is a tested domain, is a war-fighting domain, is becoming a war-fighting domain."⁴⁶ At that same conference, Maj. Gen. Michael Traut, commander of the German Space Command, stated that operational capabilities are needed "in and for space," and that those operational capabilities "consist of defensive and offensive means...I can repeat that officially. Defensive and offensive means, shield and sword."⁴⁷

Defense Minister Boris Pistorius announced in September 2025 that Germany plans to spend €35 billion on military space-related projects by 2030, citing threats from Russia and China and the vulnerabilities of satellite networks as justification.⁴⁸ He also talked about "guardian satellites," establishing a military satellite operations center inside the German Space Command, strengthening space situational awareness, and hardening systems for their protection.⁴⁹ Pistorius said that Germany must "discuss offensive capabilities" so that it will "be able to deter in space in order to be defensible."⁵⁰ He pointed out that "Even today, the systems of the German Armed Forces are affected by jamming attacks" and that Russia's cyberattack on ViaSat in February 2022 had significant effects in Germany as well: "The operational control of a total of almost 6,000 wind turbines was massively restricted."⁵¹ To contextualize this planned military space spending, €35 billion is comparable to the European Space Agency (ESA)'s five-year budget.⁵²

Germany published its *Space Safety and Security Strategy* in November 2025.⁵³ The joint foreword by Boris Pistorius, federal minister of defence, and Johann Wadephul, federal minister for foreign affairs, notes, “A central pillar of this strategy is close cooperation with our NATO Allies and our European and international partners. Developing and enforcing norms, rules and principles for the peaceful, responsible and sustainable use of space is only possible if we work together.”⁵⁴ The strategy states that “security-relevant space infrastructure and systems are as essential a part of defence-related infrastructure as vital and defence-critical facilities on Earth.”⁵⁵ Some of the principles it says that must be prioritized are “Achieving the capability for military space operations” and “Achieving the capability for cyber operations and electromagnetic spectrum operations in the space domain.”⁵⁶ Russian and Chinese counterspace activities are cited to demonstrate the threat to the space domain, while SSA and the ability to detect and defend against threats requires “new capabilities to conduct space operations, such as reusable spaceplanes, inspection and surveillance satellites, and on-board sensors for satellites to identify any attempts to approach and interfere.”⁵⁷ It asserts that “potential enemies can only be deterred if we have the necessary capabilities, are willing to use them and communicate this willingness;” as such, the strategy says that “we will ensure Germany’s ability to take action in the space domain along the entire spectrum from peace to crisis to national and collective defence.”⁵⁸

Some technologies mentioned as those that Germany wants to conduct research in are: active co-orbital protection, on-orbit servicing, “space-based contributions to territorial ballistic missile defence,” and “reusable spaceplanes.”⁵⁹ Finally, it calls space “an independent and dynamic area of military operations” and thus “We are strengthening the Bundeswehr’s ability to act in space and enabling it to limit the use of space by adversaries. The operation of space systems, conducting space operations and the ability to generate effects in space are essential military capabilities.”⁶⁰

It ends with lists of strategic lines of action, which include:

- “Establishing a classifiable wargaming centre as well as a simulations and space testbed
- “Strengthening the responsibility of the Bundeswehr Space Command in exercising military responsibility over the space domain and improving the necessary command and control processes in accordance with the principle of unity in command
- “Developing technical and operational capabilities to restrict/prevent military use of space by an adversary at national level and/or in cooperation with partners, including deep precision strike and hypersonic capabilities
- “Developing and using highly agile standardised inspection, maintenance and refuelling/logistics satellites as well as reusable spaceplanes to resolve technical problems
- “Developing active and passive protective measures for all space segments, including hardening against electromagnetic pulses and against the impact of nuclear explosions in space
- “Developing and using highly agile low-signal surveillance and bodyguard satellites and reusable spaceplanes to inspect and effect an adversary’s systems
- “Establishing the capability for comprehensive cyber operations and electromagnetic spectrum operations in the space domain”⁶¹

In September 2022, Germany formally pledged not to conduct destructive

53 *Space Safety and Security Strategy*, Federal Ministry of Defence and Federal Foreign Office, November 2025, <https://www.bmvg.de/resource/blob/6042580/128d-bebd8cce8d7b8e61eb680edf91ad/weltraumsicherheitsstrategie-2025-en-data.pdf>.

54 *Space Safety and Security Strategy*, *ibid.*

55 *Space Safety and Security Strategy*, *ibid.*

56 *Space Safety and Security Strategy*, *ibid.*

57 *Space Safety and Security Strategy*, *ibid.*

58 *Space Safety and Security Strategy*, *ibid.*

59 *Space Safety and Security Strategy*, *ibid.*

60 *Space Safety and Security Strategy*, *ibid.*

61 *Space Safety and Security Strategy*, *ibid.*

- 62 "Germany commits in Geneva not to conduct anti-satellite direct-ascent missile tests," Federal Foreign Office, September 13, 2022, <https://www.auswaertiges-amt.de/en/aussenpolitik/themen/anti-satellite-missile-tests/2551852/>.
- 63 Rudy Ruitenberg, "Space is the new frontier of war, officials say in change of tone," *DefenseNews*, September 17, 2025, <https://www.defensenews.com/global/europe/2025/09/17/space-is-the-new-frontier-of-war-officials-say-in-change-of-tone/>.
- 64 Marco Seliger, "Starting from behind, Germany is joining the new military space race," *NZZ*, June 6, 2025, <https://www.nzz.ch/english/germanys-military-aims-to-expand-its-presence-in-space-ld.1887757>.
- 65 Vivienne Machi, "Germany establishes new military space command," *DefenseNews*, July 13, 2021, <https://www.defensenews.com/space/2021/07/13/germany-establishes-new-military-space-command/>.
- 66 Machi, "Germany establishes new military space command," *ibid*.
- 67 Machi, "Germany establishes new military space command," *ibid*.
- 68 "Germany launches 'space command' to protect infrastructure," *Associated Press via Stars and Stripes*, July 13, 2021, <https://www.stripes.com/theaters/europe/2021-07-13/Germany-space-command-protect-infrastructure-2136440.html>.
- 69 "Germany launches 'space command' to protect infrastructure," *ibid*.
- 70 Robert Wall, "Germany Drafting Military Space Architecture, Major General Says," *Aviation Week & Space Technology*, September 16, 2025, <https://aviationweek.com/space/budget-policy-regulation/germany-drafting-military-space-architecture-major-general-say>.
- 71 Wall, "Germany Drafting Military Space Architecture," *ibid*.
- 72 "NATO Space Centre of Excellence Reaches Full Operational Capability, Reinforcing Alliance Readiness in the Space Domain," NATO, January 26, 2026, <https://www.act.nato.int/article/space-coe-reinforces-nato-readiness/>.
- 73 "NATO Space Centre of Excellence Reaches Full Operational Capability," *ibid*.
- 74 LaDonna Davis, "US Space Command hosts Global Sentinel 2025 exercise," *US Space Force*, May 6, 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.
- 75 Davis, "US Space Command hosts Global Sentinel 2025 exercise," *ibid*.

DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.⁶²

In 2024, Germany's \$655 million USD put it in eighth place globally for military space spending.⁶³ Germany has eight military satellites on orbit that are used for remote sensing and communication.⁶⁴

Organization

The German Space Command was started in July 2021 under the authority of the German Air Force.⁶⁵ At the time, the Ministry of Defence explained that this was in response to "the increasing significance of space for our state's ability to function, the prosperity of our population, and the increasing dependency of the armed forces on space-supported data, services and products."⁶⁶ It was stood up at the GSSAC.⁶⁷ One of the Space Command's responsibilities is to detect and track objects in space; as well, Defence Minister Annegret Kramp-Karrenbauer said at its creation that the goal was to gather all capabilities in one place and to build new ones.⁶⁸ Kramp-Karrenbauer also said that German space operations "are always defensive operations."⁶⁹

Germany is said to be working on a new military space architecture that will strive to predict what new military space systems are needed and plan out how to ensure they are interoperable, as well as determine when they need to be updated.⁷⁰ There are three planned phases: the first is intended to be ready in 2029; the second, 2035; and the third is roughly around 2040.⁷¹

Germany participates in NATO's Space Centre of Excellence, which was created in July 2023 and reached full operational status in January 2026.⁷² According to NATO, the Centre "develops space operations concepts, strengthens staff readiness, supports major exercises, and feeds operational lessons back into NATO's adaptation cycle."⁷³

The US Space Command holds an annual conference, Global Sentinel, to practice combined space operations. The most recent iteration was held in April 2025 and included operators from 29 countries plus NATO; Germany was one of the participating nations.⁷⁴ According to Maj. Gen. Richard L. Zellmann, Combined Joint Force Space Component deputy commander, the exercises the group worked through ran the gamut from "a normal, standard launch all the way to direct ascent, satellite weapons and everything in between."⁷⁵

The United States started its Schriever Wargame in 1998 as a biennial tabletop exercise to look at how advanced space technologies influenced future conflicts in space. In recent years, the Schriever Wargame has become an annual event that also explored policy and strategy issues, diplomatic, economic, military, and information activities, and included participation from a growing number of allied military and commercial partners. Germany has been participating in it since 2012.⁷⁶ The 17th and most recent iteration of the Schriever Wargame was held in August 2025, included policy-makers from Australia, Canada, France, Germany, Italy, Japan, New Zealand, Norway, and the United Kingdom, and had an Indo-Pacific focus.⁷⁷ It included a special access cell so that the participants could share information about special access programs.⁷⁸ The next version of the wargame will be in 2027 and for the first time, will have allies involved in its creation and planning, as opposed to the United States doing all of it.⁷⁹

Operation Olympic Defender (OOD), USSPACECOM's plan to protect US and allied satellites during a conflict, was created by USSTRATCOM in 2013 and opened for ally participation in 2018.⁸⁰ After having rejected in 2021 an offer to join, Germany joined in October 2024.⁸¹ The group is working on how to share SSA data in order to develop a common operating picture of space and is now called Multi-National Force-OOD (MNF-OOD).⁸²

Potential Military Utility /

Germany officials have expressed interest in inspector satellites and spaceplanes and its new *Space Safety and Security Strategy* calls for researching those kinds of capabilities, so it is possible that Germany could have a co-orbital counterspace capability eventually. Germany's recent acceptance of the Arrow 3 ballistic missile defense system gives it a latent DA-ASAT capability, although it was not designed nor tested for that mission. As well, the preference is to have non-debris-causing ways to interfere with adversary satellites, so this is less likely to be used. German officials' statements about lasers, combined with its plans to spend €35 billion on space defense systems by the end of the decade, means that DEW could be explored but it would be unlikely to serve any real military utility in the near-term. Based on Germany's solid existing SSA capabilities and its planned enhancements thereof, it is possible that its SSA capabilities could provide some military utility for both offensive and defensive counterspace operations. Given the policy documents that have come out over the past several years, it does indicate that Germany is looking for an offensive role for its military in space and would consider using counterspace capabilities.

76 Julian Hale, "7 NATO Countries To Join US in Schriever Wargame," *DefenseNews*, April 18, 2012, <http://www.defensenews.com/print/article/20120418/DEFREG02/304180009/7-NATO-Countries-Join-U-S-Schriever-Wargame>.

77 Sandra Erwin, "Schriever Wargame to give allies bigger role as US shifts toward coalition-led space strategy," *SpaceNews*, August 18, 2025, <https://spacenews.com/schriever-wargame-to-give-allies-bigger-role-as-u-s-shifts-toward-coalition-led-space-strategy/>; Christopher W. Chang & Daniel P. Burns, "Schriever Wargame 2025: Space Planning For Future Operations," Space Systems Command Warfighter Integration Office, August 29, 2024, <https://www.ssc.spaceforce.mil/Newsroom/Article-Display/Article/3890751/schriever-wargame-2025-space-planning-for-future-operations>.

78 Courtney Albon, "Space Force wargame could inform framework for allied info sharing," *DefenseNews*, August 7, 2025, <https://www.defensenews.com/space/2025/08/07/space-force-wargame-could-inform-framework-for-allied-info-sharing/>.

79 Sandra Erwin, "Schriever Wargame to give allies bigger role as US shifts toward coalition-led space strategy," *SpaceNews*, August 18, 2025, <https://spacenews.com/schriever-wargame-to-give-allies-bigger-role-as-u-s-shifts-toward-coalition-led-space-strategy/>; Christopher W. Chang & Daniel P. Burns, "Schriever Wargame 2025: Space Planning For Future Operations," Space Systems Command Warfighter Integration Office, August 29, 2024, <https://www.ssc.spaceforce.mil/Newsroom/Article-Display/Article/3890751/schriever-wargame-2025-space-planning-for-future-operations>.

80 Theresa Hitchens, "'Major Milestone' as Allies Join SPACECOM's War Plan," *Breaking Defense*, May 21, 2020, <https://breakingdefense.com/2020/05/major-milestone-as-allies-join-spacecoms-war-plan/>.

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09

IRAN

51.3890°E

Iran has a nascent space program, building and launching small satellites that have limited capability. Technologically, it is unlikely Iran has the capacity to build on-orbit or direct-ascent anti-satellite (DA-ASAT) capabilities, and little military motivation for doing so at this point. Iran's military has an independent ability to launch satellites, separate from Iran's civil space program. Iran has not demonstrated any ability to build homing kinetic kill vehicles, and its ability to build nuclear devices is still constrained. Iran has demonstrated an electronic warfare (EW) capability to persistently interfere with commercial satellite signals and Starlink ground terminals, although its capacity to interfere with military GPS signals is difficult to ascertain.

9.1 – IRANIAN CO-ORBITAL ASATS

Iran has no known co-orbital ASAT capabilities or development program, and its indigenous satellite manufacturing and operations capabilities are very basic. Iran has put a small number of low-mass satellites on orbit, starting with liquid-fulled SLVs like the Safir and Simorgh, but it has had recent success with mix- and solid-fuelled SLVs built by the Iran Revolutionary Guard Corps (IRGC) like the (respectively) Qassed and Qaem-100. Its pace of launch attempts is slow, possibly due to sanctions on its ability to make progress, or perhaps because it is sensitive to international reaction to satellite launches because of their similarities to ballistic missile launches.

Iran has not demonstrated the ability to manufacture satellites with significant on-orbit maneuverability or remote sensing capabilities, nor the ability to successfully conduct precision command-and-control (C2), which would be necessary to develop an effective co-orbital ASAT capability.

9.2 – IRANIAN DIRECT-ASCENT ASATS

Assessment /

There is no public evidence that Iran has developed, or is developing, a dedicated DA-ASAT capability. However, Iran does have a robust ballistic missile program, including a demonstrated satellite launch vehicle, which could theoretically be used as a DA-ASAT rocket. It would still need to be combined with several other technologies that Iran has not yet tested.

Specifics /

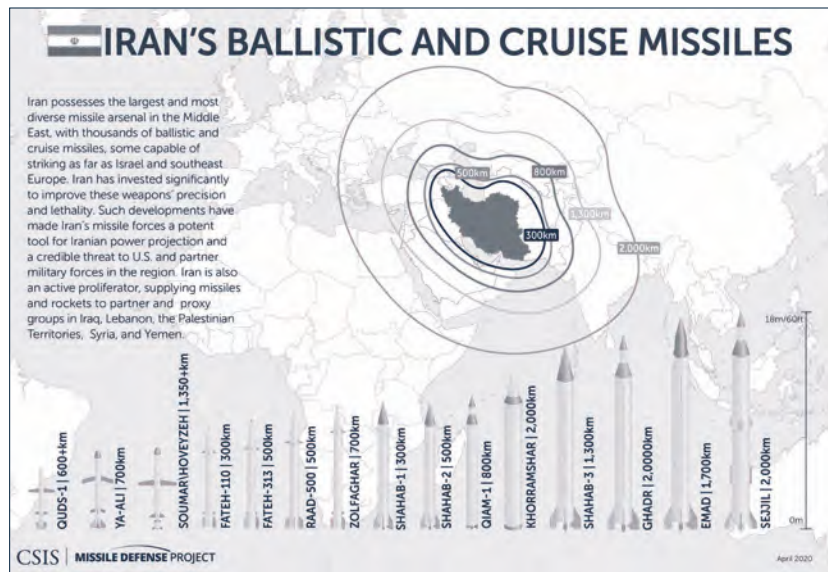
Iran has several short- and medium-range ballistic missiles, either in operational status or in development, with estimated ranges from 150 km to more than 2,000 km. The longer-range missiles could theoretically be used as the basis for a DA-ASAT rocket, with a potential ceiling of roughly half their ballistic range. There is no evidence Iran has ever tested its ballistic missiles in this role, nor that it has a program to develop this capability.

There are some who claim Iran is developing the ability to create crude electromagnetic pulse (EMP) weapons by putting nuclear-tipped ballistic missiles on ships. Such weapons, they argue, could be used to conduct surprise attacks on national power grids, or as an indiscriminate ASAT weapon.¹ However, many other experts discount Iran's ability to use a primitive nuclear device in this way² and state that this is a scare tactic designed to promote missile defense.³

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FIGURE 9-1 – IRANIAN BALLISTIC AND CRUISE MISSILES

Image Credit: CSIS⁴

Civil Space Launch Vehicles

Iran started off with the Safir launch vehicle, which launched from the Semnan Space Launch Complex (see Imagery Appendix, pg. 17-20). Iran's first vehicle to make it to space was a version of the Safir called Kavoshgar-1, launched in February 2008.⁵ It had two stages and reached an altitude of 200 km; while it did not place a satellite into orbit, it did carry scientific instruments to collect and reportedly transmit data.⁶ A year later, in February 2009, Iran used a version of the Safir called the Safir-2 to place its first domestically-built satellite, Omid (2009-004A, 33506) into space; it was designed to be a data-processing satellite.⁷ Iran used its Safir LV (this time, the Safir-1B) to place an imaging satellite, Rasad (2011-025A, 37675) into orbit in June 2011.⁸ Intended to help with mapping and topography missions, its images had a resolution of 150 m; as well, its mass was 15.3 kg. The Safir-1B was again used in February 2012 to place a third satellite, Navid (2012-005A, 38075), into orbit; this satellite's mission was to collect weather information and take images with a resolution of 400 m.⁹ A fourth satellite, Fajr (2015-006A, 40387), was launched with the Safir-1B in February 2015.¹⁰ The 50-kg satellite was an imaging satellite with resolution thought to be 500 meters; it also had cold gas thrusters to use as an on-board propulsion system if it needed to raise its orbit.¹¹

The Safir's follow-on launch vehicle is the Simorgh, which had a troubled development. Simorgh shares some design similarities with the North Korean Unha SLV and was initially meant to have been launched in 2010.¹² In April 2016, the first known test of the Simorgh was reported by US intelligence agencies to have been a "partial success" but did not reach orbit.¹³ A second test in July 2017 was reported by Iranian press to have been a success, but US intelligence officials stated it was a catastrophic failure and no objects reached orbit.¹⁴ A January 2019 launch of the Simorgh saw its third stage not reach its "necessary speed" per Iranian officials and thus failed to place its satellite, Payem, in orbit.¹⁵ It appeared that Iran suffered another launch failure, as Iranian officials announced that a satellite called Doosti was ready to be launched on Feb. 4, 2019; satellite images from the following days showed activity at the Imam Khomeini Space Center that appeared that a launch had occurred but Iranian officials never confirmed it.¹⁶

In February 2020, Iran tried to launch the Zafar 1, a communications satellite, via the Simorgh SLV. However, it experienced an anomaly at some point between the second and third stages. Defense Ministry space program spokesperson Ahmad Hosseini stated, "Stage-1 and stage-2 motors of the carrier functioned properly and the satellite was successfully detached from its carrier, but at the end of its path it did not reach the required speed for being put in the orbit."¹⁷ An unsuccessful space launch was detected by US military analysts in June 2021; it is unclear what rocket was used, but it is possible that it was a Simorgh. A second launch may have been held at that same launch pad later that month, possibly of a Simorgh again.¹⁸ In December 2021, Iran launched a Simorgh with three payloads on-board, none of which appear to have made it to orbit.¹⁹

A successful launch of the Simorgh SLV finally occurred in January 2024, when a Simorgh lifted three satellites to an altitude of 450 km. The four objects from the launch have only been catalogued as Object A (2024-018A, 58849), Object B (2024-018B, 58850), Object C (2024-018C, 58851), and Object D (2024-018D, 58852) and it is unclear which satellite corresponds to which object. Two cubesats, Kayhan-2 and Hatef-1, are intended to test narrowband communication and geopositioning technology. A larger third satellite, Mehda, is described as a "research satellite" intended to help the ISA ascertain how well the Simorgh is at placing objects in orbit.²⁰

In December 2024, a Simorgh LV was launched from the Imam Khomeini Space Launch Terminal and via a multi-phase mission, took to orbit a domestically designed and manufactured space tug (Saman-1), as well as a nanosat (Fakhr-1 communication satellite) and an unnamed research payload.²¹ The Saman-1 was designed at the Iranian Space Research Center and is intended to bring satellites to higher orbits to obviate the need for bigger SLVs.²² The launch put its payloads (Iran's heaviest indigenously-launched payload to date) in an elliptical orbit where the apogee is 410 km and the perigee is 300 km.²³

The Aerospace Industries Organization (AIO), a civilian entity, has announced plans to develop three new SLVs. The first is the Sarir, a follow-on to the Simorgh, and is intended to be a liquid-fuel SLV that can take payloads up to 700 kg to 1000 km.²⁴ Then there is the Soroush, which is supposed to use parallel booster rockets to get payloads to geosynchronous orbit, and the Soroush-2, which is intended to use cryogenic fuels to enable payloads up to 2500 kg to reach GEO.²⁵ These are all notional and have yet to appear on any launch pads.

Military Space Launch Vehicles

In addition to the civil SLVs being developed by the Iranian Space Agency, the Iranian military is also developing their own SLV that has shown more success. Satellite imagery has detected a limited number of what appear to be engine tests at the Islamic Revolutionary Guard Corps (IRGC)'s Jihad Self-Sufficiency Organization at the Shahroud facility (see Imagery Appendix, pg. 17-21), and in February 2020, Iranian officials released imagery of a motor being tested there, which they stated was of the Salman engine (intended to be a smaller upper stage motor).²⁶ Footage showed that the developers appear to have been able to make at least two technologies that would be helpful for an SLV program and also a long-range ballistic missile capability: carbon fiber motor casings and thrust vector control (via flexible nozzles).²⁷ The same day that the Salman motor footage was released, Iranian news reported that a solid fueled SLV, the Zuljanah, was finished and would be able to launch the Nahid I satellite, potentially as early as June 2020.²⁸

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Footage of the launch of the Zuljanah rocket was aired on Iranian television in February 2021. The launch did not attempt to put a satellite in orbit, but Iranian defense ministry officials who oversaw the program stated that it could carry one 220 kg-sized satellite or 10 smaller ones.²⁹ Satellite imagery in February 2022 showed the aftereffects of an apparent explosion at the Imam Khomeini Spaceport; the damaged gantry resembled the one used for launching the Zuljanah satellite launch vehicle in 2021.³⁰ Reports emerged in June 2022 that Iran had launched the Zuljanah SLV but it is unclear when the launch occurred. Again, the Zuljanah did not appear to be carrying any satellites.³¹

In April 2020, the IRGC launched from its Shahroud base a satellite (Noor-1, 2020-024A, 45529) on a previously unknown SLV, the Qassed.³² This SLV used a combination of liquid and solid fuel, based respectively on the Iranian Ghadr-110 medium-range ballistic missile and Salman solid-fueled rocket engine. The Qassed has three stages and can be launched via a TEL. Noor-1 was described as a military reconnaissance satellite which appears to be a 6U cubesat; it was detected in an SSO at an altitude of 425 km and it eventually deorbited in April 2022.³³ Ali Jafarabadi, head of IRGC's space force, announced in June 2020 that Iran is working on an all solid-fuel Qassed-2 SLV, which he said is lighter and can carry payloads farther, and indicated an interest in launching something to GEO.³⁴ In July 2025, Iran held a suborbital flight test of the Qassed, which state media described as "assessing some emerging new technologies in the country's space industry."³⁵

In January 2022, the IRGC reported that it launched a solid-fueled rocket for the first time.³⁶ The IRGC successfully launched Noor-2 (2022-024A, 51954) on the Qassed SLV to an altitude of 500 km in March 2022. This marked the second military satellite in orbit for Iran.³⁷ The third military satellite for Iran, Noor-3 (2023-150A, 57962), was launched in September 2023, also on a Qassed SLV; this is thought to be an imaging satellite and has been tracked to an altitude of about 450 km.³⁸

The IRGC successfully launched a new three-stage, solid-fueled SLV called the Qaem-100 in November 2022 in a test flight that was suborbital.³⁹ In January 2024, the IRGC used the Qaem-100 to place the 50-kg Sorayya satellite (2024-015A, 58817) into an altitude of 750 km, reported to be the highest altitude yet reached by an Iranian satellite.⁴⁰ The IRGC announced after the Sorayya was launched that it intended to test another new SLV, the Qaem-105, within the next year, and the Qaem-120 within three years; the Qaem-120 is planned to allow Iran to reach GEO.⁴¹ In September 2024, the Qaem-100 launched a payload to 550 km altitude: the 60-kg, domestically-developed Chamran-1 (2024-165B, 61072).⁴² Per Iranian state media, its primary mission is "to test hardware and software systems for orbital maneuvering technology." It also is intended to "assess the performance of cold gas propulsion subsystems and evaluate navigation and attitude control systems in space."⁴³

In 2010, Iran announced its plans to create a launch base at Chabahar, along its southeastern coast.⁴⁴ After many years of work, it appears that the initial design and construction phase may be completed by March 2026.⁴⁵ Phase 2, where it can launch international payloads, is to be completed by 2031 and phase 3 - launching solid-fuel LVs - at some point after that.⁴⁶ The Chabahar base is intended to be able to launch larger SVs, and it is also relatively near the equator (25 degrees north latitude), which gives it some advantages to launch satellites in certain orbits.⁴⁷

Foreign Launch Vehicles

Iran does have plans to launch larger satellites, developed both domestically and through bilateral cooperation with other countries.⁴⁸ So far, Russia has been the foreign launcher of choice, starting in October 2005 with the launch of Sina-1 (2005-043D, 28893), Iran's first satellite, designed to conduct remote sensing and telecommunications.⁴⁹ Russia launched another remote sensing satellite ("Khayyam", 2022-096A, 53370) for Iran in August 2022. Iranian officials said that the satellite was intended to conduct environmental monitoring and scientific research.⁵⁰ In 2024, Russia launched Pars-1 (2024-039Q, 59065) in February 2024, while Kowsar (2024-199AL, 61769) and Hodhod (2024-199AK, 61768) (which were reported to have been developed privately) were launched in November.⁵¹ In 2025, Russia launched Iran's Nahid-2 communications satellite (2025-155, 64886) in July as part of a batch with 19 Russian satellites; and in December, Russia launched Iran's Kowsar, Paya (or Tolou-3), and Zafar-2 satellites.⁵² All three satellites have imaging sensors, with Paya having propulsion capabilities in order to station keep and, at 150 kg, is Iran's heaviest Iranian satellite launched to date.⁵³ Russia is also thought to be working on a geostationary communications satellite, "Ekvator," while it is not clear that Iran is the customer, its slot is 34 degrees east longitude, which according to the International Telecommunication Union (ITU), is a slot that is reserved for an Iranian communication satellite.⁵⁴

9.3 — IRANIAN ELECTRONIC WARFARE

Assessment /

Iran has demonstrated an EW capability to persistently interfere with the broadcast of commercial satellite signals and has interfered with Starlink ground terminals, although its capacity to interfere with military signals is difficult to ascertain. It appears to have received at least two EW jammers from Russia.

Specifics /

Iran has been accused of repeatedly interfering with commercial communications satellites' ability to broadcast Persian-language programming into Iran over the last several years. In some cases, it appears Iran coordinated with other States to perform the jamming. For example, the jamming of Telstar 12's broadcast of Persian-language content originating from California was jammed from Havana, Cuba, started in 2003, and eventually, similar jamming occurred from Bulgaria and Libya in 2005/2006.⁵⁵ Eventually, it appears, Iran became able to jam these channels from within its own territory.

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In 2010, the ITU ordered Iran to assist in stopping the jamming originating from its territory, saying that it was acting on two complaints from Eutelsat that its broadcasts of Persian language programs by the BBC and the Voice of America have been interfered with.⁵⁶ Eutelsat stated in October 2022 that two of its satellites were undergoing jamming from transmissions originating in Iran.⁵⁷

Iran may have sufficient electronic warfare capability to interfere with satellite-based command and control signals or GPS signals. In late 2011, a stealthy US RQ-170 Sentinel UAV landed in Iran.⁵⁸ The United States confirmed that a UAV had landed in Iran and asked for its return.⁵⁹ The UAV was reportedly part of an intelligence operation near the Iran-Afghanistan border and there had been no intent for it to land in Iran.

The United States first suggested that the UAV crash-landed because of a technical malfunction and later, because of pilot error. Iran claims that it took command of the UAV and brought it down with little damage. Because these UAVs fly at high altitudes and are stealthy, and the UAV was displayed largely in one piece, it is unlikely that it was shot down. It is also unlikely that Iran took control of the UAV: C2 of such a UAV would typically be done over encrypted military satellite channels that would require extremely sophisticated capabilities to hijack.

Some reporting suggests that instead of gaining direct control of the UAV, Iranian electronic warfare specialists used a combination of techniques to bring it down. The attack would have started by interrupting C2 communications with the UAV. Reportedly, under these circumstances, a drone would be programmed to return to its home base. In an interview, an Iranian engineer claims that Iran then faked or spoofed GPS coordinates so that the drone would land in Iran, not at its home base in Afghanistan.⁶⁰ While the ability to conduct such a spoofing attack on the civil GPS signal has been demonstrated,⁶¹ conducting a similar attack on the military GPS signal would be much more challenging because it is encrypted. It is possible that Iran may have found a way to jam the military GPS signal, forcing the UAV to fall back on the civil signal. After the capture of the sophisticated drone, Iran claims it had been able to break into encrypted data on-board the drone, gaining access to sensitive information about the program, but this is difficult to confirm from public sources.⁶²

In August 2019, the US government issued public warnings to commercial shipping about potential Iranian jamming and spoofing of space services.⁶³ The warning cites several incidents of ships reporting GPS interference, bridge-to-bridge communications spoofing, and/or other communications jamming.⁶⁴ Unnamed US officials told CNN that Iran had placed GPS jammers on Iran-controlled Abu Musa Island near the entrance to the Strait of Hormuz, but so far they have only affected civilian GPS signals and not US military ships and aircraft.

There were reports in March 2020 of "circle spoofing" of GPS devices around the staff college for Iran's Army, the AJA University of Command and Staff.⁶⁵ There was another incident of circle spoofing detected by the fitness app Strava around an Iranian government facility in Tehran.⁶⁶

In September 2023, there were numerous reports of commercial airlines losing their navigation systems when flying in the Middle East, with their GPS information being spoofed so that they thought they were somewhere other than they actually were, causing some to fly off-course.⁶⁷ At times, the spoofing sent aircraft up to 80 nautical miles off-course.⁶⁸ The source of the spoofing

was traced to outside of Tehran. In some cases, it was also reported that the planes' Inertial Reference Systems (IRS), which are supposed to serve as back-ups to GPS, were also corrupted by the spoofing. Some believe that Russia is sharing with Iran EW and GPS-interference lessons learned from its actions in Syria and Ukraine.⁶⁹ GPS interference reportedly followed Iranian Supreme Leader Ali Khamenei as he went on a tour in June 2024, which outsiders thought might have been done to protect him against attacks, particularly following the death of Iranian President Ebrahim Raisi in a helicopter crash in May 2024.⁷⁰ Neshan, an Iranian navigation app, called it "the most extensive GPS disruption" it had recorded, with users in Tehran reporting their positional data was showing that they were at time "significant distances" from where they actually were.⁷¹

The Iranian Army opened an electronic warfare center in eastern Iran in August 2024. The center is called "Jangaal," which is described as "an abbreviation of two Persian words that mean electronic warfare."⁷²

FIGURE 9-2 – COBRA-V8 EW JAMMER



Image Credit: Planet Labs PBC⁷³

Iran is reported to have received the Krasukha-4 and Murmansk-BN EW jamming systems from Russia. The Krasukha has a truck-mounted jammer that is designed to interfere with satellite communications (including those of ISR satellites) and satellite links, and is estimated to have a range of 150-300 km.⁷⁴ Commercial satellite imagery from January 2024 showed the Cobra-V8 EW jammer deployed to Bandahar.⁷⁵ Iran's Cobra-V8 EW jammer is thought by Western analysts to be actually a locally-produced version of the Krasukha; the Iranian government says it to be designed and produced by the Sayran Company of the Ministry of Defense and Armed Forces Support, who has been doing so for over a decade.⁷⁶

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FIGURE 9-3 - MURMANSK-BN SYSTEM WITH FOUR JAMMING ANTENNAS

Image credit: Armada ⁷⁷

The Murmansk-BN is designed to interfere with High Frequency communications with an estimated range of 5000 - 8000 km; it also can interfere with radio signals, satellite communications, and GPS.⁷⁸ It is based on six trucks, four of which carry antennas that are 32 meters high.⁷⁹

As a result of Iran's 12-day war with Israel in June 2025, Iran jammed GPS over several metropolitan areas in Iran to thwart drone and missile attacks. Deputy Communications Minister Ehsan Chitsaz acknowledged, "Some of the disruptions to the GPS system originate from within the country for military and security purposes." Domestic and international navigation apps were telling users that they were in different parts of the country and the world and showed wrong maps.⁸⁰ During that war and for a period after, tankers in the Strait of Hormuz reported GPS jamming (the Maritime Information Cooperation & Awareness, or MICA, Center estimated 970 ships per day experienced this), causing traffic through the Strait to drop by 20 percent as many ships chose to pass through during daylight hours only.⁸¹

During protests in January 2026, Starlink users in Iran reported interference with their internet access, with some users undergoing packet losses of 30-80 percent.⁸² It turned out that the Starlink ground terminals were getting their GPS units spoofed,⁸³ which impaired their ability to connect to Starlink satellites; once users switched their settings so that they were using Starlink's own internal position estimates and not GPS, this interference dropped.⁸⁴ As well, SpaceX released a software update to help Starlink avoid interference.⁸⁵

On the other side, hackers were able in January 2026 to insert videos of the exiled Crown Prince Reza Pahlavi and what looked like Iranian forces into several channels of the Iranian state broadcaster, with one graphic that read, "This is a message to the army and security forces...Don't point your weapons at the people. Join the nation for the freedom of Iran."⁸⁶

9.4 – IRANIAN SPACE SITUATIONAL AWARENESS CAPABILITIES

Iran is developing some SSA capabilities that in theory could eventually be used to track targets and be used in future counterspace capabilities, but currently appear to be very limited in capability and coverage. In 2013, a center in Delijan (see Imagery Appendix, pg. 17-57) was opened that was intended to provide Iran with space object monitoring capabilities via electro-optical, radar, and radio methods.⁸⁷ As a member of Asia-Pacific Space Cooperation Organization (APSCO), Iran is part of its Asia Pacific Ground-Based Space Object Observation System (APOSOS) and had a telescope installed in support of that in 2016.⁸⁸ In 2018, Brigadier General Hossein Salami, the deputy commander of Iran's Islamic Revolutionary Guard Corps, said that Iran had the ability to monitor satellites in LEO.⁸⁹

9.5 – IRANIAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

The IRGC announced in April 2020 the existence of its Aerospace Force's Space Command.⁹⁰ Iranian presidents put a lot of emphasis on Iran's space program. For example, then-president Ebrahim Raisi chaired a meeting of the Supreme Space Council in 2021, which had not convened in over a decade, where he said that Iran would be able to reach GEO by 2026; as of February 2026, this has not happened.⁹¹ The meeting also resulted in a launch schedule going through March 2023 to deal with some of the backlog of Iranian satellites waiting to be launched.⁹² In February 2023, it was reported that the Raisi administration wished to turn Iran into an exporter of space technology services within a year or the end of the Raisi administration, again, demonstrating the government's continued interest in enhancing its domestic space capabilities.⁹³ President Masoud Pezeshkian said in February 2025 that "We have worked to continuously strengthen our defense capabilities with the efforts of dedicated, innovative young scientists. This development will continue, and dear Iran will join the ranks of countries conducting extraterrestrial flights, showcasing our nation's scientific strength."⁹⁴

In an effort to achieve independence from the US-created GPS position, navigation, and timing (PNT) system, Iran was reported in 2016 to have designed and manufactured its own Local Positioning System, "Hoda."⁹⁵ Intended to be carried out in three stages, the first stage was to consist of "15 network stations and two data centers" collecting positional data.⁹⁶ It is not thought to have full national coverage.⁹⁷

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Potential Military Utility /

Iran's current counterspace efforts appear focused on electronic warfare and cyber attacks, and not on destructive counterspace capabilities. Its satellites are very short-lived, and without sophisticated rendezvous and proximity technology or C2 capabilities, it is extremely unlikely Iran could command a co-orbital ASAT to deliberately collide with another satellite with any degree of certainty. The best Iran could hope for would be to increase the possibility of a risk of collision to a degree that might force its adversary to alter the trajectory of their satellite. Iran is not known to possess the technology for a kinetic kill vehicle that would be capable of a DA-ASAT attack. If Iran can produce a working nuclear weapon and miniaturize it, develop a ballistic missile or SLV that can carry it, and mate the two, it would theoretically be possible to conduct a crude EMP attack against LEO satellites. However, it would be extremely difficult to direct such an attack against specific satellites, and most US military satellites are hardened against radiation and EMP effects. Such an attack would also have indiscriminate effects against many other non-military satellites in LEO.⁹⁸

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In 1988, Israel became the eighth country to be able to launch its own satellite into orbit. It has maintained a space program that has largely been civil in nature and co-developed a missile defense system that has been until recently strictly for endoatmospheric interception of rockets. However, in recent years Israel has moved to expand its military space program and launched a Space Directorate Unit within the Israel Defense Forces (IDF). Moreover, there is evidence it has developed counterspace capabilities. These include the recent demonstration of an exoatmospheric missile defense intercept capability and use of EW in active military conflicts. It is possible that Israel has additional counterspace capabilities that are not publicly visible or documented.

10.1 – ISRAELI CO-ORBITAL ASATs

While Israel does not have any known co-orbital capabilities, executives at the government-owned company Israel Aerospace Industries (IAI) have expressed interest in collaborating on the US Golden Dome missile shield architecture and are waiting on a response as of January 2026; if so, the space-based interceptors that are intended to be part of that architecture could provide Israel with a co-orbital capability.¹ These executives are interested in integrating IAI's Arrow interceptor technology within two layers of the Golden Dome project.² According to IAI Chief Executive Boaz Levy, the Arrow 3 system, developed jointly between Israel and the United States, with some "adaptation," could potentially serve as a space-based interceptor.³

10.2 – ISRAELI DIRECT-ASCENT ASATs

Israel has never tested DA-ASAT technologies or had an explicit DA-ASAT development program, but likely has an inherent DA-ASAT capability from part of its ballistic missile defense system. The Arrow 3, which is co-developed by the Israel Missile Defense Organization (IMDO) and the US Missile Defense Agency, is the most viable platform. In 2009, Yitzhik Ben-Israel, then chairman of the Israel Space Agency, noted that "If there's a threat from space, a logical answer is the Arrow upper tier" missile defense system.⁴

While the exact capabilities of the Arrow 3 in a counterspace role are unknown, it reportedly achieved an exoatmospheric intercept for the first time in November 2023 when it was used to intercept a long-range missile fired from Houthi-controlled Yemen.⁵ It is unclear at what altitude the intercept was made, only that it was likely above 100 km. The Arrow 3's range suggests that it can theoretically intercept targets up to 1200 km but its manufacturer, IAI, estimates that the system is able to intercept ballistic missiles fired from a distance of up to 2,400 kilometers.⁶ However, its ability to track and target objects at that altitude is unknown and undemonstrated. IAI officials have acknowledged the need to upgrade their ability to differentiate targets in a crowded field.⁷

10.3 – ISRAELI ELECTRONIC WARFARE

There have been reports of interference with aircraft navigation systems for years in the eastern Mediterranean region. In spring 2023, these included reports of GPS jamming occurring over Israel and the eastern Mediterranean region, with Israeli EW systems reportedly bringing down at least one Iranian drone.⁸ In April 2023, there was a particularly high level of GPS interference with aircraft guidance systems: 20 percent of civilian aircraft flying in the region reported interference with their navigation systems.⁹

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- 17 Joseph Gedeon, "Can't teach an old GPS new tricks," *Politico Weekly Cybersecurity*, May 8, 2024, <https://www.politico.com/newsletters/weekly-cybersecurity/2024/05/28/cant-teach-an-old-gps-new-tricks-00160066>. "Israel's GPS warfare aims to keep its own drones flying and enemies baffled," *The Times of Israel*, February 23, 2024, <https://www.timesofisrael.com/israels-gps-warfare-aims-to-keep-its-own-drones-flying-and-enemies-baffled/>.
- 18 "Harmful Interference to Radio Navigation Satellite Service (RNSS)," International Telecommunications Union, November July 2025, <https://www.itu.int/harmful-interference-to-rnss/>.
- 19 "Harmful Interference to Radio Navigation Satellite Service (RNSS)," *ibid*.

After the Hamas surprise attack in Southern Israel on October 7, 2023, the amount of jamming activities in the region increased quickly, with a focus on GPS interference and jamming of communications networks. It is hard to distinguish from open sources whether the EW is being conducted by Israel, Hamas, or potentially other actors.¹⁰ The GNSS interference was degraded to the point where air traffic into Ben Gurion Airport in Israel had slowed considerably due to flight safety concerns.¹¹ As the war has progressed, the Israeli Defense Forces (IDF) stated publicly that it was jamming GPS in the region "in a proactive manner for various operational needs. Citizens should be aware that the disruption can cause various and temporary effects on location-based applications."¹² Pilots were reportedly warned to not depend on GPS when landing in Israel.¹³ The GPS interference was reported to be both jamming and spoofing. In March 2024, Lebanon's Foreign Affairs Minister declared in a statement that, "Lebanon holds Israel internationally responsible for the consequences of any accident or disaster caused by Israel's deliberate policy of jamming air and ground navigation systems, and deliberately disrupting signal receiving and transmitting devices" and added that Lebanon will file a complaint with the UN Security Council.¹⁴ In April 2024, researchers working on the origin of false signals affirmed that spoofing activities against GPS signals were conducted from an Israeli air base, causing the US-operated Global Positioning System to list planes, people, and ships in false locations.¹⁵ The same month, disruptions in GPS services were noticed in Jordan and neighboring countries, affecting air traffic management and GPS-enabled applications.¹⁶ According to observers, these capabilities have been used for defense against vehicles and systems flying at a very low altitude, and in May 2024, interferences were reported to occur preemptively, in anticipation of potential drone strikes.¹⁷

At the 100th Radio Regulations Board (RRB) Meeting of the International Telecommunications Union (ITU) in November 2025, the Board highlighted Addendum 6 to Document RRB25-3/11, which contained a submission from the Administration of Israel.¹⁸ Within this submission, the Administration of Israel gave information on its efforts pointed out harmful interference cases to receivers in the RNSS, including their commitment to implement operational safeguards, ensuring that transmissions that interfered with receivers in the RNSS were strictly limited to "situations where there was an imminent and verifiable threat to human life or critical national infrastructure, and in such cases, did not exceed a duration of 15 minutes," after a July 2025 meeting with Jordan and Egypt.¹⁹ Since then, no complaint regarding cases of interference to the RNSS has been reported.

10.4 – ISRAELI DIRECTED ENERGY WEAPONS

Israel is developing a high-energy laser weapon called “Iron Beam” which is part of its Iron Dome defense system. The Iron Beam is a 100 kw laser that is intended to be used against air-breathing threats.²⁰ It is unclear whether Iron Beam could be used against exo-atmospheric targets for dazzling purposes, given it is said to have a range of a few kilometers.²¹ It should be noted that in December 2024, Rafael chairman Yuval Steinitz explained that larger laser beams suffer increased atmospheric interference when weaponized, air disperses their energy, rendering them ineffective at high altitude or over long ranges.²² In January 2025, Rafael announced having signed a contract with the Israel Ministry of Defense for the expansion of Iron Dome interceptor production, including advanced Laser Defense System.²³ In March 2025, Defense Minister Israel Katz announced that the Rafael-produced Iron Beam laser air defense system would be operational before the end of 2025; this was after several years’ worth of delays in the program.²⁴ However, in this case, it proved accurate as Iron Beam was declared operational in late 2025 after completing final tests.²⁵

In May 2025, Israel’s Ministry of Defense announced that the Israeli Air Force Aerial Defense Array deployed and operated a high-power laser system prototype. This prototype reportedly successfully intercepted enemy threats and according to Brig. Gen. Yehuda Elmakias, head of the research and development unit at the Israel Ministry of Defense’s Directorate for Defense R&D (DDR&D), this deployment “culminat(ed) in the world’s first successful high-power laser interceptions on the battlefield.”²⁶

10.5 – ISRAELI SPACE SITUATIONAL AWARENESS CAPABILITIES

Israel has limited SSA capabilities that are primarily derived from its ELM-2080 Green Pine missile defense radar.²⁷ The system was developed as part of the Arrow missile defense system and is known to have a range of 500-900 km, which could be used to track objects in LEO.²⁸ Versions of the radar have been exported to India (see Indian Space Situational Awareness, Section 4.4), (see South Korean Space Situational Awareness, Section 13.3).

The United States and Israel signed an SSA sharing agreement in 2015, but it appears more to have been a way to “streamline the process for USSTRATCOM partners to request specific information gathered by its Joint Space Operations Center;” it is unclear if SSA information is shared in both directions between the United States and Israel.²⁹

10.6 – ISRAELI COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

The Space and Satellite Administration was created within the Israeli Ministry of Defense in the 1980s, while the Israeli Space Agency (ISA) was created in 1983 and operates within its Ministry of Science and Technology (MOST).³⁰ The Israeli government agencies focus on scientific research and development for economic benefit, as well as ensuring Israel’s national security is strengthened. The chair of IAI, Boaz Levy, stated in a May 2023 interview that “Israel is working on space warfare capabilities;” he went on to say, “This is an area in which all the superpowers are investing, and if you ask me if I see it happening – then yes, I see it happening, but I don’t know when it will happen.”³¹ IAI is owned by the Israeli government but it is not clear that he was speaking for the

20 Mikayla Easley, “Israeli-Made High-Energy Laser Makes Debut,” *National Defense*, March 21, 2023, <https://www.nationaldefensemagazine.org/articles/2023/3/21/israeli-made-high-energy-laser-makes-debut>.

21 “Iron Beam High Energy Laser Weapon System,” *Rafael*, accessed February 29, 2024, <https://www.rafael.co.il/worlds/land/iron-beam/>.

22 Stew Magnuson, “Israel’s Iron Beam Set For Historic Deployment,” *National Defense*, January 29, 2025, <https://www.nationaldefensemagazine.org/articles/2025/1/29/israels-iron-beam-set-for-historic-deployment>.

23 “Rafael Signs Contract with Israeli MOD for Expansion of Iron Dome Interceptor Production under US Aid Package,” *Rafael*, January 28, 2025, <https://www.rafael.co.il/news/rafael-signs-contract-with-israeli-mod-for-expansion-of-iron-dome-interceptor-production-under-u-s-aid-package/>.

24 “Israeli DM Katz announces Iron Beam defense system to be operational before year’s end,” *All Israel News*, March 16, 2025, <https://allisrael-news.com/israeli-dm-katz-announces-iron-beam-defense-system-to-be-operational-before-year-s-end>.

25 Ryan Finnerty, “Rafael’s Iron Beam laser air defense system enters operational service in Israel,” *Flight Global*, February 3, 2026, <https://www.flightglobal.com/military-uavs/rafaels-iron-beam-laser-air-defence-system-enters-operational-service-in-israel/166193.article>.

26 Chris Panella, “Israel becomes the first country the first country to down drones in combat with laser weapon,” *Business Insider*, May 31, 2025, <https://www.businessinsider.com/see-israels-laser-weapon-the-first-shoot-down-drones-war-2025-5>.

27 “ELM-2080 Green Pine Radar,” *IAI*, accessed March 1, 2024, <https://www.iai.co.il/p/elm-20802080s-green-pine>.

28 “Green Pine Radar (Israel),” *Missile Defense Advocacy Alliance*, accessed on February 26, 2024, <https://missiledefenseadvocacy.org/defense-systems/green-pine-radar-elm-2080-israel/>.

29 “US Strategic Command signs space data-sharing agreement with Israel,” US Strategic Command Public Affairs, August 12, 2015, <https://www.stratcom.mil/Media/News/News-Article-View/Article/983672/us-strategic-command-signs-space-data-sharing-agreement-with-israel/>.

30 “Space and Satellite Administration,” Copyright Israeli Ministry of Defense 2018, https://english.mod.gov.il/About/Innovative_Strength/Pages/Space_and_Satellite_Administration.aspx; “About the Israeli Space Agency,” accessed February 11, 2024, <https://www.space.gov.il/en/about>.

31 Yoav Limor, “Israel is working on space warfare capabilities,” *Israel Hayom*, May 3, 2023, <https://www.israelhayom.com/2023/05/03/israel-is-working-on-space-warfare-capabilities/>.

- 32 "Ready for take-off: A look inside the IDF's new Space Directorate Unit," *The Jerusalem Post*, March 18, 2024, <https://www.jpost.com/israel-news/defense-news/article-792560>.
- 33 "Israel's Statement to the LSC 2023 under General exchange of views," Israel, Item 3, at United Nations Committee on Peaceful Uses of Outer Space Legal Subcommittee Meeting, March 22, 2023, https://www.unoosa.org/documents/pdf/copuos/lsc/2023/Statements/22_AM/3_Israel_22Mar_AM.pdf.
- 34 LaDonna Davis, "US Space Command hosts Global Sentinel 2025 exercise," United States Space Force, May 6, 2025, <https://www.spaceforce.mil/news/article-display/article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.
- 35 Davis, "US Space Command hosts Global Sentinel 2025 exercise," *ibid*.
- 36 Davis, "US Space Command hosts Global Sentinel 2025 exercise," *ibid*.
- 37 Anna Ahronheim, "From Gaza to Iran, Israel readies space 'surprises' for next conflicts - exclusive," *The Jerusalem Post*, February 3, 2026, <https://www.jpost.com/defense-and-tech/article-885413>.
- 38 Ahronheim, "From Gaza to Iran, Israel readies space 'surprises' for next conflicts - exclusive," *ibid*.

Israeli government. In February 2024, the Israel Defense Forces announced the launch of a Space Directorate Unit, composed of two structures: satellite projects and cooperation with the Air Force and defense systems.³² While Israel has been working on national legislation regarding space, it is still in draft form.³³

Israel participated in US Space Command's Global Sentinel 2025 in April 2025 (see US Counterspace Policy, Doctrine and Organization, Section 1.6).³⁴ This event included nearly 30 partner nations, including NATO, aiming to strengthen international partnerships, collaboration, and responsible space behaviors.³⁵ The Global Sentinel exercised a dedicated Global Sentinel version of Space-Track.org for capstone modeling and simulation gameplay, replicating potential real world events through this usage.³⁶

In February 2026, Avi Berger, Head of the Space Office at the Defense Ministry's Directorate of Defense Research & Development (MAFAT), noted that Israel is continuing to develop space-based capabilities to gain advantages in their war against Iran.³⁷ Berger emphasized that, "We knew right away that we had to build and create new surprises for the next war...Whatever was deployed in June won't be enough next time. The IDF now has new capabilities—and we can't forget that the enemy will be different next time around, too."³⁸

Potential Military Utility /

Israel's current counterspace capabilities appear focused on electronic warfare and interference with navigation systems, are reversible and temporary in nature, and are being used in an active military conflict. While it has a theoretical DA-ASAT capability with its Arrow 3 missile defense system, it has not been tested in that capacity.

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11

JAPAN

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Japan has long been a well-established space actor and its space activities have historically been non-military in nature. In 2008, Japan released a *Basic Space Law* that allowed for national security-related activities in space and since then, government officials have begun to publicly speak about developing various counterspace capabilities and military SSA capacity. Japan has reorganized its military space activities and is focusing on the development of enhanced SSA capabilities to support military and civil applications. While Japan does not have any acknowledged offensive counterspace capabilities, it has policy guidance that calls for developing counterspace capabilities to defend Japanese satellites. Japan does have a latent DA-ASAT capability via its missile defense system but has never tested it in that capacity.

11.1 – JAPANESE CO-ORBITAL ASATs

In August 2019, the Japanese government announced that it was deliberating whether to develop a satellite that could be used to intercept foreign satellite threats.¹ The goal was to decide in the following fiscal year whether to do so. According to a senior Ministry of Defense official, this capability would be developed because Japan's Self-Defense Forces (SDF) "don't have any defense capability for the satellites."² To develop this counterspace capability, the Japanese government reportedly researched different ways in which to interfere with satellite threats, including cyberattacks, radiofrequency interference (RFI), and robotic arms.³ In July 2025, Japan's Ministry of Defense published the nation's first guidelines for space domain defense, which introduced a program to develop "bodyguard satellites" for the protection of Japanese space assets. The space domain defense guidelines stated that development and demonstration tests of these satellites are scheduled to be conducted by FY2029.⁴

11.2 – JAPANESE DIRECT-ASCENT ASATs

Japan has no designated direct-ascent anti-satellite (DA-ASAT) systems under development or in operation. However, it does have the SM-3 sea-based ballistic missile defense interceptor, which the United States demonstrated in 2008 could be used to intercept a satellite with only a software modification (see US Direct-Ascent ASAT, Section 1.2). A similar software modification might enable Japan to have a DA-ASAT capability against satellites 600 km or lower, although Japan has never tested the SM-3 in that capacity nor expressed a desire to develop it.⁵ Japan is also working with the United States on the 3rd stage rocket motor and nose cone of the SM-3 Block IIA interceptor, which is intended to be a more capable hit-to-kill missile interceptor. The SM-3 Block IIA has a faster burn-out speed than its earlier iteration and could theoretically reach any satellite in LEO if used in a DA-ASAT role.⁶ The SM-3 Block IIA successfully intercepted a threat-representative ICBM target during a flight test in November 2020.⁷ Two Japanese destroyers launched SM-3 Block IIAs (done so for the first time from a Japanese vessel) and successfully made exo-atmospheric intercepts of their targets during a ballistic missile defense test run jointly in Hawaii with the United States in November 2022.⁸ In 2024, Raytheon announced that the SM-3 Block IIA reached full-rate production, which is set to continue through February 2031.⁹

11.3 – JAPANESE ELECTRONIC WARFARE

The Japanese government has considered developing jamming capabilities that could be used against both airborne warning and control system

1 "Satellite interceptor sought by mid-2020s," *The Japan News*, August 19, 2019, <https://the-japan-news.com/news/article/0005948349>.

2 "Satellite interceptor sought by mid-2020s," *ibid.*

3 Daniel Darling, "Japanese Government Considers Launching a Satellite Interceptor," *Defense and Security Monitor*, August 26, 2019, <https://dsm.forecastinternational.com/wordpress/2019/08/26/japanese-government-considers-launching-a-satellite-interceptor/>.

4 Jesse Johnson, "'Killer satellites' beware: Japan unveils first space defense guidelines," *The Japan Times*, July 29, 2025, <https://www.japan-times.co.jp/news/2025/07/29/japan/politics/japan-space-defense-guidelines/>.

5 Laura Grego, "The AntiSatellite Capability of the Phased Adaptive Approach Missile Defense," *Federation of American Scientists*, Winter 2011, p. 3, <https://fas.org/pubs/pir/2011winter/2011Winter-Anti-Satellite.pdf>.

6 Grego, "The AntiSatellite Capability of the Phased Adaptive Approach Missile Defense," *ibid.*

7 Ronald O'Rourke, "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress Updated," *Congressional Research Service Report RL33745*, December 17, 2019, p. 3, <https://fas.org/sqp/crs/weapons/RL33745.pdf>; "US Successfully Conducts SM-3 Block IIA Intercept Test Against an Intercontinental Ballistic Missile Target," US Department of Defense, November 17, 2020, <https://www.defense.gov/Newsroom/Releases/Release/Article/2417334/us-successfully-conducts-sm-3-block-ii-a-intercept-test-against-an-intercontinen/>.

8 Dzirhan Mahadzir, "Two Japanese Destroyers Score in Ballistic Missile Defense Test off Hawaii," *USNI News*, November 21, 2022, <https://news.usni.org/2022/11/21/two-japanese-destroyers-score-in-ballistic-missile-defense-test-off-hawaii>.

9 John Hill, "SM-3 Block IIA production reaches full-rate production," *Naval Technology*, October 17, 2024, <https://www.naval-technology.com/news/sm-3-block-ii-a-production-reaches-full-rate-production/?cf-view>.

- 10 "Satellite interceptor sought by mid-2020s," *The Japan News*, August 19, 2019, <https://the-japan-news.com/news/article/0005948349>.
- 11 "Japan requests record \$50 billion defense budget in eighth straight increase," *The Defense Post*, August 30, 2019, <https://thedefensepost.com/2019/08/30/japan-record-defense-budget-50-billion/>.
- 12 Kosuke Takahashi, "Japan pushes ahead with plans to develop a new EW aircraft based on the Kawasaki P-1," *Naval News*, September 20, 2024, <https://www.navalnews.com/naval-news/2024/09/japan-pushes-ahead-with-plans-to-develop-a-new-ew-aircraft-based-on-the-kawasaki-p-1/>.
- 13 Justin Katz, "Japan to get US Navy's Lockheed-made EW system in first international sale," *Breaking Defense*, October 29, 2024, <https://breakingdefense.com/2024/10/japan-to-get-us-navys-lockheed-made-ew-system-in-first-international-sale/>.
- 14 Doug Messier, "Preventing Collisions Between Debris and Spacecraft," *Parabolic Arc*, May 9, 2017, <http://www.parabolicarc.com/2017/05/09/preventing-collisions-between-debris-spacecraft/#more-61468>; OHKAWA Shuichi, TAJIMA Mika, WATANABE Masato, ONO Katsuhiko, ODA Hiroshi, UEMOTO Arimi, SAWAMURA Shohtaroh, SAKURAI Yasuyuki, HINAGAWA Hideaki, "Operational Status Report on JAXA's SSA System," 11th Space Debris Workshop, November 30, 2024, <https://jaxa.repo.nii.ac.jp/record/2001415/files/AA2430008042.pdf>.
- 15 "Operational Status Report on JAXA's SSA System," *ibid.*
- 16 "ASDF space operations unit established to monitor space debris and satellites," *The Yomiuri Shimbun*, March 19, 2022, <https://japannews.yomiuri.co.jp/politics/defense-security/20220319-12551/>.
- 17 "Protecting Space Security: A New Mission for Japan's Self-Defense Forces," *The Government of Japan*, August 2, 2024, https://www.japan.go.jp/kizuna/2024/08/protecting_space_security.html.
- 18 "Japan to launch second counterspace operations unit in fiscal 2022," *Nikkei Asia*, November 14, 2021, <https://asia.nikkei.com/Politics/Japan-to-launch-second-outer-space-operations-unit-in-fiscal-2022>.
- 19 Debra Werner, "Japan Air Self Defense Force awards contract to LeoLabs," *SpaceNews*, May 24, 2022, <https://spacenews.com/leolabs-contract-japan-ministry-of-defense/>.
- 20 "Protecting Space Security: A New Mission for Japan's Self-Defense Forces," *ibid.*
- 21 "Northrop Grumman and IHI sign MOU to work together on small maneuverable satellites," *IHI*, March 15, 2023, https://www.ihico.jp/en/all_news/2022/aeroengine_space_defense/1198211_3494.html.
- 22 Joint Statement of the Security Consultative Committee, April 19, 2019, p. 3, <https://www.mofa.go.jp/files/000470738.pdf>.
- 23 Theresa Hitchens, "Air Force Funds Hosted Payloads On Japan Sats," *Breaking Defense*, February 19, 2020, <https://breakingdefense.com/2020/02/air-force-funds-hosted-payloads-on-japan-sats/>.

(AWACS) planes and then foreign satellites.¹⁰ In August 2019, the Japanese MoD released a budget request for FY2020 that included a request for a 4 billion yen (USD 38 million) program for a "study on electromagnetic disruption system" and purchasing equipment that could detect when its satellites are being electromagnetically interfered with.¹¹

Japan requested 41.4 billion yen (USD 292.1 million) for FY2025 toward the development of an electronic warfare aircraft, based on the Kawasaki P-1. Prototype production is planned to occur from 2024 through 2031, according to the Ministry of Defense.¹² In October 2024, Lockheed Martin announced its first international sale of the AN/SLQ-32, an electronic warfare anti-ship missile capability, to Japan.¹³

11.4 – JAPANESE SPACE SITUATIONAL AWARENESS CAPABILITIES

The Japan Aerospace Exploration Agency (JAXA) has been the primary source of Japan's SSA capabilities until recently. JAXA's Kamisaibara Space Guard Center (see Imagery Appendix, pg. 17-58) has a radar facility that can see up to 10 objects of a diameter of 1 meter or greater to an altitude of 2000 km (or 10 cm objects to 650 km), and the Bisei Space Guard Center (see Imagery Appendix, pg. 17-59) has an optical telescope for SSA tracking to GEO.¹⁴ Japan is also developing an SSA analysis system at Tsukuba Space Center. The SAKURA (Ssa Key technology Unified Research and Analysis system), located at the Tsukuba Space Center, receives space object information, determines if there will be any conjunctions to Japanese satellites (and issues warnings if there are), predicts reentry, and shares information with the Japanese Ministry of Defense and the CSPoC.¹⁵

In March 2022, the Japanese Air Self-Defence Force (ASDF) announced the creation of a new space operations unit with an SSA mission. The unit will operate a satellite that will be launched in FY2026 and ground-based radar that is still being built in the Yamaguchi prefecture.¹⁶ As of August 2024, Japan's plan to launch an SDA satellite in FY2026 remains on schedule.¹⁷ The Japanese Defense Ministry has been actively developing space situational awareness (SSA) laser-detecting capabilities and setting up a second space operations unit that will utilize electromagnetic waves to monitor and discern threats to its satellites.¹⁸ Additionally, LeoLabs announced in May 2022 it had won a "multimillion" dollar contract to provide SSA data and training to the Japanese ASDF.¹⁹ Since 2023, the ASDF Space Operations Group has begun "the full operation of a system to grasp the position and orbit of space objects...and notifies satellite operators of the possibility of approaching objects," according to the Government of Japan.²⁰

On March 15, 2023, Northrop Grumman signed a partnership within Japanese company IHI to develop "small, highly maneuverable satellites and other solutions" to aid Japanese SSA capabilities and help protect satellites in GEO.²¹

The SDF SSA system is intended to be tied to the US SSA network, and both hope to be linked to JAXA's network. The fact sheet for the April 2019 2+2 Dialogue held between US and Japanese officials mentioned the possibility of putting US SSA sensors on Japan's Quasi-Zenith Satellite System (QZSS) GPS augmentation constellation.²² The USAF's 2021 budget documents included a request for funding two US SSA payloads on the QZSS that would improve "Geostationary Earth Orbit (GEO) Space Situational Awareness capabilities over the Eurasian theater and facilitates resilient capabilities in the Space Surveillance Network (SSN)."²³ In February 2025, Japan launched a QZSS satellite

carrying the first USSF SSA payload, and the second QZSS-hosted payload was scheduled to launch in late 2025.²⁴ The February 2025 launch marked the first bilateral US-Japan space effort focused on national security, according to the US Space Force.²⁵ In December 2025, the second payload launch was cancelled on the launch pad, and a new target launch date has not yet been announced.²⁶

11.5 – JAPANESE COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Japan historically defined peaceful uses of outer space to be non-military, a definition that was formalized by a 1969 Diet resolution. However, in 2008, the Japanese Diet passed the *Basic Space Law* that allowed space to be used for national security purposes, so long as it would be defensive in nature.²⁷ This was part of a larger shift to incorporating space into national security needs. The Cabinet office created two organizations to help focus on the foundations for space security policy: what is now the National Space Policy Secretariat in July 2012, and the Strategic Headquarters for Space Development in 2015.²⁸ The *2018 National Defense Program Guidelines* stated, “To ensure superiority in use of space at all stages from peacetime to armed contingencies, SDF will also work to strengthen capabilities including mission assurance capability and capability to disrupt opponent’s command, control, communications and information.”²⁹ The guidelines also discussed how for space and cyber, “establishing international rules and norms has been a security agenda.”³⁰ The guidelines directed Japan to build a “Multi-Domain Defense Force,” as its defense capability which would bring together “capabilities in all domains including space, cyberspace and electromagnetic spectrum; and is capable of sustained conduct of flexible and strategic activities during all phases from peacetime to armed contingencies.”³¹ The SDF would, in cases of armed attack against Japan, be permitted to “block and eliminate the attack by leveraging capabilities in space, cyber and electromagnetic domains.”³²

In June 2020, Japan released its *Outline of the Basic Plan on Space Policy*. This document identifies “ensuring space security” as one of the Basic Space Plan’s goals and focuses on satellites for positioning and maritime domain awareness, cooperation with allies on SSA sharing, becoming involved in international discussions on rules, and focusing on mission assurance.³³ In November 2024, Japan’s FY2025 defense space budget request totaled over \$1.4 billion, close to the FY2023 and FY2024 requests combined.³⁴ In July 2025, Japan’s Ministry of Defense published the nation’s first guidelines for space domain defense, which outlined plans to protect Japanese satellites, identify attacking entities, address jamming of Japanese satellites, and operate satellites in an autonomous and highly maneuverable manner.³⁵ The guidelines also included plans to strengthen responsive launch, engagement in technical cooperation between the public and private sectors in Japan, and cooperation with allies.³⁶

Japan has also announced steps to reorganize its military space activities. In January 2020, during remarks at the 60th anniversary of the *Treaty of Mutual Cooperation and Security Between the United States and Japan*, Prime Minister Shinzo Abe noted the need to make the US-Japan alliance more “robust” and “to make it a pillar for safeguarding peace and security in both outer space and cyberspace.”³⁷ Abe also announced at a session of the Diet in January 2020 that Japan will “drastically bolster capability and systems in order to secure superiority.”³⁸ During that speech, he announced that Japan would be establishing a space domain mission unit in April 2020, with the goal of having

24 Greg Hadley, “Japan Puts New US Space Force Capability into Orbit,” *Air & Space Forces Magazine*, February 6, 2025, <https://www.airand-spaceforces.com/space-force-payload-japanese-satellite/>.

25 “Space Systems Command, Japan launch first bilateral space effort,” United States Space Force, February 5, 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4055022/space-systems-command-japan-launch-first-bilateral-space-effort/>.

26 Mike Wall, “Launch of Japan’s Michibiki 5 navigation satellite scrubbed late in countdown,” *Space.com*, December 16, 2025, <https://www.space.com/space-exploration/launches-spacecraft/japan-h3-rocket-launch-michibiki-5-navigation-satellite>.

27 *Basic Space Law (Law No.43 of 2008)*, JAXA, May 21, 2008, <https://stage.tksc.jaxa.jp/spacelaw/country/japan/27A-1.E.pdf>, p. 2.

28 Ryo Hinata-Yamaguchi, “One Small Step for Japan’s Space Security Strategy,” *East Asia Forum*, April 1, 2020, <https://www.eastasiaforum.org/2020/04/01/one-small-step-for-japans-space-security-strategy/>.

29 *National Defense Program Guidelines for FY 2019 and Beyond*, Japanese Ministry of Defense, December 18, 2018, p. 20, https://www.cas.go.jp/jp/siryout/pdf/2019boueikeikaku_e.pdf.

30 *National Defense Program Guidelines for FY 2019 and Beyond*, *ibid.*, p. 4.

31 *National Defense Program Guidelines for FY 2019 and Beyond*, *ibid.*, p. 11.

32 *National Defense Program Guidelines for FY 2019 and Beyond*, *ibid.*, p. 12.

33 *Outline of the Basic Plan on Space Policy (Provisional Translation)*, National Space Policy Secretariat, Cabinet Office, Japan, June 30, 2020, https://www8.cao.go.jp/space/english/basicplan/2020/abstract_0701.pdf, p. 6.

34 “Overview of FY2025 Budget Request,” Japan Ministry of Defense, November 2024, https://www.mod.go.jp/en/d_act/d_budget/pdf/20241126a.pdf.

35 “Outline of Space Domain Defense Guidelines,” Japanese Ministry of Defense, July 2025, https://www.mod.go.jp/en/images/outline_space-domain-defense-guidelines_20250807.pdf.

36 “Outline of Space Domain Defense Guidelines,” *ibid.*

37 “Japan To Stand Up Space Domain Mission Unit In April 2020 To Counter Threats To Satellites,” *SpaceWatchGlobal*, January 2020, <https://spacewatch.global/2020/01/japan-to-stand-up-space-domain-mission-unit-in-april-2020-to-counter-threats-to-satellites/>.

38 Mari Yamaguchi, “Abe says new unit will defend Japan from space tech threats,” *Associated Press*, January 20, 2020, <https://apnews.com/2d88b7c34a5d004eaa59791b8587579d>.

- 39 "Japan To Stand Up Space Domain Mission Unit In April 2020 To Counter Threats To Satellites," *SpaceWatchGlobal*, January 2020, <https://spacewatch.global/2020/01/japan-to-stand-up-space-domain-mission-unit-in-april-2020-to-counter-threats-to-satellites/>.
- 40 Park Si-soo, "Japan to launch 2nd space defense unit to protect satellites from electromagnetic attack," *SpaceNews*, November 15, 2021, <https://spacenews.com/japan-to-launch-2nd-space-defense-unit-to-protect-satellites-from-electromagnetic-attack/>.
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it be fully operational by 2022.³⁹ By 2022, the Space Operations Squadron was established within Japan's Air Self-Defense Force and was intended to work with both USSPACECOM and JAXA. In April 2021, the Japanese ASDF and USSPACECOM signed an agreement to increase collaboration on space security. Under the agreement, an ASDF officer will receive an assignment in the US Space Command headquarters at Peterson Space Force Base, Colorado.⁴⁰ By 2022, the Space Operations Group was established as an expansion of the Space Operations Squadron within the ASDF.⁴¹ Japan has also announced a plan to change the name of the Air Self-Defense Force to the Air and Space Self-Defense Force (ASSDF) by FY2027 to better represent its interest in strengthening space defense.⁴²

In September 2022, Japan formally pledged not to conduct destructive DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.⁴³

Japan released a *National Security Strategy* in December 2022 that would allow it, for the first time, to be able to conduct counterstrike operations using long-range missiles.⁴⁴ This move is intended to integrate Japan's air and missile defense systems, and is not intended to be used in its space operations, but does signal a change to Japan's historically defensive posture. The *National Security Strategy* also notes that "Japan will drive forward measures to capitalize on Japan's overall space-related capabilities in the field of security, such as strengthening cooperation between the Japan Aerospace Exploration Agency (JAXA) and the SDF."⁴⁵

In July 2022, Japan participated in Global Sentinel, an annual USSPACECOM-led space security cooperation effort across 25 participating nations. During Global Sentinel, Japan supported a regional multinational space operations center to command and control SSA sensors and responded to scenarios that modeled real-world events.⁴⁶ At a January 2023 meeting of the US-Japan Security Consultative Committee convened by the US Secretaries of Defense and State and the Japanese Ministers of Defence and Foreign Affairs, the ministers released a statement noting that they considered "attacks to, from, or within space present a clear challenge to the security of the Alliance, and affirmed such attacks, in certain circumstances, could lead to the invocation of Article V of the Japan-US Security Treaty;" invocation of Article V would be made "on a case-by-case basis, and through close consultations between Japan and the United States, as would be the case for any other threat."⁴⁷ Japan participated in subsequent Global Sentinel exercises in 2023,⁴⁸ 2024,⁴⁹ and 2025 hosted by USSPACECOM.⁵⁰

In June 2023, Japan released a new *Space Security Initiative* (SSI) that outlines the strategy for responding to space threats over the next decade.⁵¹ The document described the changing space security environment and the plan for Japan to increase use of space systems for security on Earth, as well as protecting its own use of space. The latter approach focuses on improving the resilience of space systems, more cooperation with allies and between JAXA and the MOD in enhancing SSA, and helping develop international norms of responsible behavior. The SSI also outlined four priorities to achieve security from space: intelligence collection, missile defense, anti-jamming communication capabilities, and position, navigation, and timing (PNT) services.⁵²

Potential Military Utility /

Japan currently possesses very limited potential counterspace capabilities; if and when it develops co-orbital “guardian” satellites, that could enhance its offensive counterspace capabilities. In the interim, Japan could potentially use its limited SSA capabilities to detect, track, and target a modified SM-3 missile as a DA-ASAT against an adversary satellite in LEO, perhaps with additional tracking assistance and intelligence from the United States. Japan likely possesses the technological foundations to conduct EW against space capabilities, but the military utility and effectiveness of its ability to do so is unknown.

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12

NORTH KOREA

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North Korea has no demonstrated capability to mount kinetic attacks on space assets. North Korea does not appear highly motivated to develop kinetic counterspace assets, though certain capabilities in their ballistic missile program could eventually be evolved for such a purpose. North Korea has exhibited the capability to jam civilian and military GPS signals within a limited geographical area.

12.1 – NORTH KOREAN CO-ORBITAL ASATs

North Korea currently possesses a rudimentary satellite development and command and control capability, but it has not demonstrated any of the rendezvous and proximity operations necessary for a co-orbital ASAT satellite capability.

Due to a lack of detected signals and instability of their platforms, both of its two Kwangmyŏngsŏng satellites are thought to have failed soon after launch. Kwangmyŏngsŏng 3-2 (KMS 3-2, 2012-072A, 39026) was reported to be tumbling on December 17, 2012, five days after launch, and Kwangmyŏngsŏng 4 (KMS 4, 2016-009A) was reported to be tumbling as early as February 9, 2016, only three days after launch.¹ However, despite tumbling, the satellites were still following a relatively predictable orbital trajectory and did not pose a collision threat to other space objects. Kwangmyŏngsŏng 4 re-entered the atmosphere on June 9, 2023, and Kwangmyŏngsŏng 3-2 re-entered on September 13, 2023.

Although both satellites were announced as remote sensing systems, it is doubtful if they conducted much sensor activity due to their early failures. The North Korean satellite expertise is considered to be rudimentary, with the payloads likely being capable of only producing low resolution imagery at best, and it is doubtful if either of the two satellites would have been militarily useful, even had they not failed prematurely. The Malligyong-1 (2023-179A, 58400) is thought to be able to take at best low-resolution pictures.² After a May 2023 launch failure, South Korean officials were able to dredge parts of the satellite and its launch rocket and announced that they assessed that the satellite “has no military utility as a reconnaissance satellite.”³ After the successful launch of Malligyong-1 in November 2023, an observer noted that orbit raising maneuvers were carried out by the Malligyong-1 in February,⁴ June⁵ and September 2024,⁶ and in January 2025, with nominal positions plotting over the mid-Atlantic, instead of North Korea.⁷ These changes in Malligyong-1’s orbits indicate the possibility for North Korea to control the spacecraft monitor foreign military and political sites. However, radio trackers do not seem to have detected signals from the spacecraft and observers stated that the satellite seemed to be simply adjusting its position in space, returning to its post-launch orbit, rather than attempting a specific maneuver, noting that the satellite was “much too small” to cause any disruptive action.⁸ In July 2025, the United Nations Office for Outer Space Affairs (UNOOSA) received an emergency conjunction warning from Malaysia of a Malaysian satellite and a North Korean satellite. The approaching North Korean satellite was approximately 75 meters away from the Malaysian satellite, but North Korean satellite operators managed to avoid a collision by performing an evasive maneuver.⁹

There is no indication that North Korea’s satellites have any counterspace capability nor is there any indication of intent by North Korea to develop such a capability. Any serious attempt at co-orbital counterspace capabilities would require a sophistication that is beyond North Korea’s current technological capacity.

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12.2 – NORTH KOREAN DIRECT-ASCENT ASATs

Specifics /

The North Korean ballistic missile program traces its start back to the 1980s with the acquisition of Soviet-era Scud technology. At present, no dedicated ASAT program exists separate from the country's ballistic missile programs. North Korean systems comprise two primary components: rapidly maturing ground-launched ballistic missile capabilities and the development of some radar systems.

North Korea has multiple ballistic missile systems, including intermediate-range ballistic missile (IRBM) and intercontinental ballistic missile (ICBM) classes, which potentially could be used as the basis for future DA-ASAT capabilities. The first is the Pukguksong family of IRBMs, which include the KN-11 (Pukkuksong-1) and the KN-15 (Pukkuksong-2). The KN-11 is a two-stage solid-fuel SLBM with a purported range of 500-2,500 km, while the KN-15 is the land-based variant. North Korea conducted a successful cold-launched test of the KN-15 in May 2017.¹⁰

The Hwasong-10 (Musudan) is an IRBM reportedly modeled off of the Soviet R-27/SS-N-6 missile system. The system is liquid-fueled with a maximum range of 3,500 km. The Musudan has a spotty testing record, but the sixth test of the system reportedly was a success.¹¹ The Hwasong-12 (KN-17) is a newer ballistic missile, tested May 14, 2017, August 28, 2017, and September 14, 2017, using liquid propellant and a high-thrust engine and mounted on a transporter erector launcher (TEL). An additional, possibly ICBM-relevant flight test, using a similar engine to the KN-17, was conducted in March 2017. This was possibly just a larger variant of the existing Hwasong-10 IRBM, but the test indicates the ability to comfortably overshoot Guam and reach lower satellite orbital altitudes. The Hwasong-12 is presumed to be a one-stage missile with a range of 3,700-4,500 km.¹²

North Korean leader Kim Jong Un announced in the annual 2017 New Year's Address that the country was nearly ready to flight-test an ICBM.¹³ There were then two ICBM tests in 2017 of a relatively new system, the Hwasong-14. North Korea tested the Hwasong-14 (KN-20) on July 4, 2017, and July 28, 2017, using a lofted trajectory. Several estimates place the range around 10,000 km, placing US cities and satellites beyond LEO potentially at risk.¹⁴ The Hwasong-14 is a two-stage liquid fuel design.

The Hwasong-15 (KN-22) was launched for the first time on November 29, 2017, when the liquid-fueled ICBM flew on a lofted trajectory to an altitude of 4,500 km.¹⁵ If flown on a standard trajectory, it could have a feasible reach of 13,000 km, which, according to David Wright of the Union of Concerned Scientists, "is significantly longer than North Korea's previous long-range tests."¹⁶ According to North Korea's Korean Central News Agency (KCNA), this flight test was of "an intercontinental ballistic rocket tipped with super-large heavy warhead" which could reach "the whole mainland of the US."¹⁷ There was another launch of an ICBM-class launch vehicle in March 2022; this rocket (either the Hwasong-15 or possibly the newer Hwasong-17) flew a distance of 1100 km and reached an altitude of 6000 km (placing objects in LEO within reach).¹⁸ A Hwasong-17 is suspected to have been launched in November 2022; it failed during its flight test.¹⁹ North Korean officials announced that they had launched a Hwasong-15 in February 2023; it flew a heavily lofted flight and reached a distance of nearly 1000 km at an altitude of about nearly 5800 km.²⁰ If it had flown a less lofted trajectory, it is thought that it could reach the continental United States, indicating it could likely reach objects in LEO as well.²¹ The Hwasong-17, a liquid-

fuelled mobile ICBM, was successfully launched in March 2023, at a range of about 1000 km and an altitude of about 6000 km.²² Three launches of the Hwasong-18, which is also described as ICBM-class and uses solid propellant, were held in 2023: it had a test flight in April 2023;²³ it flew a second time in July 2023, when it ranged about 1000 km and went to an altitude of about 6000 km;²⁴ and then flew a third time in December 2023, when it again ranged about 1000 km and went to an altitude of about 6000 km.²⁵ In October 2024, the launch of a Hwasong-19 missile reportedly covered approximately 1,000 km, reaching an altitude of over 7,000 km before landing in the sea,²⁶ representing, according to Khaled Khiari, Assistant Secretary-General for Asia at the UN Department of Political Affairs, “a grave threat to regional stability.”²⁷ According to officials in Tokyo and Seoul, this test appeared to be a new type of solid-fuel ICBM.²⁸

North Korea has other presumed ICBM-range systems that have not yet been flight-tested or deployed. The first is the Hwasong-13 (KN-08), a three-stage road-mobile ICBM first seen in the 2012 military parade, and the second is a variant of this missile known as the KN-14, shortened to two stages. These are alleged road-mobile ICBMs displayed in past military parades but have not yet been flight-tested or deployed.²⁹

North Korea’s only known operational space launch vehicle is the Unha-3. It appears to derive design components from the Taepodong-2 (TD-2), which was originally believed by US intelligence to be a possible ICBM.³⁰ Although operational, the reliability of the Unha-3 is not assured. The TD-2 failed in several tests throughout the 2000s, raising some questions regarding both its relationship to the Unha-3 and the latter’s reliability. The first attempt to use the Unha-3 to launch the Kwangmyŏngsŏng 3 satellite in April 2012 resulted in failure, but in December 2012, the Unha-3 successfully placed the first North Korean satellite, Kwangmyŏngsŏng 3-2 in orbit.³¹ The Unha-3 was used to put the second satellite, Kwangmyŏngsŏng 4 into orbit in 2016.³² Commercial imagery captured in March 2019 of North Korea’s Sohae Satellite Launching Station (see Imagery Appendix, pg. 17-24) indicated that it may have returned to normal operations.³³

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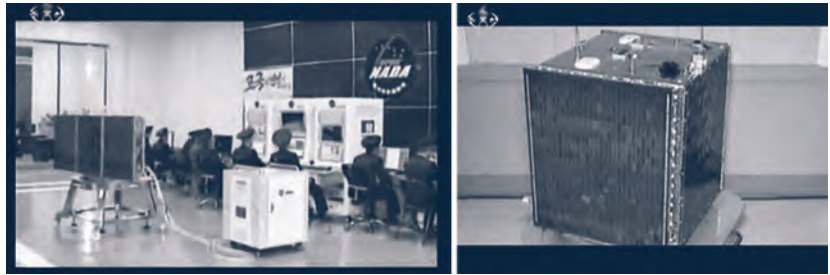
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FIGURE 12-1 — KWANGMYŎNGSŎNG-4



Two views of the purported earth-observation satellite Korea launched in January 2016. Image credit: *chinaspaceflight.com*.³⁴

The Unha-3 is known to be a multi-stage rocket with liquid propellant requiring a conventional launch pad and extensive visible preparations. The first stage consists of four Nodong engines, making it too large for mobile use.³⁵

North Korea's second proven space launch vehicle is the Chollima-1. North Korean news agency KCNA announced in May 2023 that it had tried to use the Chollima-1 to launch its military reconnaissance Malligyong-1 satellite, but failed in the second stage.³⁶ It was followed up by another attempt in August 2023, with the Chollima-1 again attempting to place the Malligyong-1 in orbit; this time, it failed in its third stage.³⁷ The third attempt for the Chollima-1 proved to be a success. In November 2023, North Korean officials announced the successful launch of the SLV and the placement of the Malligyong-1 into a 512 km by 493 km at 97.43 degrees orbit.³⁸ North Korea reported that Malligyong-1 was an active remote sensing satellite and had imaged US military bases, but there was debate about its functionality until it maneuvered in a series of steps to raise its perigee in mid February 2024.³⁹

In May 2024, North Korea announced that its attempt to launch a new military reconnaissance satellite failed due to an explosion of a newly developed rocket engine during flight.⁴⁰ Analysts interpreted this attempt to launch a satellite as the potential test of a new form of rocket technology, including the development of a liquid fuel rocket motor.⁴¹ According to the vice general director of the National Aerospace Technology Administration (NATA), experts consider that the accident occurred due to the air blast of the new-type satellite carrier rocket during the first-stage flight and is attributable to the reliability of operation of the newly developed liquid oxygen and petroleum engine.⁴² Moreover, South Korea's Yonhap News Agency reported that a "large number of Russian experts" had entered North Korea to assist with the launch.⁴³

Some have speculated that North Korea could combine a ballistic missile and a nuclear warhead into an EMP weapon, targeted against either US satellites or domestic infrastructure. However, it seems unlikely at this point that North Korea would dedicate one of its limited nuclear warheads to an unproven task.⁴⁴ Although North Korea likely demonstrated a thermonuclear capability in September 2017, it is unknown how large of a yield from a nuclear warhead is necessary to affect the US electrical grid.⁴⁵ Additionally, North Korea's ICBM force, while growing in technical sophistication and performance, is not currently capable of carrying such a heavy warhead. Historical nuclear tests in space, such as the US Starfish Prime test in 1962, are known to have generated effects that damaged or destroyed satellites in orbit at the time.⁴⁶ It would be difficult to predict the ability of creating such effects against military satellites, particularly since many US military satellites are hardened against radiation and EMP effects. Non-hardened satellites would be affected by an EMP, however. For a longer discussion of this, please see Section 2.4, Russian Directed Energy Weapons.

12.3 – NORTH KOREAN ELECTRONIC WARFARE

On numerous occasions, North Korea has demonstrated the capability to interfere with civilian GPS navigation used by passenger aircraft, automobile, and ship systems in the vicinity of the South-North border and nearby coastal areas.⁴⁷ This type of interference (i.e., downlink jamming) targets GPS receivers within range of the source of the jamming signal but has no impact on the GPS satellites themselves nor the service provided to users outside the range of the jammers. The area affected will depend on the power emitted by the jammer and the local topography. In the case of the reported North Korean incidents, the range was estimated to be several tens of kilometers.

According to unnamed US officials, this type of jamming would not affect US military members who use the military GPS signals.⁴⁸ The GPS interference incidents along the South-North border appear to have been deliberately targeting civilian receivers, presumably as part of a North Korean political strategy or tactic. Some events have coincided with joint South Korea-US military exercises. North Korea could also be developing jammers that are effective against the military GPS signals, but to date, there is no public evidence of such development, testing, or use.

There is extremely limited public information about whether North Korea could jam satellite communications. North Korea does routinely jam terrestrial broadcasts from foreign sources, such as the BBC, Voice of America, Radio Free Asia, and South Korea's KBS, to prevent their citizens from listening.⁴⁹ However, there is only one report from 2012 about North Korea possibly jamming military communications being broadcast from a South Korean satellite.⁵⁰ It is assessed that uplink jamming of communication satellites has otherwise not or has rarely occurred, since that would likely have been reported by the targeted satellite operators. Downlink jamming, which affects only the receivers in a local area, may be occurring within North Korea, but there is no publicly-available information available on this subject.

In March 2024, North Korea attempted to jam GPS signals during South Korean military exercises, which marked the first reported use of GPS jamming by North Korea in eight years.⁵¹ In May 2024, South Korea reported that 201 airplanes and 731 ships had experienced GPS problems over its national territory and that it had identified the Gangryong and Ongjin regions of North Korea as the source of interference.⁵² The following month, South Korea's

44 Jeffrey Lewis, "Welcome to the Thermonuclear Club North Korea," *Foreign Policy*, September 4, 2017, <http://foreignpolicy.com/2017/09/04/welcome-to-the-thermonuclear-club-north-korea/>.

45 Kyle Mizakami, "North Korea Can't Kill Ninety Percent of Americans," *Popular Mechanics*, March 3, 2017, <http://www.popularmechanics.com/military/weapons/a25883/north-korea-cant-kill-ninety-percent-of-americans/>; "North Korea: Overview," *Nuclear Threat Initiative*, last updated October 2020, <https://www.nti.org/learn/countries/north-korea/>.

46 Richard Hollingham, "The Cold War nuke that fried satellites," *BBC News*, September 11, 2015, <http://www.bbc.com/future/story/20150910-the-nuke-that-fried-satellites-with-terrifying-results>.

47 "North Korea 'jamming GPS signals' near South border," *BBC News*, April 1, 2016, <http://www.bbc.com/news/world-asia-35940542>.

48 "Pentagon concerned about North Korea jamming GPS signals, officials say," *Fox News US*, April 6, 2016, <http://www.foxnews.com/us/2016/04/06/pentagon-concerned-about-north-korea-jamming-gps-signals-officials-say.html>.

49 Julian Ryall, "North Korea 'aggressively' jamming BBC's new Korean-language service," *The Telegraph*, September 27, 2017, <https://www.telegraph.co.uk/news/2017/09/27/north-korea-aggressively-jamming-new-bbc-broadcasts/>.

50 Martyn Williams, "Report: DPRK Jams South Korean Satellite Comms," *North Korea Tech*, November 17, 2012, <https://www.northkoreatech.org/2012/11/17/report-dprk-jams-south-korean-satellite-comms/>.

51 Takaaki Yamamoto, "The History and Evolution of North Korea's Space Capabilities," *CSIS*, August 2025, https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-08/250819_Yamamoto_DPRK_Space.pdf.

- 52 "Press Release, GPS signal interference situation," ROK Ministry of Science and ICT, May 31, 2024, <https://www.msit.go.kr/bbs/view.do?sCode=user&mId=113&mPid=238&pageIndex=&bbsSeqNo=94&nttSeqNo=3184566&searchOpt=ALL&searchTxt=>; "North Korea Spoofing Aircraft and Ships – GPS World," *Resilient Navigation and Timing Foundation*, June 3, 2024, <https://rntfnd.org/2024/06/03/north-korea-spoofing-aircraft-and-ships-gps-world/>.
- 53 Kim Seung-yeon, "S. Korea raises N. Korea's GPS signal jamming with 3 int'l agencies: foreign ministry," *Yonhap News Agency*, June 4, 2024, <https://en.yna.co.kr/view/AEN20240604007400315>.
- 54 "North Korea launches GPS interference, South Korea's military says," *Reuters*, November 9, 2024, <https://www.reuters.com/world/asia-pacific/north-korea-launches-gps-interference-yonhap-reports-2024-11-09/>.
- 55 "North Korea jams GPS signals, affecting planes and ships in South Korea," *France24*, November 9, 2024, <https://www.france24.com/en/live-news/20241109-n-korea-jams-gps-signals-affecting-ships-aircraft-in-south>.
- 56 Takaaki Yamamoto, "The History and Evolution of North Korea's Space Capabilities," *CSIS*, August 2025, https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-08/250819_Yamamoto_DPRK_Space.pdf?VersionId=hyjBSfWepI-GKDehnbIBwNtuaUcVmXut.
- 57 "ICAO Assembly condemns GNSS Radio Frequency Interference originating from the DPRK and the Russian Federation," *ICAO*, October 3, 2025, <https://www.icao.int/news/icao-assembly-condemns-gnss-radio-frequency-interference-originating-dprk-and-russian>.
- 58 Joseph S. Bermudez Jr., "NADA General Satellite Control Building," *38North*, March 22, 2018, <https://www.38north.org/2018/03/nada032318/>.
- 59 Dave Schmerler, "Revealed: North Korea's under-development space environment test center," *NKPro.com*, June 25, 2019, <https://www.nknews.org/pro/revealed-north-koreas-new-space-environment-test-center/>.
- 60 Dave Majumdar, "If Donald Trump Attacks North Korea: Beware of Kim's Air Defense Systems," *National Interest*, April 14, 2017, <https://nationalinterest.org/blog/the-buzz/if-donald-trump-attacks-north-korea-beware-kims-air-defense-20207>.

Foreign Ministry spokesperson Lim Soo-suk said that South Korea raised its renewed concerns over this repeated GPS jamming with the International Telecommunication Union (ITU), the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO).⁵³

In November 2024, South Korean military officials affirmed that North Korea staged GPS interference two days in the North's Haeju and Kaesong areas, impacting ships and civilian aircraft in South Korea.⁵⁴ This interference has been interpreted as a way for North Korea "to shield their own communications and intelligence exchanges during critical military operations" both at home and abroad.⁵⁵ Also in November 2024, a South Korean military reconnaissance drone reportedly crashed due to GPS interference by North Korea. In January 2025, South Korea's defense ministry reported that North Korea's GPS jamming had persisted for over three months.⁵⁶ In October 2025, the ICAO passed a resolution determining that the GNSS interference originating in North Korea was indeed an infraction of the 1944 Convention on International Civil Aviation, condemned it for doing so, and called for it to fulfill its obligations under the Convention.⁵⁷

12.4 – NORTH KOREAN SPACE SITUATIONAL AWARENESS CAPABILITIES

There is little publicly available information about North Korea's SSA capabilities. North Korea does have a General Satellite Control Building, which headquarters its National Aerospace Development Administration (NADA) and is the facility from which North Korea tracks and monitors its own satellite launches.⁵⁸ Since May 2017, imagery has detected construction on an adjacent facility. The facility is most likely intended to be a space environment test center and most likely does not have SSA capabilities.⁵⁹ North Korea has been reported to possess Iranian phased array radars as part of its air defense network; their capabilities are unknown.⁶⁰

12.5 – NORTH KOREAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

There is an absence of discussion on counterspace weapons in the North Korean state media. Surveying the archives from 2010-2025 does not reveal a mention of ASAT or counterspace.⁶¹ North Korean state media claimed in April 2020 that “The purpose of the republic’s space development is to adhere to the interests of the state and to use science and technology to solve scientific and technological problems essential to economic construction and people’s lives.”⁶² In 2021, however, North Korea publicly expressed an intention to develop space capabilities and achieve “mastery of space defense science and technology” at both the 8th Congress of the Workers’ Party of Korea and the 4th Plenary Meeting of the 8th Central Committee.⁶³ In 2022, North Korea reportedly revised its Space Development Law to allow for the use of space for national defense purposes. The revision removed sentences that committed to only use space for peaceful purposes and that voiced opposition to the “militarization of space,” while introducing the threat of “appropriate countermeasures” in response to countries that attempt to target the North Korean space program.⁶⁴ The revised Space Development Law also tasked North Korea’s NATA with “the promotion of space development projects to strengthen national defensive capabilities.”⁶⁵

In November 2021, the North Korean aerospace sector facilitated a space conference to discuss peaceful space development plans and the use of satellite technology for economic growth. The conference occurred after Kim Jong Un ordered the development of military reconnaissance satellites earlier in 2021, demonstrating a potential increase in desire to develop space assets and technology.⁶⁶ Kim Jong Un visited the Sohae Launch Center in March 2022 and called for it to be “modernized” so to “enable large carrier rockets to be launched there,”⁶⁷ which indicates that SLV capabilities continue to be an increased priority for the North Korean government. Satellite imagery taken later in 2022 indicated that construction is in full swing at Sohae, presumably to carry out the modernization called for by Kim.⁶⁸

61 Most state media references to space cite North Korean efforts to successfully launch satellites, ostensibly for Earth observation purposes. These references discuss the development of high-thrust engines (usually referenced as the March 18th engine) for delivery of satellites into orbit, and the development of the earth observation satellite technology (only EO satellites so far (Kwangmyongsong-4), launched in 2016). See: “Kim Jong Un Watches Ground Jet Test of Newly Developed High-Thrust Engine,” *Korean Central News Agency*, March 19, 2017. Thus far, official statements from North Korea have emphasized space as a common good: “Space is wealth common to man,” and have emphasized peaceful uses. “Peaceful Development and Use of Space Are Legitimate Right of Sovereign State: DPRK Delegation,” *Rodong Sinmun*, June 21, 2017. State media also references work on meteorological atmospheric observation systems, which may have some applications for radar tracking systems. See: “A Breakthrough,” *Naenara News*, July 12, 2015.

62 Elizabeth Shim, “North Korea highlights space program in state media,” *UPI*, April 6, 2020, https://www.spacewar.com/reports/North_Korea_highlights_space_program_in_state_media_999.html.

63 Heylyung Yun, “North Korea’s Pursuit of Coercive Leverage in the Information Age: Expanding Cyber and Counterspace Capabilities,” *The Korean Journal of International Studies*, August 31, 2025, <https://kjis.org/journal/view.html?pn=mostread&uid=326&vmd=Full>.

64 Martyn Williams, “North Korea Revised its Space Law to Permit Military Use,” *38North*, June 2, 2025, <https://www.38north.org/2025/06/north-korea-revised-its-space-law-to-permit-military-use/>.

65 Williams, “North Korea Revised its Space Law to Permit Military Use,” *ibid*.

66 Colin Zwirko, “North Korea holds space conference, says launching satellites will help economy,” *NK News*, November 22, 2021, <https://www.nknews.org/2021/11/north-korea-holds-space-conference-says-launching-satellites-will-help-economy/>.

67 “N. Korea calls for satellite site ‘expansion’ as US slams ICBM tests,” *Agence France-Presse*, March 11, 2022, https://www.spacewar.com/reports/NKorea_calls_for_satellite_site_expansion_as_US_slams_ICBM_tests_999.html.

68 Peter Makowsky, Jack Liu, and Jenny Town, “Sohae Satellite Launch Station: Site Upgrades Begin in Earnest,” *38North*, September 6, 2022, <https://www.38north.org/2022/09/sohae-satellite-launch-station-site-upgrades-begin-in-earnest/>.

- 69 Peter Makowsky, Jack Liu, Iliana Ragnone and Jenny Town, "Sohae Satellite Launching Station: Construction Resumes as Spring Unfolds," *38North*, March 7, 2024, <https://www.38north.org/2024/03/sohae-satellite-launching-station-construction-resumes-as-spring-unfolds/>.
- 70 Colin Zwirko, "New work underway at DPRK space launch site but Seoul says liftoff not imminent," *NK News*, April 22, 2024, <https://www.nknews.org/2024/04/new-work-underway-at-dprk-space-launch-site-but-seoul-says-liftoff-not-imminent/>.
- 71 New work underway at DPRK space launch site but Seoul says liftoff not imminent," in front of *ibid*.
- 72 Colin Zwirko, "Major construction underway at factory building North Korea's biggest missiles," *NK News*, September 5, 2024, <https://www.nknews.org/pro/major-construction-underway-at-factory-building-north-koreas-biggest-missiles/>.
- 73 Colin Zwirko, "North Korean ICBM factory upgrade project slows, satellite imagery shows," *NK News*, February 19, 2025, <https://www.nknews.org/pro/north-korean-icbm-factory-upgrade-project-slows-satellite-imagery-shows/>.
- 74 Micah McCartney, "America Can Outgun North Korea's Nuclear Missiles, US General Says," *Newsweek*, February 20, 2025, <https://www.newsweek.com/general-says-us-forces-can-overwhelm-north-korea-nuclear-attack-2033554>.
- 75 Linus Höller, "Mysterious annex at North Korean missile plant has analysts puzzled," *Defense News*, July 23, 2025, <https://www.defense-news.com/global/asia-pacific/2025/07/23/mysterious-annex-at-north-korean-missile-plant-has-analysts-puzzled>.
- 76 Höller, "Mysterious annex at North Korean missile plant," *ibid*.
- 77 Mike Stone and Ju-min Park, "New pier completed at North Korea rocket launch site, satellite imagery shows," *Reuters*, July 17, 2025, <https://www.reuters.com/business/aero-space-defense/new-pier-completed-north-korea-rocket-launch-site-satellite-imagery-shows-2025-07-17>.
- 78 Stone and Park, "New pier completed at North Korea rocket launch site," *ibid*.
- 79 Stone and Park, "New pier completed at North Korea rocket launch site," *ibid*.
- 80 Stone and Park, "New pier completed at North Korea rocket launch site," *ibid*.

In March 2024, observers noted progress in the expansion and modernization of the Sohae complex and, after a period of little activity, signs of advance preparations with personnel on site and the addition of new buildings.⁶⁹ A construction site appeared in proximity to the launchpad that was used for the successful launch of the Chollima-1 rocket in November 2023.⁷⁰ During a briefing in April 2024, Republic of Korea Joint Chiefs of Staff spokesperson, Lee Sung-jun, stated that the "preparations for additional reconnaissance satellite launches by the North Korean military have been continuously detected, but there are no signs of an imminent [launch]." ⁷¹ In September 2024, observers reported a construction project at the Thaesong Machine Factory, which likely houses liquid-fuel engine production lines for ICBM or satellite carrier rockets.⁷² The expansion of the factory reportedly slowed down between the end of 2024 and the beginning of 2025,⁷³ which was interpreted by General Gregory Guillot, head of US Northern Command and North American Aerospace Defense Command, in Congressional testimony as evidence that North Korea "is eager to transition [its] strategic weapons program from research and development to serial production and fielding."⁷⁴ In June 2025, satellite imagery from Planet confirmed on-going construction at Thaesong.⁷⁵ Imagery analysis highlighted a new annex likely related to TEL and missile testing, ongoing construction of a new factory hall, and the groundwork for a new construction project on the site of former factory halls.⁷⁶

In July 2025, satellite imagery taken over the Sohae complex revealed that a new maritime pier had been constructed at the launch center.⁷⁷ The new pier would enable transport of larger rocket components than previously possible using rail, according to an ICEYE representative.⁷⁸ Imagery revealed a newly constructed jetty and vessels, which indicates potential operational status.⁷⁹ Additionally, expansion work on road and rail infrastructure throughout Sohae was ongoing as of July 2025.⁸⁰

Potential Military Utility /

North Korea likely possesses very limited counterspace capabilities. It lacks significant SSA capabilities, demonstrated hit-to-kill capabilities, or any real RPO capabilities, and has very limited space launch capabilities. This very likely limits North Korean counterspace options to either jamming/spoofing or broad area attacks such as nuclear detonations in LEO that could damage large numbers of satellites over a long period of time.

37.5665°N

13

SOUTH KOREA

126.9780°E

Over the last several years, South Korea has increased its focus on military space capabilities. South Korea is working to enhance the space capabilities of the Republic of Korea Air Force through the establishment of the Korea Space Operations Center, cooperating with the United States on sharing SSA capabilities, and the creation of a Space Operations Squadron in charge of informing and supporting the entire military on space threats. South Korea is developing its own space launch vehicles and has expressed interest in developing its own reversible counterspace capabilities.

13.1 – SOUTH KOREAN DIRECT-ASCENT ASATS

There is no public evidence that South Korea has developed, or is developing, a dedicated DA-ASAT capability. However, it does have a significant ballistic missile program, and is putting an extensive amount of resources into developing its indigenous space launch program, which could theoretically be used as part of a future DA-ASAT capability. It would still need to be combined with several other technologies that South Korea has not yet tested either, such as hit-to-kill (HTK) intercepts.

In October 2021, South Korea launched its first domestically built rocket (“Nuri”) with a dummy satellite (which failed to make it to orbit); Nuri was estimated to cost \$1.6 billion to develop.¹ The three-stage liquid-fueled rocket was built by the Korea Aerospace Research Institute (KARI), the civilian space agency in South Korea.² President Moon Jae-in said, “We will use our launch vehicles to achieve the dream of landing on the moon by 2030.”³ A June 2022 launch of the Nuri SLV was reported to have put six satellites into orbit, marking the first time an indigenously built South Korean launch vehicle was able to do so.⁴ A fire broke out at the Naro Space Center in January 2023 while researchers were working on a follow-on SLV for the Nuri, known as KSLV-III,⁵ a launch vehicle which is intended to be made reusable by 2035.⁶

In March 2022, South Korean officials announced the successful launch of a “solid-fueled space projectile” which tested separating a dummy satellite from the launch vehicle as part of a test by Agency for Defense Development (ADD).⁷ A second test of the solid-fueled launch vehicle was successfully flown in December 2022, and was justified by the South Korean Ministry of Defense as, “The South Korean military will greatly develop its own space-based surveillance and reconnaissance capabilities based on the technology and know-how associated with solid propulsion engines.”⁸

The inaugural flight of the Nuri finally occurred on May 25, 2023, and successfully placed eight satellites in LEO.⁹

Additionally, South Korea’s military technology agency, the Korea Research Institute for Defense Technology Planning and Advancement (KRIT), released a report titled “Defense Science & Technology Level Assessment by Country” in January 2022 that argued the country needed “strategic” and “intensive” investments in space weapons in order to keep up with other military powers.¹⁰ According to KRIT, “The space weapon system is the field that requires intensive research and development, considering the conditions of the future battlespace and South Korea’s possession of some projectile technologies including the test-launch of Nuri...But as South Korea is far behind the US in the technology, we view that strategic investment is needed.” It is unclear what kind of space weapons the report was calling for more research and development on.

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- 4 Mike Wall, “South Korea’s homegrown Nuri rocket launches satellites into orbit for 1st time,” *Space.com*, June 22, 2022, <https://www.space.com/south-korea-nuri-rocket-launch-success>.
- 5 “Fire breaks out at space center during fuel test for next generation space rocket,” *Yonhap News Agency*, February 1, 2023, <https://en.yna.co.kr/view/AEN20230201009700320>.
- 6 Andrew Jones, “South Korea approves strategic plans for space,” *SpaceNews*, February 28, 2025, <https://spacenews.com/south-korea-approves-strategic-plans-for-space/>.
- 7 Jeongmin Kim, “South Korea tests indigenous solid-fuel rocket week after North’s ICBM launch,” *NK News*, March 30, 2022, <https://www.nknews.org/2022/03/south-korea-tests-indigenous-solid-fuel-rocket-week-after-norths-icbm-launch/?t=1656492835423>.
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- 14 Park, "US, South Korea agree to enhance security cooperation in outer space," *ibid*.
- 15 Park, "US-South Korea joint space drills to focus on space situational awareness," *ibid*.
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- 19 *Republic of Korea, Agenda Item 7: Space Debris*, UN COPUOS Scientific and Technical Subcommittee, Sixtieth Session, February 9, 2023, https://www.unoosa.org/documents/pdf/copuos/stsc/2023/Statements/10_PM/7_Republic_of_Korea_10_Feb_PM_1.pdf.
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13.2 – SOUTH KOREAN ELECTRONIC WARFARE

As part of its Space Odyssey 2050 program, the ROKAF is working on EW counterspace capabilities that can be used to deter or counter adversary space capabilities.¹¹ Few public details are known about the state of development or planned capabilities for this system.

13.3 – SOUTH KOREAN SPACE SITUATIONAL AWARENESS CAPABILITIES

South Korea is working to enhance its indigenous SSA capabilities through the development of a national SSA infrastructure planned to be operational by the mid-2020s. It was anticipated to include a space weather forecast system, reconnaissance satellites, and an electro-optical satellite surveillance system. In August 2021, military officials from South Korea and the United States agreed to cooperate on security space issues. Signed between Gen. Park In-ho, the ROKAF chief of staff, and General Raymond, USSF chief of space operations, it established a joint consultative body on space policy. They also agreed to share information on SSA, hold joint drills, and work to enhance joint space operations capabilities. ROKAF Colonel Park Ki-tae, chief of the Korean Space Operations Center (KSpOC), indicated SSA is a priority for the ROKAF, stating in October 2021 that "What we urgently need is 'eyes' to look at what's happening in outer space." The bilateral Space Cooperation Working Group that met in Washington, DC, in April 2022 resulted in another signed agreement on cooperation on space security issues, including sharing SSA data, and the creation of a joint space policy research organization. As a result of bilateral agreements between the United States and South Korea, the United States has launched a series of synthetic aperture radar (SAR) satellites for South Korea. The first satellite launch from the Vandenberg Space Force Base in California took place in late 2023, followed by two more satellite launches in 2024. In April 2025, South Korea's *Yonhap* news agency announced the successful launch of the fourth satellite. In November 2025, South Korea's fifth and final reconnaissance satellite was launched by the United States, marking a completion of the space-based surveillance network.¹⁸

In February 2023, South Korea delivered a statement at the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) Scientific and Technical Subcommittee (STSC), declaring that the Korea Astronomy and Space Science Institute, serving as the national SSA agency, operates an electronic optical monitoring system, the Optical Wide-field patrol Network (OWL-Net) for tracking objects in low Earth orbits below 2,000 km, alongside a Satellite Laser Ranging (SLR) system for monitoring specific targets.¹⁹ South Korea also revealed a project to introduce an optical monitoring system for space objects in the areas of 2,000 to 36,000 km, and the development of a SSA radar system to monitor space objects with a diameter of 10 cm or more in LEO.²⁰ In another statement in January 2024, South Korea stated that a telescope will be developed and deployed in the southern hemisphere to complement the OWL-Net space object optical surveillance system currently operating in the northern hemisphere to monitor objects located in MEO and GEO.²¹ In February 2025, in a technical presentation to the COPUOS Scientific and Technical Subcommittee, South Korea gave a precise description of their OWL-Net global SSA system, stating that the network is composed of five robotic observatories located in Mongolia (OWL-1), Morocco (OWL-2), Israel (OWL-3), United States (OWL-4), and South Korea (OWL-5 and OWL-6), including a domestic SSA system using precise orbit determination through laser ranging measurement and optical observation.²²

South Korea declared that in 2023, they started the Project Korea Enhanced Platform for Lowering space Risk (KEPLER), an integrated system designed to assess risks related to space object reentry and collisions using data from optics, radar, and lasers.²³ In 2025, presenting the architecture of the KEPLER project to the COPUOS Scientific and Technical Subcommittee, South Korea representative unveiled a database spacebook to observe, collect, analyze and manage data, complemented by a Space Risk Warning Portal to display and distribute data to users.²⁴

13.4 – SOUTH KOREAN COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

Policy

In 2013, the ROKAF unveiled its “Space Odyssey 2050,” a three-part strategy that aims to build its own space capabilities by 2050 to protect South Korea’s military forces. As part of the strategy, the ROKAF plans to develop the ability to monitor and “counter” space threats.²⁵

In October 2022, South Korea formally pledged not to conduct destructive DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.²⁶

Organization and Budget

The ROKAF launched its KSpOC in September 2021, which is charged with creating and carrying out space policy, as well as working with other branches of the South Korean government on enhancing space capabilities.²⁷ It will have three departments: one for sharing space information, one for space policy development, and one for developing space weapons. According to ROKAF Chief of Staff Gen. Park In-ho, “The Air Force’s space center will focus its capabilities on developing our national defense space force through building space weaponry, training professionals, and strengthening the organization. That will strengthen our national security in space and enable the Air Force to become a space force.”²⁸ In December 2022, the ROKAF established a Space Operations Squadron. Major Kim Jong-ha, commander of the newly created ROKAF’s Space Operations Squadron, declared that the squadron comprises five divisions, including the KSpOC, Space Surveillance Team and Satellite Control Team, and “is tasked with informing the entire military of space threats and the common operational picture (COP) to help each military branch to operate its plan effectively,” while working in cooperation with the US Space Force.²⁹

South Korean officials announced that they intended to spend \$619 million on space programs in 2022, a 15% increase from 2021 levels; of this, \$175.8 million was slated for SLV development.³⁰ \$70 million was intended to be spent on developing the Korea Positioning System, South Korea’s planned PNT constellation of eight satellites to be deployed between 2027 and 2034. In March 2023, South Korea announced another significant increase in spending on space programs of \$674 million, an increase of 19.5% from 2022.³¹ The second largest item in the budget (\$113.6 million) is for development of a next-generation space launch vehicle, and the third largest item (\$73.1 million) is for space defense programs.³²

After the adoption of a special law in January 2024, South Korea created the Korea AeroSpace Administration (KASA), with a budget of 758.9 billion won (\$556 million).³³ In March 2024, the Ministry of Science and ICT proposed

23 Republic of Korea, *Agenda Item 6: Space Debris*, UN COPUOS Scientific and Technical Subcommittee, Sixty-first Session, January 30, 2024, https://www.unoosa.org/documents/pdf/copuos/stsc/2024/Statements/item_6_ROK_1.pdf.

24 Eun Jung Choi, “KEPLER: Status and Plans for Space Situational Awareness in the Republic of Korea,” *ibid.*

25 “Air Force Sets up Space Center,” *KBS News*, September 30, 2021, https://world.kbs.co.kr/service/news_view.htm?lang=e&Seq_Code=164568.

26 Statement by H.E. Joonkook Hwang, *Permanent Representative of the Republic of Korea to the United Nations First Committee of the 77th Session of the General Assembly / General Debate New York*, October 4, 2022, https://overseas.mofa.go.kr/un-en/brd/m_24404/view.do?seq=11&page=2.

27 “Air Force Sets up Space Center,” *ibid.*

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31 Park Si-soo, “South Korea sets record space budget to bolster industry, develop new rocket,” *SpaceNews*, March 31, 2023, <https://spacenews.com/south-korea-sets-record-space-budget-to-bolster-industry-develop-new-rocket/>.

32 Park, “South Korea sets record space budget,” *ibid.*

33 Baek Byung-yeul, “Korea launches space agency, targets moon landing by 2032,” *The Korea Times*, May 27, 2024, <https://m.koreatimes.co.kr/pages/article.asp?newsIdx=375421>.

- 34 James Dargan, "South Korea Establishes Aero-Space Agency, Aims For Moon Landing By 2032," *Space Insider*, May 27, 2024, <https://spaceinsider.tech/2024/05/27/south-korea-establishes-aero-space-agency-aims-for-moon-landing-by-2032/>.
- 35 Kim Arin, "South Korea to launch space security center under spy agency," *The Korea Herald*, April 26, 2024, <https://www.koreaherald.com/article/3380845>.
- 36 Kuksung Nam, "South Korea launches national effort to tackle space security with new consultative body," *Readable*, June 5, 2024, <https://thereadable.co/south-korea-space-security-satellite-cybersecurity/>.
- 37 Nam, "South Korea launches national effort to tackle space security with new consultative body," *ibid*.
- 38 Hwang Joo-young, "DAPA to streamline procedures for joint civil-military space projects," *The Korea Herald*, July 30, 2025, <https://www.koreaherald.com/article/10543158>.
- 39 "25 Nations Participate in Global Sentinel 22," US Space Command, August 3, 2022, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/3115832/25-nations-participate-in-global-sentinel-22/>.
- 40 Chae Yun-hwan, "S. Korea to hold tabletop exercise against space hazards," *Yonhap News Agency*, April 12, 2023, <https://en.yna.co.kr/view/AEN20230412003300325>.
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- 42 Rachel Buitrago, "Space Forces Korea holds first POLARIS HAMMER - KOREA," US Space Forces Korea, February 2025, <https://www.spaceforce.mil/News/Article-Display/Article/4054548/space-forces-korea-holds-first-polaris-hammer-korea/>.
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- 44 "Space Operations Command leaders visit the Republic of Korea to strengthen partnership," Seventh Air Force Public Affairs, February 13, 2025, <https://www.spoc.spaceforce.mil/News/Article-Display/Article/4069899/space-operations-command-leaders-visit-the-republic-of-korea-to-strengthen-part>.
- 45 Kim Hyun-soo, "S. Korea, France reach agreement on defense space cooperation," *Yonhap News Agency*, September 16, 2025, <https://en.yna.co.kr/view/AEN20250916002600315>.

an amendment to the Space Development Promotion Plan, with various missions, including space security.³⁴ Under legislative revisions, South Korea is also considering the establishment of a National Space Security Center, under the National Intelligence Service, that could respond to threats faced by space infrastructure and other enemy threats in the space domain.³⁵

In June 2024, South Korean government agencies and research institutions started working on secure satellite systems, with the formation of a consultative body of twenty organizations, dedicated to protecting satellites throughout their entire life cycle. Including government agencies, the military, and research institutions, the goal of the consultative body is to help counter potential cyber threats against satellite systems.³⁶ Moreover, the National Intelligence Service can now establish and enforce security guidelines related to data on space assets.³⁷ In July 2025, South Korea's Defense Acquisition Program Administration (DAPA), Korea Aerospace Administration (KASA), and the Korea Coast Guard announced a jointly-led project to launch 30 ultraspace satellites by 2030, designed to monitor activity in North Korea. This satellite constellation falls within a broader effort to streamline management and regulation of joint civil-military space development projects.³⁸

Doctrine

In July 2022, South Korea participated in Global Sentinel, a USSPACECOM-led space security cooperation effort across 25 participating nations. During Global Sentinel, South Korea supported a regional multinational space operations center to command and control SSA sensors and responded to scenarios that modeled real-world events.³⁹

In April 2023, South Korea announced plans to hold a table-top exercise with military and government officials to examine how to respond to dangers from space and strengthen coordination between the military and space-related agencies.⁴⁰ Defense officials declared that the exercise will be held once a year.⁴¹ In January 2025, at Osan Air Base, South Korea, US Space Forces Korea held the first phase of Polaris Hammer – Korea, a space warfighter inclusive command-and-control exercise designed as a three-stage exercise in coordination with the US Space Force 392nd Combat Training Squadron.⁴² According to Colonel John Patrick, SPACEFOR-KOR commander, "[this] event was the first time US Space Forces Korea, with six [US Space Force] and South Korean command organizations, executed an operational level combined and joint command and control exercise." Phase II of Polaris Hammer – Korea was scheduled to occur in conjunction with combined exercise Freedom Shield 25, held by the United States and South Korea in March 2025.⁴³ It is unknown when the third phase of this exercise will be held.

In February 2025, senior leaders from US Space Force's Space Operations Command met with Lieutenant General Kim Hyoung Soo, commander of the ROKAF Operations Command, and toured South Korea's Space Operations Group to discuss integration at the operational level and strategic level of war between the United States and South Korea.⁴⁴

In September 2025, DAPA signed an agreement with France's procurement agency, committing to expand research, development, and intelligence sharing in the defense space sector and to facilitate an exchange of experts between South Korea and France.⁴⁵

Potential Military Utility /

In theory, South Korea's indigenously-developed space launch and ballistic missile expertise could be leveraged for a future DA-ASAT capability. However, given that South Korea has not tested additional technologies, such as hit-to-kill intercept, it is unlikely to be very capable. Also, since South Korea does not have an indigenous SSA capability yet, its ability to target objects in orbit is questionable; however, it does intend to develop its SSA capabilities within the middle of the decade and it has signed an SSA-sharing agreement with the United States, so it is possible that this could change. The ROKAF may have a basic EW counterspace capability through its Space Odyssey 2050 program, although again this is in very early stages (if it does indeed exist anywhere outside a planning document).

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14

THE UNITED KINGDOM

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The United Kingdom has long played a supporting role in military space activities through its participation in NATO and its bilateral relationship with the United States. Over the past few years, the United Kingdom has begun to add additional elements to increase its indigenous military space capabilities, primarily in SSA, along with policy, organization, and doctrine. The United Kingdom and the United States conducted an RPO. While the United Kingdom has not publicly announced any specific plans to develop offensive counterspace capabilities, its recently published Strategic Defence Review does include a focus on space control.

14.1 – UNITED KINGDOM CO-ORBITAL ASATS

In September 2025, US Space Command and UK Space Command (UKSC) announced the conduction of their first jointly coordinated RPO maneuver, occurring between September 4-12, 2025.¹ During this RPO maneuver, UKSC stated that a satellite, USA 271 (2016-052B, 41745), “maneuvered near the UK (satellite) SKYNET 5A (2007-007B, 30794) communications satellite, a complex and meticulously planned operation.”² Going into more detail, the the US commercial SSA company COMSPOC reported that it was one of the US GSSAP satellites, USA 271, which had been drifting westward but stopped near SKYNET-5A at 95.3°E from September 5-11, 2025.³ From July 2025, USA 271 satellite had been drifting at a rate of -1.5° per day, until an in-track maneuver was detected on September 4, 2025, with additional maneuvers that followed, until USA 271 was within 0.05° of the British satellite and at its closest point, was 13 km away.⁴ According to Major General Paul Tedman, commander of UK Space Command, “This operation was a first of its kind for U.K. Space Command.”⁵

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- 3 @COMSPOC_OPS, “Meeting on Earth AND in Space – USA 271 Drops by SKYNET-5A,” *Twitter*, September 19, 2025, https://x.com/comspoc_ops/status/1969124972661784944.
- 4 @COMSPOC_OPS, “Meeting on Earth AND in Space – USA 271 Drops by SKYNET-5A,” *ibid*.
- 5 “PRESS RELEASE: US and UK demonstrated partnership in first-ever on-orbit operation,” US Space Command, September 18, 2025, <https://www.spacecom.mil/Newsroom/News/Article-Display/Article/4308024/press-release-us-and-uk-demonstrate-partnership-in-first-ever-on-orbit-operation/>; Erwin, “US, UK Space Commands execute first joint satellite maneuvers,” *ibid*.
- 6 “Sky is No Longer the Limit for UK-US Military Operations,” Royal Air Force, September 19, 2025, <https://www.raf.mod.uk/news/articles/sky-is-no-longer-the-limit-for-uk-us-military-operations/>.

FIGURE 14-1 – DIAGRAM OF UNITED STATES-UNITED KINGDOM RPO MANEUVER FROM SEPTEMBER 4-12, 2025.⁶



Image Credit: UK Ministry of Defence © Crown copyright 2026.

- 7 Sky is No Longer the Limit for UK-US Military Operations," *ibid.*
- 8 "RAF Fylingdales: The Station," Royal Air Force, accessed February 21, 2022, <https://www.raf.mod.uk/our-organisation/stations/raf-fylingdales/>.
- 9 "RAF Fylingdales," *Wikipedia*, last edited December 24, 2024, https://en.wikipedia.org/wiki/RAF_Fylingdales#Systems.
- 10 "UK technology scans the skies for space hazards," *RAL Space*, accessed February 26, 2023, <https://www.ralspace.stfc.ac.uk/Pages/UK-technology-scans-the-skies-for-space-hazards.aspx>.
- 11 "UK technology scans the skies for space hazards," *ibid.*
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- 14 "DOD Signs Space Data Sharing Agreement with UK," US Strategic Command Public Affairs, September 25, 2014, <https://www.stratcom.mil/Media/News/News-Article-View/Article/983787/dod-signs-space-data-sharing-agreement-with-uk/>.
- 15 "Case Study: Monitor Your Satellites," UK Space Agency, May 10, 2022, <https://www.gov.uk/government/case-studies/monitor-your-satellites>.

FIGURE 14-2 — IMAGING OF UNITED STATES-UNITED KINGDOM RPO MANEUVER FROM SEPTEMBER 4-12, 2025.⁷

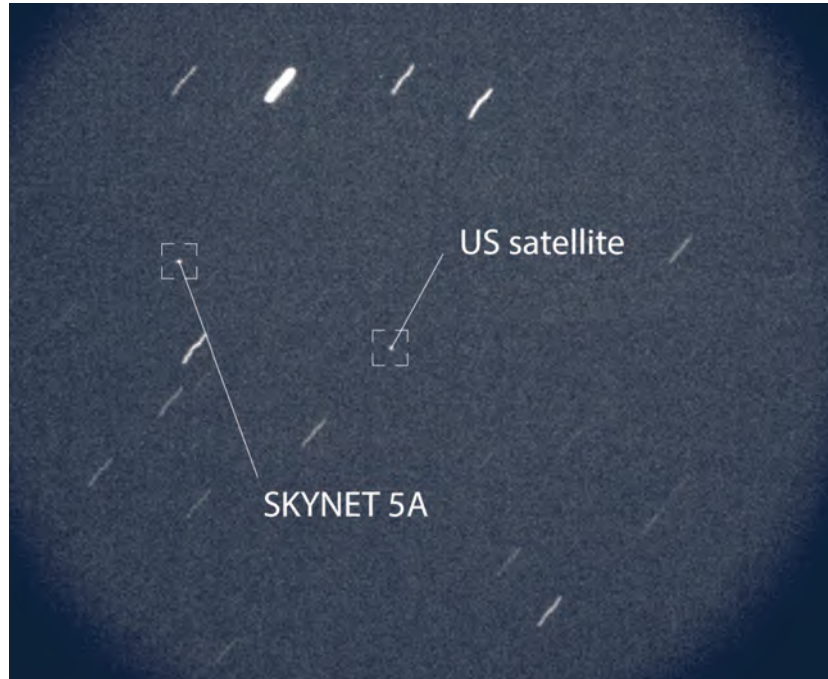


Image Credit: UK Ministry of Defence © Crown copyright 2026.

14.2 — UNITED KINGDOM SPACE SITUATIONAL AWARENESS CAPABILITIES

RAF Fylingdales (see Imagery Appendix, pg. 17-32) has been the site of an operational radar since 1963, providing ballistic missile early warning to the US and UK governments.⁸ Furthermore, as part of its participation in the Space Surveillance Network, its solid-state phased array radar can track objects to an altitude of 3000 nautical miles.⁹ UK space surveillance technology is being incorporated into the European Space Agency (ESA)'s first coordinated tracking campaign by contributing, via the UK Space Agency (UKSA), the capabilities of the Chilbolton Observatory (a meteorological radar experimental facility) and Space Insight's Starbrook (an optical space surveillance sensor system).¹⁰ The Chilbolton Advanced Meteorological Radar (CAMRa) can detect objects with a radar cross section as small as 1 square meter as far as 1000 km in altitude, while the Starbrook sensor can detect objects down to 1 meter as far as 40,000 km in altitude.¹¹ In April 2023, the United Kingdom asked industry to propose bids for a new ground-based telescope located at a UK military base in Cyprus.¹² In November 2023, the UK Ministry of Defence announced that SpaceFlux has been tasked with establishing and operating the telescope in Cyprus, named Project Nyx Alpha.¹³ There have been no public updates to this project as of February 2026.

The United Kingdom and the United States signed an SSA data sharing agreement in September 2014.¹⁴

In early 2022, the UKSA announced a pilot program called "Monitor Your Satellites," a service where operators of UK-based satellites could receive warnings of close approaches between their satellites and other space objects.¹⁵ While it was invite-only at the beginning, the service was eventually opened up to all UK operators and by October 2022, one-third of all UK satellite operators

had signed up for the service.¹⁶ In a 2022-2023 Annual Report compiled by the UKSA, “Monitor Your Satellites” was then being used by the operators of over 70 percent of UK satellites. The UK National Space Operations Centre was tasked to take over “Monitor Your Satellites” by April 2024.¹⁷

The UK Space Command released the *Cross-Government Space Domain Awareness Requirements* in August 2024.¹⁸ This initiative aimed to develop system of systems SSA requirements and to “inform industry and academia about potential future needs within the government space sector.”¹⁹

Deep Space Advanced Radar Capability (DARC) Program

In December 2023, the United States announced that Australia and the United Kingdom had officially joined the Deep Space Advanced Radar Capability (DARC) program.²⁰ DARC is an effort to develop a new set of radars to detect, track, and identify objects in deep space and consists of three geographically distributed sites that each have multiple transmit and receive radars meshed together (see US Space Situational Awareness Capabilities, Section 1.5). The United Kingdom announced plans to build 27 radar dishes for the DARC program, which will be located in Pembrokeshire in southwest Wales. In June 2024, Pembrokeshire locals launched an opposition campaign to the planned project, which they claimed would impact the landscape that attracts tourism to the area.²¹ In August 2024, however, the Ministry of Defence (MoD) stated that the DARC program is crucial for allied efforts to monitor threats in deep space, and UK press reporting confirmed that the radar site will continue as planned.²² Northrop Grumman was awarded the DARC radar site contract for the United Kingdom, “Site 2,” in September 2024.²³

DARC has been having issues maintaining its set schedule. USSF’s Gen. Stephen Purdy said in February 2025 that DARC might be one of the “slow” and “expensive” legacy systems that might be better replaced by commercial providers.²⁴ A June 2025 report by the US Government Accountability Office (GAO) noted that delays in the build of Site 1 because of issues in creating the site’s systems integration lab were “due to the contractor’s lack of expertise in building such a lab” and that seven-month delay had created follow-on delays.²⁵ For example, “the program delayed Site 2 construction by 9 months to April 2027 and deferred operational acceptance by 13 months to November 2029. Similarly, for Site 3, the program postponed both construction start and operational acceptance by 26 months, to September 2029 and January 2032, respectively.”²⁶ In August 2025, Northrop Grumman reported that Site 1’s “calibrated antenna arrays operated as a single system to successfully characterize the movement of multiple satellites and demonstrate the effectiveness of the system’s precision radar tracking technology” and is scheduled to be completed in 2027.²⁷ The growing cost of construction for Site 1 could impact the future of program funding for Site 2 as well, yet the overall project is still scheduled to be operational by 2032.²⁸

14.3 – UNITED KINGDOM COUNTERSPACE POLICY, DOCTRINE, AND ORGANIZATION

The UK Space Command was formed in April 2021 (at RAF High Wycombe, where the RAF Air Command is located as well) with the goal of providing command and control of all the United Kingdom’s space capabilities; oversight of the development of space-based capabilities; strengthen space workforce development; and continue the United Kingdom’s participation in the Combined Space Operations initiative.²⁹ It is operated jointly by the RAF, Royal Navy, and the Army. In July 2024, the UK Space Command held the country’s first

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20 “US, UK, Australia announce trilateral Deep Space Advanced Radar Capability Initiative,” US Space Force, December 2, 2023, <https://www.spaceforce.mil/News/Article-Display/Article/3604036/us-uk-australia-announce-trilateral-deep-space-advanced-radar-capability-initia/>.

21 Aled Scourfield, “Space radar plan near national park ‘unacceptable,’” *BBC*, June 12, 2024, <https://www.bbc.com/news/articles/c6ppnyzjr4lo>.

22 Jessica Elgot and Hannah Devlin, “Deep space radar site in Wales to go ahead to protect UK from ‘space warfare,’” *The Guardian*, August 8, 2024, <https://www.theguardian.com/politics/article/2024/aug/08/plans-deep-space-radar-site-wales-go-ahead>.

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24 Theresa Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *Breaking Defense*, March 11, 2025, <https://breakingdefense.com/2025/03/ssc-reviewing-expensive-legacy-programs-for-possible-commercial-shift/>.

25 *Weapon Systems Annual Assessment: DOD Leaders Should Ensure That Newer Programs Are Structured for Speed and Innovation*, Government Accountability Office Report GAO-25-107569, p. 158, June 2025, <https://www.gao.gov/assets/gao-25-107569.pdf>.

26 Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *ibid*.

27 Sandra Erwin, “Deep-space radar in Australia begins tracking satellites for AUKUS partners,” *SpaceNews*, August 12, 2025, <https://spacenews.com/deep-space-radar-in-australia-begins-tracking-satellites-for-aukus-partners/>.

28 Hitchens, “Space Systems Command reviewing expensive legacy programs for possible commercial shift,” *ibid*.

29 “Guidance: UK Space Command,” UK Ministry of Defence, April 1, 2021, <https://www.gov.uk/guidance/uk-space-command>.

- 30 "Space Command holds UK's first space wargame," Royal Air Force, July 29, 2024, <https://www.raf.mod.uk/news/articles/space-command-holds-uks-first-space-wargame/>.
- 31 "National Space Strategy," HM Government, September 2021, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1034313/national-space-strategy.pdf.
- 32 "National Space Strategy," *ibid.*
- 33 "National Space Strategy," *ibid.*, p. 20.
- 34 "National Space Strategy," *ibid.*, p. 33.
- 35 "National Space Strategy," *ibid.*, p. 34.
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- 37 "Defence Space Strategy," *ibid.*, p. 19.
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- 42 Sandra Erwin, "U.K. announces \$2 billion in new funding for military space programs," *SpaceNews*, February 1, 2022, <https://spacenews.com/u-k-announces-2-billion-in-new-funding-for-military-space-programs/>.
- 43 Erwin, "U.K. announces \$2 billion in new funding for military space programs," *ibid.*
- 44 "UK Space Command successfully launches first military satellite," *HM Government*, August 17, 2024, <https://www.gov.uk/government/news/uk-space-command-successfully-launches-first-military-satellite>.
- 45 Joint Doctrine Publication (JDP) 0-40, UK Space Power, UK Ministry of Defence, September 2022, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1111805/JDP_0_40_UK_Space_Power_web.pdf.
- 46 Joint Doctrine Publication (JDP) 0-40, UK Space Power, *ibid.*, p. 29.
- 47 Joint Doctrine Publication (JDP) 0-40, UK Space Power, *ibid.*, p. 80.

space wargame, titled "Space Warrior." Major General Paul Tedman, Commander of UK Space Command, oversaw the exercise, which focused on the integration of commercial and defense space-based intelligence, surveillance, and reconnaissance (ISR) capabilities.³⁰

The United Kingdom released its *National Space Strategy* (NSS) in September 2021.³¹ In it, the United Kingdom identified its national vision for space, which included "the UK will grow as a space nation" and the ability to "protect and defend UK interests in space."³² It had five goals for the United Kingdom in space; number four was "Protect and defend our national interests in and through space," mostly through resiliency, collaboration, and integration.³³ It also highlighted the need for diplomacy, stating, "The UK will deliver global leadership on a safe, sustainable, and secure space environment working through international and intergovernmental forums and with our partners and allies."³⁴ Specifically relevant to this document, the NSS also said, "We will support global stability through arms control and non-proliferation regimes and will work with allies to deter hostile activity against space systems including the use of weapons in space."³⁵

In February 2022, the United Kingdom published its *Defence Space Strategy* (DSS) in order to "protect and defend the UK's equities in space and the services derived from space assets."³⁶ Important components of the DSS included the desire to "improve our ability to generate appropriate measures to protect and defend our critical space capabilities. This suite of integrated, high-tech capabilities that can collect, process, exploit and transmit data, information, and intelligence activity in space."³⁷ The DSS included the additional promise of investment, over £145M, until 2032, in space, with the ultimate goal of achieving operational independence in the domain.³⁸ This followed the 2021 designation of the UK Space Command being tasked with leading the UK approach to SSA, space control, and command and control.³⁹ Furthermore, a joint civilian-military National Space Operations Centre was created to enhance the UK Space Operations Center (UKSpOC) and work with the UKSA.⁴⁰ Following these actions, the National Space Operations Centre (NSpOC) was launched in May 2024, along with the designation that space was now the fifth operational, not necessarily warfighting, domain.⁴¹ As part of its new military space strategy, the United Kingdom intended to invest £1.4 billion in military space satellite capabilities.⁴² Most of it is dedicated to the Istari program, which is planned to provide military ISR and laser communications capabilities, along with the Minerva program, which is intended to create a satellite network in support of military operations that can take in information and process it from United Kingdom and ally satellites. According to Jeremy Quin, Minister for Defence Procurement, these two satellite networks will be "building blocks" of the United Kingdom's future military space architecture.⁴³ In August 2024, UK Space Command successfully launched Tyche (2024-149AE, 60496), the first ISR satellite of the United Kingdom's planned Istari program. Tyche is the first satellite that is fully owned by the UK MoD.⁴⁴

Space Power, a military doctrine, was released by the United Kingdom in September 2022, aiming to "provide a basis for understanding the utility of the space domain in the military context."⁴⁵ *Space Power* further highlights four key space power roles: space domain awareness, space control, space support to operations, and space service support.⁴⁶ The doctrine notes that "deterrence in, through or using space capabilities is not an independent activity but must form part of the wider strategy. It is a whole-of-government activity to which Defence contributes," and emphasizes that UK's deterrence posture "remains enshrined in NATO" through Article 5 of the NATO treaty.⁴⁷

In October 2022, the United Kingdom formally pledged not to conduct destructive DA-ASAT missile tests, as one of the growing number of signatories to the moratorium on such testing initiated by the United States.⁴⁸

In June 2023, the United Kingdom created a Joint Task Force Space-Defence Commercial Operations Cell (JCO-UK) to augment the existing US Joint Commercial Operations (JCO) located at Schriever Space Force Base in Colorado.⁴⁹ The UK version will be integrated with the US JCO to enable operators to more easily track space objects around the clock.

In 2024, the UKSA engaged in more than 130 meetings with the MoD, regarding the need to jointly “protect critical national infrastructure from space-based threats...(which could become a) new frontier of conflict.”

The United Kingdom participated in US Space Command's Global Sentinel 2025 in April 2025 (See US Counterspace Policy, Doctrine, and Organization, Section 1.6).⁵⁰ This event included nearly 30 partner nations, including NATO, focused on strengthening international partnerships, collaboration, and responsible space behaviors.⁵¹ The Global Sentinel exercised a dedicated Global Sentinel version of Space-Track.org for capstone modeling and simulation gameplay, replicating potential real world events through this usage.⁵²

The UK MoD produced their *Strategic Defence Review* in July 2025, focused on delivery and assurance of space-based capabilities for defensive purposes.⁵³ According to this policy paper, “With counterspace capabilities proliferating rapidly, defence must urgently develop the resilience of its military space systems...investment should be focused on three areas without which the Integrated Force will not be able to operate effectively.”⁵⁴ Keeping in mind the importance of UK security and success, the MOD further emphasized their decision to invest in resilient military space systems, emphasize the space and cyber domains, and focus on space control.⁵⁵ The *Strategic Defence Review* highlights the following concepts: space control, decision advantage, rapid/accurate space based systems (e.g., ISR, PNT).⁵⁶ Most importantly, this publication singled out space as a separate domain to air, land, sea, and cyber for the first time.⁵⁷ Following the *Strategic Defence Review's* publication, Major General Paul Tedman CBE gave a speech on the United Kingdom's expanded focus on space, stating, “The increasing counterspace threat now means that gaining control of the Space Domain...is a necessary first step to protecting the force from adversary space and delivering vital space effects, such as PNT, SATCOM, and ISR to our own forces... Access is no longer enough. We must be able to control space, defend our assets, and—if required—deny its use to hostile actors.”⁵⁸

Potential Military Utility /

Although it possesses some of the underlying technologies, such as indigenous ballistic missile expertise, the United Kingdom is very unlikely to develop DA-ASAT capabilities. It has not expressed any interest in doing so and has not developed policies allowing it as an option (its military space doctrine focuses largely on SSA capabilities). It does not have an indigenous space launch capacity. The United Kingdom has also not shown an interest in a co-orbital ASAT program, but its coordination of a bilateral RPO with the United States does indicate that perhaps this capability may eventually be an option in the future. Based on the United Kingdom's solid existing SSA capabilities and the evolution thereof (in terms of offering conjunction warnings to UK satellite operators), it is possible that its SSA capabilities could provide some military utility for both offensive and defensive counterspace operations.

48 “Responsible space behaviours: the UK commits not to destructively test direct ascent anti-satellite missiles,” press release from the Foreign, Commonwealth & Development Office and UK Space Agency, October 3, 2022, <https://www.gov.uk/government/news/responsible-space-behaviours-the-uk-commits-not-to-destructively-test-direct-ascent-anti-satellite-missiles>.

49 Theresa Hitchens, “New UK military ‘cell’ to partner with US SPACECOM on space domain awareness,” *Breaking Defense*, June 26, 2023, <https://breakingdefense.com/2023/06/new-uk-military-cell-to-partner-with-us-spacecom-on-space-domain-awareness/>.

50 LaDonna Davis, “US Space Command hosts Global Sentinel 2025 exercise,” United States Space Force, May 6, 2025, <https://www.space-force.mil/news/article-display/article/4175650/us-space-command-hosts-global-sentinel-2025-exercise/>.

51 Davis, “US Space Command hosts Global Sentinel 2025 exercise,” *ibid*.

52 Davis, “US Space Command hosts Global Sentinel 2025 exercise,” *ibid*.

53 “Policy Paper: The Strategic Defence Review 2025 - Making Britain Safer: secure at home, strong abroad,” UK Ministry of Defence, July 8, 2025, <https://www.gov.uk/government/publications/the-strategic-defence-review-2025-making-britain-safer-secure-at-home-strong-abroad/the-strategic-defence-review-2025-making-britain-safer-secure-at-home-strong-abroad>.

54 “Policy Paper: The Strategic Defence Review 2025 - Making Britain Safer: secure at home, strong abroad,” *ibid*.

55 Sharon Fisher, “Military leaders say integrated space power crucial for national defense,” *SpaceNews*, August 4, 2025, <https://space-news.com/military-leaders-say-integrated-space-power-crucial-for-national-defense/>.

56 “Policy Paper: The Strategic Defence Review 2025 - Making Britain Safer: secure at home, strong abroad,” *ibid*.

57 Sharon Fisher, “Military leaders say integrated space power crucial for national defense,” *SpaceNews*, August 4, 2025, <https://space-news.com/military-leaders-say-integrated-space-power-crucial-for-national-defense/>.

58 Major General Paul Tedman CBE, “UK Space Commander speech on defence in the space domain,” UK Ministry of Defence, July 25, 2025, <https://www.gov.uk/government/speeches/uk-space-commander-speech-on-defence-in-the-space-domain>.



Cyber Counterspace Capabilities



GLOBAL CYBER COUNTER- SPACE CAPABILI- TIES

Assessment /

Multiple countries likely possess cyber capabilities that could be used against space systems; however actual evidence of cyberattacks in the public domain is limited. The United States, Russia, China, France, Iran, Israel, and North Korea have all demonstrated the ability and willingness to engage in offensive cyberattacks against non-space targets. Additionally, a growing number of non-state actors are actively probing commercial satellite systems and discovering cyber vulnerabilities that are similar in nature to those found in non-space systems. This indicates that manufacturers and developers of space systems may not yet have reached the same level of cyber hardness as other sectors. But to date, there have only been a few publicly disclosed cyberattacks directly targeting space systems, and nearly all have gone after the end user segment and not satellites themselves.

There is a clear trend toward lower barriers to access, and widespread vulnerabilities coupled with reliance on relatively unsecured commercial space systems create the potential for non-state actors to carry out some counterspace cyber operations without nation-state assistance. However, while this threat deserves attention and will likely grow in severity over the next decade, there remains a stark difference at present between the cyberattack capabilities of leading nation-states and other actors.

Specifics /

Cyber capabilities include a broad set of different tools and techniques aimed at exploiting ever-changing vulnerabilities in each layer of the infrastructure that underpins space access. Extant capabilities have demonstrated the capacity to produce a wide range of strategic and tactical effects, both destructive and non-destructive. These include theft, alteration, or denial of information, as well as control or destruction of satellites, their subcomponents, or supporting infrastructure. As space capabilities continue to shift towards incorporating more advanced on-board processing, all-digital components, software-defined radios, packet-based protocols, and cloud-enabled high-performance computing, the attack surface for cyberattacks is likely to increase.

Cyberattacks against space capabilities are similar to cyberattacks against non-space systems. They often involve attempts to feed user-provided information to a system that causes the software to perform in unexpected ways, commonly known as “bugs”. In some cases, bugs can be exploited to crash systems, run unauthorized code, and/or gain unauthorized access. Other common cyberattacks exploit the lack of, or faulty, authentication of users and commands. The more software features or components a system has, and the more types and channels of data it processes, the higher the attack surface of potential vulnerabilities that an attacker can exploit. There is also an unclear distinction between cyberattacks and electronic warfare, with some arguing for a merger of the two fields.¹

Some bugs can lead to vulnerabilities, which are weaknesses in a computer system that can be leveraged by an attacker to breach a system. An exploit is an active attack that takes advantage of a specific vulnerability.

Any cyberattack requires four things: access, vulnerability, a malicious payload, and a command-and-control system.² Three primary points of access exist for exploitation, attack, and service denial of space assets in the cyber domain: the supply chain, the extended land-based infrastructure that sustains space-based assets, including ground stations, terminals, related companies, and end-users, and the satellites themselves.³ Successful penetration of any one of these may be sufficient to produce the desired espionage, ‘soft’-

- 1 Eric Chabrow, “Aligning Electronic and Cyber Warfare,” *Gov Info Security*, July 10, 2012, <https://www.govinfosecurity.com/aligning-electronic-cyber-warfare-a-4930>.
- 2 Andrea Gini, “Cyber Crime – From Cyber Space to Outer Space,” *Space Safety Magazine*, February 14, 2014, <http://www.spacesafetymagazine.com/aerospace-engineering/cyber-security/cyber-crime-cyber-space-outer-space/>.
- 3 Mark Holmes, “Cybersecurity Expert Assesses Potential Threats to Satellites,” *Via Satellite*, February 21, 2017, <http://www.satellitetoday.com/technology/2017/02/21/cybersecurity-expert-assess-potential-threats-satellites/>; David Livingstone and Patricia Lewis, “Space, the Final Frontier for Cybersecurity?,” *Chatham House*, September 2016, <https://www.chatham-house.org/sites/default/files/publications/research/2016-09-22-space-final-frontier-cybersecurity-livingstone-lewis.pdf>; Madeline Moon (Rapporteur), “The Space Domain and Allied Defence,” NATO Parliamentary Assembly, Defence and Security Committee, Sub-Committee on Future Security and Defence Capabilities, October 8, 2017, <https://www.nato-pa.int/download-file?filename=sites/default/files/2017-11/2017%20-%2016%20DSCFC%2017%20E%20rev%201%20fin%20-%20SPACE%20-%20MOON%20REPORT.pdf>.

- 4 Eric Sterner and Jennifer McArdle, "Cyber Threats in the Space Domain," The American Foreign Policy Council, *Defense Technology Program Brief*, March 31, 2016, <https://www.afpc.org/uploads/documents/Defense%20Brief%20Issue%2015.pdf>; Mark Holmes, "Cybersecurity Expert Assesses Potential Threats to Satellites," *Via Satellite*, February 21, 2017, <http://www.satellitetoday.com/technology/2017/02/21/cyber-security-expert-assess-potential-threats-satellites/>; Jason D. Wood, "Strategic Security: Toward an Integrated Nuclear, Space, and Cyber Policy Framework," accessed March 23, 2018, https://csis-website-prod.s3.amazonaws.com/s3fs-public/110916_Wood.pdf.
- 5 Matthew Olay, "Senior Pentagon Official Says Cyber Warfare Poses Significant Threat to Joint Force," *DOD News*, April 22, 2025, <https://www.war.gov/News/News-Stories/Article/Article/4163237/senior-pentagon-official-says-cyber-warfare-poses-significant-threat-to-joint-f/>.
- 6 "Significant Security Deficiencies in NOAA's Information Systems Creates Risks in its National Critical Mission," *National Oceanic and Atmospheric Administration*, July 15, 2014, <https://www.oig.doc.gov/OIGPublications/OIG-14-025-A.pdf>; Mark Clayton, "Can military's satellite links be hacked? Cyber-security firm cites concerns," *Christian Science Monitor*, April 25, 2014, <https://www.csmonitor.com/World/Passcode/2014/0425/Can-military-s-satellite-links-be-hacked-Cyber-security-firm-cites-concerns>; David Livingstone, "Cyberattacks in Space: We Must Defend the Final Frontier," *Newsweek*, November 26, 2014, <http://www.newsweek.com/cyber-attacks-space-we-must-defend-final-frontier-287525>; David Livingstone and Patricia Lewis, "Space, the Final Frontier for Cybersecurity?," *Chatham House*, <https://www.chatham-house.org/sites/default/files/publications/research/2016-09-22-space-final-frontier-cybersecurity-livingstone-lewis.pdf>.
- 7 Chris Gordon, "Cybersecurity Is the 'Soft Underbelly' of Space Operations, SpOC Commander Says," *Air & Space Forces Magazine*, October 14, 2022, <https://www.airandspaceforces.com/cybersecurity-is-the-soft-underbelly-of-space-operations-spoc-commander-says/>; Sandra Erwin, "The real space war is being fought in cyberspace," *SpaceNews*, October 3, 2025, <https://spacenews.com/the-real-space-war-is-being-fought-in-cyberspace/>.
- 8 Kevin Pollpeter, "Testimony Before the US-China Economic and Security Review Commission: Hearing on China's Advanced Weapons," *CNA*, February 2017, https://www.cna.org/CNA_files/PDF/CPP-2017-U-014906-Final.pdf; Daniel Coats, "Statement for the Record – Worldwide Threat Assessment of the US Intelligence Community," *Office of the Director of National Intelligence*, February 13, 2018, <https://www.dni.gov/files/documents/Newsroom/Testimonies/2018-ATA---Unclassified-SSCI.pdf>.
- 9 Daniel Coats, "Statement for the Record – Worldwide Threat Assessment of the US Intelligence Community," *Office of the Director of National Intelligence*, May 11, 2017, <https://www.dni.gov/files/documents/Newsroom/Testimonies/SASC%202017%20ATA%20SFR%20-%20FINAL.PDF>.
- 10 Coats, *ibid*; see also Pollpeter, "Testimony Before the US-China Economic and Security Review Commission: Hearing on China's Advanced Weapons."

or 'hard'-kill effects, and also enables the launching of additional follow-on cyberattacks in other vectors.⁴ A wide and rapidly growing array of tools and techniques threaten each of these levels.

US Department of Defense's Director for Cyber Warfare John Garstka demonstrated the interconnected nature of military space with the commercial sector when he noted in April 2025, "If you're dependent on the DIB [defense industrial base] for operations of your space systems, you have to treat protecting the DIB as important as protecting the space system, space segment or ground segment," since cyberattacks "can shut a production line down" and thus affect military missions.⁵

As a result, cyber capabilities are critically important to the overall counterspace environment.⁶ One former senior military official has gone so far as to identify cyber vulnerabilities as the "No. 1 counter-space threat," further underscoring their strategic significance. Another military official described cyber vulnerabilities in 2022 as "the soft underbelly" of space systems, with a third saying in 2025 that his "number one concern is cyber."⁷ All major players appear extremely likely to continue the development and use of such capabilities.⁸ In 2017, the US intelligence community testified in its annual report before the Senate Select Committee on Intelligence that both Russia and China, driven by a perceived need to offset US military advantages, are certain to continue to pursue a "full range" of counter-space capabilities.⁹ Moreover, integration and complementary use of an array of ASAT capabilities, and particularly an increased "blending of EW and cyber-attack" capabilities, is likely to occur, representing a growing sophistication in tools and techniques for the denial and degradation of command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) networks.¹⁰

Categories of Cyberattacks on Space Systems

Parsing the exact nature and extent of cyber capabilities or development efforts with any precision based on open sources is a fraught exercise. There have been only a few cases of publicly acknowledged cyberattacks against satellites, and even the information on those is incomplete. Cyber weapon development is also one of the most sensitive and closely guarded secrets kept by nation states. Still, some general conclusions may be drawn about the capabilities in existence based on a technical assessment of vulnerabilities and a review of known instances of use.

The first category of cyberattacks against space systems are deliberate installation of hidden back doors in hardware or software products, which are made possible by flaws in global supply chain security.¹¹ Such back doors have been found in Chinese electronics¹² and Russian software packages¹³ used by US aerospace companies. The United States, meanwhile, has engaged in a broad and persistent campaign of computer network exploitation (CNE) operations for decades, with targets including foreign telecommunications and aerospace infrastructure.¹⁴ There have also been media reports of US intelligence agencies intercepting shipments of commercial equipment to install “implants,”¹⁵ and creating backdoors in commercial encryption software.¹⁶ Similar cyber-espionage operations can be directed against satellite manufacturers, parts suppliers, software brokers, launch service providers, and telecommunications companies are also common. Physical infiltration, social engineering, and network exploitation of these targets can provide access to the design schematics, physical components, and software packages of a given satellite. As AI becomes more prevalent in both the space sector and cybersecurity, it can both help and hinder cyber security: help in terms of identifying issues earlier than they might have been otherwise, but hinder in that they can also introduce new vulnerabilities or miss signs of problems that humans would have caught.¹⁷

11 These are largely beyond the scope of this assessment. For a brief discussion of such efforts as part of broader counterspace programs, see James Clapper, “Statement for the Record – Worldwide Threat Assessment of the US Intelligence Community,” Office of the Director of National Intelligence, February 26, 2015, https://www.dni.gov/files/documents/Unclassified_2015_ATA_SFR_-_SASC_FINAL.pdf. For a useful taxonomy of supply chain attacks, refer to John Miller, “Supply Chain Attack Framework and Attack Patterns,” *The MITRE Corporation*, December 2013, <https://www.mitre.org/sites/default/files/publications/supply-chain-attack-framework-14-0228.pdf>.

12 One high-profile instance was the discovery by a Cambridge security researcher of a backdoor built into nonencrypted Microsemi chips utilized in a range of sensitive assets including weapons systems. Some experts alleged that this could be leveraged to attack and disable or destroy millions of systems. See Steven Musil, “Experts Dispute Threat Posed by Backdoor Found in Chinese Chip,” *CNET*, May 29, 2012, <https://www.cnet.com/news/experts-dispute-threat-posed-by-backdoor-found-in-chinese-chip/>; Others disagreed, contending that the backdoor was either accidental or so difficult to exploit as to be largely irrelevant. See Robert Graham, “Bogus Story: No Chinese Backdoor in Military Chip,” *Errata Security*, May 28, 2012, <https://blog.erratasec.com/2012/05/bogus-story-no-chinese-backdoor-in.html>.

13 For example, Russia-based Kaspersky was used extensively by numerous governmental agencies, contractors, and private companies, and has been implicated in allowing Russia backdoor access to various networks including that of the US National Security Agency (NSA). See Gordon Lubold and Shane Harris, “Russian Hackers Stole NSA Data on U.S. Cyber Defense,” *The Wall Street Journal*, October 5, 2017, <https://www.wsj.com/articles/russian-hackers-stole-nsa-data-on-u-s-cyber-defense-1507222108>.

14 Of particular note are the operations of the Office of Tailored Access Operations (TAO) in the NSA, housed jointly with US Cyber Command (Cybercom) at Fort Meade. The TAO has consistently and comprehensively penetrated foreign computer and telecommunications systems, through an ever-evolving range of methods including the installation of physical backdoors in Chinese components or systems at various stages of production, distribution, and use to ensure remote access. See Matthew Aid, “Inside the NSA’s Ultra-Secret China Hacking Group,” *Foreign Policy*, June 10, 2013, http://www.foreignpolicy.com/articles/2013/06/10/inside_the_nsa_s_ultra_secret_china_hacking_group; “Documents Reveal Top NSA Hacking Unit,” *Der Spiegel*, December 29, 2013, <http://www.spiegel.de/international/world/the-nsa-uses-powerful-toolbox-in-ef-fort-to-spy-on-global-networks-a-940969.html>.

15 Sean Gallagher, “Photos of an NSA Upgrade Factory Show Cisco Router Getting Implant,” *Ars Technica*, May 14, 2014, <https://arstechnica.com/tech-policy/2014/05/photos-of-an-nsa-upgrade-factory-show-cisco-router-getting-implant/>.

16 Joseph Menn, “Exclusive: Secret Contract Tied NSA and Security Industry Pioneer,” *Reuters*, December 20, 2013, <https://www.reuters.com/article/us-usa-security-rsa/exclusive-secret-contract-tied-nsa-and-security-industry-pioneer-idUSBRE9BJ1C220131220>.

17 Mark Holmes, “Preparing the Ground to Repel Cyber Attacks,” *Satellite Today*, October 25, 2025, <https://www.satellitetoday.com/cybersecurity/2025/10/22/preparing-the-ground-to-repel-cyber-attacks/>.

- 18 Jill Stuart, "Comment: Satellite Industry Must Invest in Cyber Security," *The Financial Times*, April 10, 2015, <https://www.ft.com/content/659ab77e-c276-11e4-ad89-00144feab7de>.
- 19 "2011 Report to Congress of the US-China Economic and Security Review Commission," *US Economic and Security Review Commission*, November 2011, p. 216, https://www.uscc.gov/sites/default/files/annual_reports/annual_report_full_11.pdf.
- 20 Jim Wolf, "China Key Suspect in US Satellite Hacks; Commission," *Reuters*, October 28, 2011, <https://www.reuters.com/article/us-china-usa-satellite/china-key-suspect-in-u-s-satellite-hacks-commission-idUSTRE79R4O320111028>.
- 21 Wolf, "China Key Suspect in US Satellite Hacks," *ibid*.
- 22 Patrick Tucker, "The NSA Is Studying Satellite Hacking," *Defense One*, September 20, 2019, <https://www.defenseone.com/technology/2019/09/nsa-studying-satellite-hacking/160009/>.
- 23 This allows easy access for signal interference or hijacking. See Andy Greenberg, "How to Hack the Sky," *Forbes*, February 2, 2010, <https://www.forbes.com/2010/02/02/hackers-cybercrime-cryptography-technology-security-satellite.html#2153b10f731f>; Andrea Gini, "Cybercrime – From Cyber Space to Outer Space," *Space Safety Magazine*, February 14, 2014, <http://www.spacesafetymagazine.com/aerospace-engineering/cyber-security/cyber-crime-cyber-space-outer-space/>.
- 24 Rajeswari Pillai Rajagopalan and Daniel Porras, "Cyber Arms Race in Space: Exploring India's Next Steps," *Observer Research Foundation Issue Brief*, Issue No. 113, November 2015, http://www.orfonline.org/wp-content/uploads/2015/12/Issue-Brief_113.pdf; Juliet Van Wagenen, "WTA Urges Teleport Operators to Improve on Cybersecurity," *Via Satellite*, August 5, 2015, <http://www.satellitetoday.com/innovation/2015/08/05/wta-urges-teleport-operators-to-improve-on-cyber-security/>.
- 25 *Ibid*.
- 26 *Ibid*; this approach has been taken by China in particular, see: Robert Lai and Syed Rahman, "Analytic of China Cyberattack," *The International Journal of Multimedia and Its Applications*, Vol 4 No 3, June 2012, https://www.researchgate.net/publication/267363551_Analytic_of_China_Cyberattack.
- 27 David Kushner, "The Real Story of Stuxnet," *IEEE Spectrum Magazine*, February 26, 2013, <https://spectrum.ieee.org/telecom/security/the-real-story-of-stuxnet>.
- 28 Security Response Attack Investigation Team, "Thrip: Espionage group hits satellite, telcoms, and defense companies," *Symantec*, June 19, 2018, <https://www.symantec.com/blogs/threat-intelligence/thrip-hits-satellite-telecoms-defense-targets>.

The second category of cyberattacks against space systems are those directed against the links between satellites and ground control stations. Most of these are likely to be man-in-the-middle (MITM) attacks, an umbrella term that involves an attacker inserting themselves between the sender and receiver, thus able to monitor information being passed or perhaps even modify it. It is also possible, although often very difficult, to use a cyberattack against the command and control (C2) link to gain access to the satellite bus or payloads. This type of attack is made easier if the C2 system is unencrypted or does not properly authenticate commands. If such an attack is successful, there is little limit to the damage that can be done.

Over the last decade, there have been a few public examples of satellite C2 links being attacked (or alleged instances of attacks). In 2007, it was reported that the Tamil Tigers extremist separatist group successfully hacked ground C2 nodes and gained control of the broadcasting capabilities of a US commercial satellite.¹⁸ From 2007 through 2009, there were multiple incidents of attacks against C2 links for NASA satellites that are thought to be attributed to China, as detailed in the 2011 report of the US-China Economic and Security Review Commission.¹⁹ In October 2007, the Landsat 7 (1999-020A, 25682) remote sensing satellite experienced twelve minutes of interference. In June 2008, the Terra (1999-068A, 25994) remote sensing satellite experienced two minutes of interference, and the attackers achieved "all steps required to send commands but did not." On July 23, 2008, Landsat 7 experienced another twelve minutes of interference, but the attackers did not gain access to the C2 link. But on October 22, 2008, the Terra satellite experienced another nine minutes of interference, and once again the attackers gained control of the satellite but did not exercise it. Initial reports traced events to the Kongsberg Satellite Services ground station at Svalbard, but they said their systems could not command NASA satellites.²⁰ General Robert Kehler, then commander of United States Strategic Command, said there was no evidence to attribute the attacks at the time.²¹ A cybersecurity researcher said in 2019 that there had been six cases of hackers interfering with NASA satellites before 2011, with the first five occurring in the 2007-2008 timeframe.²²

The third category of cyberattacks against space systems involves attacks on terrestrial C2 or data relay stations. Techniques could include fly-overs with manned aircraft, unmanned aerial systems (UAS), or weather balloons;²³ signal disruption or hijacking through proximate positioning of broadcasting equipment using a more powerful signal, tapping the structure's Internet or Ethernet cables, or piggybacking off of the station's own data relays;²⁴ physical access, through either covert infiltration or social engineering;²⁵ and network exploitation or attack, using traditional means.²⁶ Although many satellite C2 facilities are hardened against cyberattacks and take precautions such as "air-gapping" critical networks, there are examples of sophisticated State attackers being able to penetrate such systems (albeit not specifically space-related air gapped networks).²⁷ In June 2018, cybersecurity firm Symantec reported on a wide-ranging cyber espionage campaign by a group named Thrip, likely based in China, that included attacks against defense and space-related companies. According to Symantec, Thrip targeted computers at a commercial operator running software that monitors and controls communications satellites.²⁸

Also in this third category are cyberattacks against ground systems that process spatial data. NASA, for example, has long been the target of cyberattacks, as have other space agencies around the world.²⁹ In 2011, attackers gained full access to 18 servers supporting multiple missions at the Jet Propulsion Laboratory and stole 87 gigabytes of data.³⁰ (Over a decade later, a 2025 report by the Government Accountability Office noted that NASA had not fully implemented all the steps of its cybersecurity risk management program.³¹) In late 2014, attackers breached NOAA's computer network, including systems used to manage and disseminate satellite weather data and products for the National Environmental Satellite, Data, and Information Service (NESDIS) and the National Earth System Prediction Capability (ESPC).³² Although the attack itself did not disrupt satellite data, NOAA stopped providing satellite images to the National Weather Service and public-facing services were taken offline for two days while the systems were cleaned. While the US government did not publicly attribute the attack, US Rep. Frank Wolf declared that "NOAA told me it was a hack and it was China."³³ The Symantec report on Thrip also claimed that the group attacked computers running Geographic Information System (GIS) software used for tasks such as developing custom geospatial applications or integrating location-based data into other applications and software for processing satellite imagery.³⁴ In a similar fashion, attackers from the hacker collective Anonymous reportedly breached the website of the Russian Space Research Institute (IKI) in March 2022 in response to the invasion of Ukraine.³⁵

In March 2025, POLSA, the Polish Space Agency, announced that it had "detected unauthorized access to the Polish Space Agency's IT infrastructure" and thus disconnected itself from the internet until it could be sure its system was secure again.³⁶ While the identity of the hacker was not made clear, Digital Minister Krzysztof Gawkowski said in January 2025 that Poland was the "most attacked country in the European Union when it comes to cyberspace incidents," and indicated that they believed Russia to be behind them.³⁷ In May 2024, Polish government IT teams saw cyber intrusions via a malware campaign against many Polish government entities and identified it to be related to APT28, a hacker group tied to the Russian government.³⁸ The March 2025 hack proved to be the last straw for POLSA head Grzegorz Wrochna, who had been at the helm of the agency through several other controversies, and his dismissal was announced later that month: a sign of how destabilizing these attacks can be.³⁹

29 Paul Martin, "NASA Cybersecurity: An Examination of the Agency's Information Security," testimony before the House Subcommittee on Investigations and Oversight, February 29, 2012, https://oig.nasa.gov/docs/FINAL_written_statement_for_%20IT_%20hearing_February_26_edit_v2.pdf; Nafeesa Syeed, "Outer-Space Hacking a Top Concern for NASA's Cybersecurity Chief," *Bloomberg*, April 12, 2017, <https://www.bloomberg.com/news/articles/2017-04-12/outer-space-hacking-a-top-concern-for-nasa-s-cybersecurity-chief>.

30 NASA Office of the Inspector General, "Cybersecurity Management and Oversight at the Jet Propulsion Laboratory," *National Aeronautics and Space Administration*, Report No. IG-19-022, June 18, 2019, <https://oig.nasa.gov/docs/IG-19-022.pdf>.

31 Government Accountability Office, "Cybersecurity: NASA Needs to Fully Implement Risk Management," GAO-25-108138, June 25, 2025, <https://www.gao.gov/products/gao-25-108138>.

32 Mary Pat Flaherty, Jason Samenow, and Lisa Rein, "Chinese Hack US Weather Systems, Satellite Network," *Washington Post*, November 12, 2014, https://www.washingtonpost.com/local/chinese-hack-us-weather-systems-satellite-network/2014/11/12/bef1206a-68e9-11e4-b053-65cea7903f2e_story.html?utm_term=.d01b2f4051a7.

33 Ibid; Timothy Cama, "Report: Chinese Hacked US Weather Systems," *The Hill*, November 12, 2014, <http://thehill.com/policy/energy-environment/223871-report-chinese-hacked-us-weather-systems>.

34 Security Response Attack Investigation Team, "Thrip: Espionage group hits satellite, telcos, and defense companies," *Symantec*, June 19, 2018, <https://www.symantec.com/blogs/threat-intelligence/thrip-hits-satellite-telcos-defense-targets>.

35 Joseph Cox, "Hackers Breach Russian Space Research Institute Website," *Vice*, March 3, 2022, <https://www.vice.com/en/article/z3n8ea/hackers-breach-russian-space-research-institute-website>.

36 Ionut Arghire, "Polish Space Agency Hit by Cyberattack," *Security Week*, March 4, 2025, <https://www.securityweek.com/polish-space-agency-hit-by-cyberattack/>.

37 Carly Page, "Polish space agency says it's investigating a cyberattack," *TechCrunch*, March 4, 2025, <https://techcrunch.com/2025/03/04/polish-space-agency-says-its-investigating-a-cyberattack/>.

38 "APT28 campaign targeting Polish government institutions," *CERT Polska*, May 8, 2024, <https://cert.pl/en/posts/2024/05/apt28-campaign/>.

39 Andrew Parsonson, "New Polish Space Agency Chief Named After Abrupt Exit of Predecessor," *European Spaceflight*, May 2, 2025, <https://europeanspaceflight.com/new-polish-space-agency-chief-named-after-abrupt-exit-of-predecessor/>.

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The European Space Agency (ESA) has also undergone a series of high-profile cyberattacks over the past several years. First, in December 2024, hackers were able to insert a fake payment page in the ESA online store in order to steal customers' financial data.⁴⁰ Then in December 2025, a threat actor was able to download 200 GB of ESA's data and leak it into the dark web; this data included passwords, source code, confidential documents, and authentication codes.⁴¹ ESA at first downplayed the breach, saying that its initial analysis had found only "a very limited number of science servers — located outside the ESA corporate network — that may be affected."⁴² However, in January 2026, the cybercrime syndicate Scattered Lapsus\$ Hunters announced that they had gotten into ESA's servers in September 2025 and were able to steal 500 GB of sensitive data, including data from ESA partners like Thales Alenia Space, Airbus Group, and SpaceX; furthermore, they claimed that the vulnerability they exploited was still around so they could get back in if they chose.⁴³ ESA's response was that it was fully cooperating with authorities and, per an ESA rep, "These authorities will manage the communication regarding the case, as those authorities will be in charge of the criminal proceedings."⁴⁴ In an interesting bit of timing, ESA released a request for proposals on January 15, 2026, for "(Cyber)security Products for Space Systems Protection."⁴⁵

A fourth category involves cyberattacks against the user segment of a space system, often the terminals or devices used to receive or process a satellite signal. In many cases, these attacks are very similar to cyberattacks against other types of computer equipment and focus on exploiting hardware or software vulnerabilities in the devices. As an example, a group of US university students developed a technique for attacking the software in common commercial GPS receivers.⁴⁶ The attack uses a specially built box that modifies the data content of real civil GPS signals and rebroadcasts them. When a GPS receiver tries to decode these malicious GPS signals, they can crash or go into constant reboot loops, effectively succumbing to a denial-of-service attack. Another report in 2014 found that over 10,000 allegedly-secure very small aperture terminals (VSATs) used for transmission of critical information, including classified defense-relevant communications, sensitive financial data, and supervisory control and data acquisition (SCADA) system data essential to the continued operation of power grids and oil rigs in the United States, were easily scanned and penetrated from abroad due to a simple failure to change default factory password settings or disable outward-facing virtual network (telnet) access.⁴⁷

Case Study: Cyberattacks Against Multiple Satellite Networks During The Russian-Ukrainian War

Several concrete examples of cyber attacks against the user segment of a space system have occurred as part of the ongoing Russian invasion of Ukraine. Within hours of Russian troops crossing the border into Ukraine in February 2022, tens of thousands of end user modems for the KA-SAT satellite communications service, managed by the US-based company Viasat, went offline.⁴⁸ The affected users included thousands of wind turbines in Germany and many other individuals and businesses across Europe, including the Ukrainian government and police, and other networks that resold the KA-SAT service in France, Hungary, Greece, Italy, and Poland.⁴⁹ Subsequent details from Viasat revealed that the attack began with a denial-of-service attack within Viasat's customer network that appeared to emanate from equipment located within Ukraine.⁵⁰ This was followed by tens of thousands of customer modems disconnecting from the network. Further analysis discovered an external attacker used a misconfigured VPN appliance to gain access to the management network for the KA-SAT service and sent a series of malicious commands to

overwrite data on user modems, and that it only took 45 minutes for the malware to be deployed.⁵¹ Although Viasat originally claimed the modems were not permanently damaged, analysis done by the cyber security firm SentinelOne discovered a new type of destructive wiper malware called AcidRain was used in the attack, a claim later confirmed by Viasat.⁵²

In May 2022, the United States, United Kingdom, and European Union publicly attributed the cyberattack against Viasat's KA-SAT services to Russia, and specifically to hackers working for the Main Directorate of the General Staff of the Armed Forces of the Russian Federation, commonly known as the GRU.⁵³ Former US Secretary of State Anthony Blinken stated that there were strong similarities between the AcidRain wiper malware and other wiper malware used by Russian military cyber operators as part of the armed conflict in Ukraine.⁵⁴

Independent analysts suggested that the aim of the cyberattack was to cripple Ukrainian communications, noting that the attack occurred one hour before the first Russian troops crossed the border, although evidence of the attack's actual impact on the war remains under debate.⁵⁵

Shortly after the attack, Ukrainian officials publicly called on SpaceX CEO Elon Musk to provide Ukraine terminals for the Starlink broadband communications system, which he did by the thousands. Ukraine was able to use Starlink to replace many links in its civilian and government communications system, and even used the service to directly support military operations against Russia. According to leaked US military documents, Russia has used at least three Tobol installations to disrupt Starlink signals over Eastern Ukraine.⁵⁶ In March 2022, SpaceX CEO Elon Musk warned Ukrainian users of potential attacks on Starlink terminals by Russian forces, claiming that Russia had jammed a terminal for several hours before SpaceX issued a software update to counter the interference.⁵⁷ However, the specifics of the jamming and mitigation measures remain unverified. By May 2024, Ukrainian military units experienced Starlink outages, attributed to Russia testing new electronic warfare systems.⁵⁸ Russia is also developing Kalinka, a system designed to disrupt Starlink signals and interfere with Ukrainian military communications, with claims that it can even detect Starshield terminals, SpaceX's LEO satellites designed to provide new military space capabilities.⁵⁹ (See Russian Electronic Warfare, Section 2.3)

In November 2022, a pro-Russian hacktivist group known as "Killnet" claimed to have launched a distributed denial-of-service attack against Starlink, and some users reported difficulty logging in for a brief time.⁶⁰ However, Musk has since stated that SpaceX had "reprioritized to cyber defense and overcoming signal jamming".⁶¹ In August 2022, SpaceX announced a "bug bounty" program where researchers were invited to try to find cyber vulnerabilities in the entire Starlink system, including apps and hardware, with a reward of up to \$100,000, depending on the severity of the flaw discovered.⁶²

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In June 2023, it was reported that a cyberattack was directed at Dozor-Teleport, a Russian satellite communications provider used by the military and security services. Both the mercenary group PMC Wagner and a hacktivist collective claimed responsibility for the attack, which reportedly damaged ground control infrastructure, including user terminals, and resulted in the service being offline for 14 hours; two years later, the Ukrainian Cyber Alliance (UCA) admitted responsibility for the attack.⁶³ Taken together, these three incidents indicate that cyberattacks on space systems are likely to occur as part of future armed conflicts which incorporate more military and commercial space systems.

Taken together, these three incidents indicate that cyber attacks on space systems are likely to occur as part of future armed conflicts which incorporate more military and commercial space systems.

Iridium, a satellite communications company whose single largest client is the Pentagon, provides another example of commercial satellite systems being behind other sectors in cyber hardening. In 2008, Iridium reportedly boasted that "the complexity of the Iridium air interface makes the challenge of developing an Iridium L-Band monitoring device very difficult and probably beyond the reach of all but the most determined adversaries."⁶⁴ A group of hackers promptly determined that it was possible to effectively eavesdrop on Iridium traffic with nothing more than a cheap, easily-accessible software-defined radio and the processing power of an old, low-end laptop.⁶⁵ While development and launch of next-generation satellite networks including Iridium NEXT should assist somewhat, this highlights the severity of the threat posed by reliance on legacy infrastructure, and the insecurity of satellite architectures generally. Other techniques, including the use of ransomware in embedded space and aerospace systems and the transmission of malicious code from compromised ground stations, have also begun to emerge, with one large-scale 2016 attack costing a mere estimated \$1,000 worth of hardware to execute, albeit with a substantial investment in time and effort.⁶⁶ Even modern platforms with a "high degree of security" engineered-in are vulnerable to such attacks due to the degree to which they necessarily rely upon and interact with highly vulnerable legacy and civilian systems.⁶⁷

In 2014, CrowdStrike released a report tracking the activities of an advanced persistent threat (APT), based in Shanghai and affiliated with the PLA General Staff Department Third Department 12th Bureau Unit 61486, that subset of what is "generally acknowledged to be China's premier SIGINT collection and analysis agency" dedicated specifically to "supporting China's space surveillance network" with a "functional mission involving satellites...inclusive of intercept of satellite communications."⁶⁸ Dubbed "Putter Panda," the group was found to have conducted comprehensive and sustained penetration and cyber-espionage operations targeted at the US defense and European satellite and aerospace industries since at least 2007.⁶⁹ This included, among other things, the use of Remote Access Tools (RATs) on space technology targets, controlled from the physical location of the 12th Bureau's headquarters. This toolset, the report notes, "provide[d] a wide degree of control over a victim system and can provide the opportunity to deploy additional tools at will."⁷⁰ Another RAT campaign labeled GhostShell, potentially linked to Iran, was discovered in July 2021 targeting aerospace and telecommunications companies, mainly in the Middle East.⁷¹

In August 2020, a presentation at the Blackhat USA 2020 conference outlined multiple examples of insecure internet communications traveling over satellite links.⁷² A researcher built an inexpensive setup that allows him to eavesdrop on Ku band signals from 18 geostationary communications satellites covering the Atlantic Ocean, South America, Europe, and Africa. The captured data included numerous examples of sensitive data, such as aircraft navigational information, system administrator credentials for computer networks, and personal identifying data. The researcher also showed how an attacker can take advantage of the high latency of satellite internet links to hijack a connection. In 2022, researchers demonstrated the ability to broadcast a signal through the unused portion of a commercial satellite being decommissioned in GEO, highlighting the lack of authentication and controls on many older satellites.⁷³ In August 2022, another hacker demonstrated how to use physical access to a Starlink terminal to bypass security measures and access protected software, and potentially the ability to upload custom firmware.⁷⁴

For some systems, cyberattacks would not even be needed to be able to intercept satellite communications. Researchers from UC San Diego and the University of Maryland College Park found in 2025 that a surprisingly large amount of transmissions from GEO satellites were unencrypted.⁷⁵ They used a satellite dish and pointed it at GEO, expecting that they might intercept a few transmissions here and there. As it turned out, they found out that “while content scrambling is standard for satellite TV, it is surprisingly unlikely to be used for private networks using GEO satellite to backhaul IP network traffic from remote areas. Many organizations appear to treat satellite[s] as any other internal link in their private networks.”⁷⁶ They were able to find unencrypted data for cellular network backhauls (connecting cell phone towers to the core network), Voice over Internet Protocol (VOIP) traffic, government/military/law enforcement communications, internal retail networks, in-flight Wifi, aviation, banking, utilities, and other infrastructure systems.

A related category, not strictly “counterspace” but nevertheless an important consideration in the context of cyberattacks on space assets, is the exploitation of satellite links to facilitate the hacking of other targets. This recently made headlines when Kaspersky Labs discovered that Russian criminal syndicate Turla had been doing so to great effect since at least 2007.⁷⁷ Turla’s technique, which couples a compromised PC using satellite-based Internet with a MITM attack, hijacks the IP addresses of legitimate users. American and British officials have stated that the Turla group also attempted to masquerade as Iranian hackers to mislead investigators.⁷⁸ This approach allows the hacker to anonymize Internet connections, impersonate legitimate high-speed Internet users, spoof DNS requests, and gain access to private networks.⁷⁹ When used as an anonymizer for subsequent attacks against high-value targets, this approach makes it very difficult for network analysts and law enforcement agencies to correctly attribute operations, or to locate and disable command servers.⁸⁰ Perhaps worst of all, information on these techniques is readily available in the public domain, and the steps are easily replicable by any motivated attacker with an intermediate skill level. Notably, the necessary tools (a low-budget satellite receiver card, open-source Linux applications, and widely available network sniffing tools) cost only around \$75 in total.⁸¹ A more sophisticated version of the technique that is harder to detect, differentiate, and counter can be achieved with only a satellite dish, cheap cables, and a satellite modem—a total cost of roughly \$1,000.⁸² The downsides of this approach are that satellite-based Internet is slow, and access through a hijacked account is unreliable and user-dependent. The benefits to an attacker seeking to carry out a sustained campaign with little risk of detection or successful attribution, however, are enormous.⁸³

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The fifth category is cyberattacks against satellites themselves, either using signals broadcast from ground antennas or perhaps from another satellite in close proximity. While there are no publicly known real-world cyberattacks in this category, researchers have started to explore this possibility. In August 2020, the US Air Force launched the "Hack-A-Sat" competition where individuals can compete to try and find vulnerabilities in software simulations of satellites.⁸⁴ In 2023, the Hack-A-Sat contest progressed to attacking the real world Moonlighter satellite in orbit.⁸⁵ In April 2023, the European Space Agency set up its own "ethical hacking exercise" at the third Cybersecurity for the Space Industry (CYSAT) conference in Paris, France, and used a ground test bench to simulate an operational OPS-SAT.⁸⁶ Attacking teams worked to try and breach different subsystems, including attitude control and an onboard camera.

A paper presented at the annual Blackhat USA conference in August 2023 also explored the many potential cyber security weaknesses of academic and scientific cubesats against malicious hacking from the ground and also found that commercial satellite developers were unaware of common cyber security practices.⁸⁷

In fact, researchers demonstrated in 2024 how to use a very well-utilized open source software, NASA's Core Flight System (cFS), to attack an in-orbit satellite with ransomware.⁸⁸ This could be done via a command injection exploit via radio commands.⁸⁹ The researchers noted that this "is the first to demonstrate an end-to-end exploit path that results in a ransomware infection without the need for a supply chain attack or compromised credentials."⁹⁰ Other open source softwares used for spacecraft missions that were found to have serious cyber vulnerabilities were Yet Another Mission Control System (Yamcs v5.8.6)⁹¹ and OpenC3 Cosmos⁹²; the Yamcs vulnerabilities were brought to the attention of its team, which fixed them.

A malware called "Orbitshade" was found in early 2025 to have the potential to interfere directly with satellite on-board systems by targeting known authentication weaknesses in uplink protocols.⁹³ It was designed to use legitimate commands as a way in which to install backdoors that hackers could later use to hamper satellite functionality; the satellite would appear to operate as normal until the hackers determined that the conditions had arrived when they wanted to start affecting the satellite's abilities.

Most leading subject matter experts maintain that across each of these areas, despite some increase in awareness of the threat in recent years, the state of cybersecurity for satellite infrastructure remains dismal.⁹⁴ This, in turn, provides both state and non-state actors with a back door into a wide array of space- and ground-based critical infrastructures.

Specific National Cyber Counterspace Capabilities

United States has among the most sophisticated cyber counterspace capabilities of any country, and declassified official documents hinting at conducting cyberattacks against space systems, under the category of "electronic nullification," date back to at least the Ford Administration in 1976. A recent hint at US capabilities comes in a news report from February 2024 that the Central Intelligence Agency (CIA) had established a secret base in Ukraine from which it has engaged in widespread attacks on Russian, Chinese, and Belarussian satellites to intercept the communications they carry.⁹⁵ And in 2025, news reports came out about the US Cyber Command having conducted a cyberattack during the second half of President Donald Trump's first term against the Wagner Group; this was done to access the Russian-affiliated mercenary group's satellite communications, as it was thought at that time to

have members in Venezuela.⁹⁶ In February 2019, multiple anonymous sources claimed that the United States had an ongoing program of offensive cyberattacks aimed at undermining Iran's ballistic missile program.⁹⁷ The sources claimed that the program included cyber sabotage of Iran's missiles and rockets and may have led to an increase in launch failures. If true, the program would be the first public example of cyberattacks being used to physically damage space capabilities.

Russia has demonstrated significant cyberattack capabilities in a range of contexts outside of space, as well as the willingness to use them. In one of the few publicly known attacks against a satellite, in 1998 hackers based in Russia hijacked control of a US-German ROSAT deep-space monitoring satellite, then issued commands for it to rotate toward the sun, frying its optics and rendering it useless.⁹⁸ More recently, since the end of 2015, Russia has engaged in a coordinated, escalating cyberattack campaign in Georgia and Ukraine that ranges from prolonged low-level cyber-espionage, sabotage, and information warfare to the use of offensive cyber operations with kinetic effects.⁹⁹ Most notably, this campaign included the physical incapacitation of Ukrainian power grids.¹⁰⁰ Cyber experts believe that, while the damage was limited and the resultant outages temporary, this was the result of deliberate restraint on the part of Russia for signaling purposes, and that the sophistication of the cyberattack and degree of access achieved would have allowed the attackers to inflict extensive physical damage and bring the power stations permanently offline had they wished to do so.¹⁰¹ As part of its ongoing war against Ukraine since February 2022, Russia continues to systematically attack the Ukrainian power grid with destructive weapons.¹⁰²

After conducting open source research via news articles and Telegram channels, a researcher, Clémence Poirier, found that from February 2022 through March 2025, 161 cyber operations had been aimed at the space sector as part of that war; these cyber operations came from Russian and Ukrainian sources and targeted 72 entities who represented both sides of the combatants.¹⁰³ She noted that hacktivists seem to be fairly new to the space sector and have at times misidentified targets or had unclear connections to their stated targets. One example was when the Finnish company ICEYE signed a contract in August 2022 to provide SAR imagery for Ukraine; this prompted the Cyber Army of Russia to call for a distributed denial of service (DDOS) attack on ICEYE and release a URL and IP address in support of that goal.¹⁰⁴ However, the URL released was that of ESA's Earth Online portal; it was unclear whether the hacktivist group meant to target ESA or if they had misunderstood the relationship between ESA and ICEYE.¹⁰⁵ Another trend identified was that often cyberattacks were undertaken in concert with political events of the war.

On the date of its Victory Day parade in June 2025, Russian hackers were able to interfere with a telecom satellite and broadcast images of military vehicles and soldiers to Ukrainian viewers.¹⁰⁶

These examples have caused significant concern in other countries, including the United States. Since at least March 2016, for example, Russian governmental actors have carried out a systematic and wide-ranging cyber offensive targeted at key US government agencies and critical infrastructure sectors. A joint report released in March 2018 by the Department of Homeland Security (DHS) and Federal Bureau of Investigation (FBI), and supplemented by threat intelligence from cybersecurity firms including Symantec, chronicled penetration and exploitation of computer networks and Industrial Control Systems (ICS) across the nuclear, water, defense, aviation, critical manufacturing, and energy sectors, among others.¹⁰⁷ Of particular note is the highly-sophisticated

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97 David Sanger and William Broad, "US revives secret program to sabotage Iranian missiles and rockets," *New York Times*, February 13, 2019, <https://www.nytimes.com/2019/02/13/us/politics/iran-missile-launch-failures.html>.

98 Ben Elgin, "Network Security Breaches Plague NASA," *Bloomberg*, November 20, 2008, <https://www.bloomberg.com/news/articles/2008-11-19/network-security-breaches-plague-nasa>; Jason Fritz, "Satellite Hacking: A Guide for the Perplexed," *The Bulletin of the Centre for East-West Cultural and Economic Studies*, Vol 10 Issue 1, Article 3, 2013, <https://www.semanticscholar.org/paper/Satellite-hacking%3A-A-guide-for-the-perplexed-Fritz/b7ba156257c4a3fef16183a4f153a46af821ee7b>.

99 Michael Connell and Sarah Vogler, "Russia's Approach to Cyber Warfare," *CNA*, March 2017, https://www.cna.org/cna_files/pdf/DOP-2016-U-014231-1Rev.pdf; Azhar Unwal and Shaheen Ghori, "Brandishing the Cybered Bear: Information War and the Russia-Ukraine Conflict," *Military Cyber Affairs*, Vol 1 Issue 1, Article 7, 2015, <http://scholarcommons.usf.edu/mca/vol1/iss1/7/>.

100 Kim Zetter, "Inside the Cunning, Unprecedented Hack of Ukraine's Power Grid," *Wired*, March 3, 2016, <https://www.wired.com/2016/03/inside-cunning-unprecedented-hack-ukraines-power-grid/>.

101 Ibid; "Analysis of the Cyber Attack on the Ukrainian Power Grid," *SANS Industrial Control Systems*, March 18, 2016, https://ics.sans.org/media/E-ISAC_SANS_Ukraine_DUC_5.pdf.

102 Joseph Majkut and Allegra Dawes, "Responding to Russian Attacks on Ukraine's Power Sector," *Center for Strategic and International Studies*, November 8, 2022, <https://www.csis.org/analysis/responding-russian-attacks-ukraines-power-sector>.

103 Clémence Poirier, "Cyber Operations Against the Space Sector in the Russo-Ukrainian War," DOI: 10.3929/ethz-b-000738640, in *Russian Analytical Digest No. 328*, May 28, 2025, pp. 20-27, <https://www.research-collection.ethz.ch/server/api/core/bitstreams/a8223100-62d3-4e65-8917-d38826dc2b1e/content>.

104 Poirier, "Cyber Operations Against the Space Sector in the Russo-Ukrainian War," *ibid*.

105 Poirier, "Cyber Operations Against the Space Sector in the Russo-Ukrainian War," *ibid*.

106 David Klepper, "Hijacked satellites and orbiting space weapons: In the 21st century, space is the new battlefield," *Associated Press*, August 18, 2025, <https://apnews.com/article/space-weapons-trump-satellites-russia-0fd-d31a1e3d350a54823e8a3d228fc17>.

107 "Russian Government Cyber Activity Targeting Energy and Other Critical Infrastructure Sectors," *US-CERT*, March 15, 2018, <https://www.us-cert.gov/ncas/alerts/TA18-074A>; "Dragonfly: Western Energy Sector Targeted By Sophisticated Attack Group," *Symantec Corporation*, October 20, 2017, <https://www.symantec.com/blogs/threat-intelligence/dragonfly-energy-sector-cyber-attacks>.

- 108 "Russian Government Cyber Activity Targeting Energy and Other Critical Infrastructure Sectors," *US-CERT*, March 15, 2018, <https://www.us-cert.gov/ncas/alerts/TA18-074A>.
- 109 Mehul Srivastava, Felicia Schwartz, and Demetri Sevastopulo, "China building cyberweapons to hijack enemy satellites, says US leak," *Arstechnica*, April 21, 2023, <https://arstechnica.com/information-technology/2023/04/china-building-cyberweapons-to-hijack-enemy-satellites-says-us-leak/>.
- 112 Dorothy Denning, "Iran's Cyber Warfare Program is Now A Major Threat to the United States," *Newsweek*, December 12, 2017, <http://www.newsweek.com/irans-cyber-warfare-program-now-major-threat-united-states-745427>.
- 113 Mark Thompson, "Iranian Cyber Attack on New York Dam Shows Future of War," *Time*, March 24, 2016, <http://time.com/4270728/iran-cyber-attack-dam-fbi/>; Evan Perez and Shimon Prokopcuk, "First on CNN: US Plans to Publicly Blame Iran for Dam Cyber Breach," *CNN*, March 10, 2016, <https://www.cnn.com/2016/03/10/politics/iran-us-dam-cyber-attack/index.html>.
- 114 For more on these attacks, as well as a comprehensive treatment of the past, present, motivations, and likely future of Iranian operations in cyberspace, refer to: "Iran's External Targets," *Carnegie Endowment for International Peace*, January 4, 2018, <http://carnegieendowment.org/2018/01/04/iran-s-external-targets-pub-75141>.
- 115 Daniel Coats, "Statement for the Record – Worldwide Threat Assessment of the US Intelligence Community," Office of the Director of National Intelligence, February 13, 2018, <https://www.dni.gov/files/documents/Newsroom/Testimonies/2018-ATA---Unclassified-SSCI.pdf>.
- 116 Morgan Chalfant, "New Attacks Spark Concerns About Iranian Cyber Threat," *The Hill*, March 11, 2018, <http://thehill.com/policy/cybersecurity/377672-new-attacks-spark-concerns-about-iranian-cyber-threat>; Morgan Chalfant, "Iranian Hacking Group Appears to Expand International Operations," *The Hill*, February 28, 2018, <http://thehill.com/policy/cybersecurity/376015-iranian-hacking-group-expands-operations-to-international-targets>.
- 117 David Sanger, David Kirkpatrick, and Nicole Perlroth, "The World Once Laughed at North Korean Cyberpower. No More," *New York Times*, October 15, 2017, <https://www.nytimes.com/2017/10/15/world/asia/north-korea-hacking-cyber-sony.html>.
- 118 Heylyung Yun, "North Korea's Pursuit of Coercive Leverage in the Information Age: Expanding Cyber and Counterspace Capabilities," *Korean Journal of International Studies*, 2025, 23(2): 331-356, published online on August 31, 2025, <https://kjis.org/journal/view.html?doi=10.14731/kjis.2025.08.23.2.331>.

character of these attacks, which appear to have deliberately chosen hard but strategically vital targets and tested a flexible and advanced array of tools and techniques, deployed as part of a two-step operation in which access would first be gained to less-secure "staging targets," whose networks were then used as additional attack vectors and malware repositories.¹⁰⁸ Given these examples and many others, there is no reason to believe that Russia is incapable of conducting similar operations in the space domain.

Several known and suspected Chinese cyberattacks against space systems were mentioned previously in this chapter. It is likely that China possesses significant cyber counterspace capabilities in addition to these known incidents, and is developing more. One hint comes from a CIA document leaked to the press in April 2023 that states China is building sophisticated cyber weapons to seize control of satellites during wartime.¹⁰⁹ According to reports of the CIA document, China is thought to be working to be able to prevent satellites from communicating with each other or weapon systems, and also to keep them from sending imagery or other data to ground control stations.¹¹⁰ As well, Chinese cyberattacks are often against other actors in the space ecosystem. For example, the Salt Typhoon surveillance hack thought to be tied to the Chinese government gathered millions of phone records; in June 2025, reports emerged that Viasat had been one of the hacking victims as well.¹¹¹

While there is no public evidence of government-sponsored Iranian cyber attacks directly targeted at space assets, Iranian cyber capabilities have exhibited steady growth in recent years. By the mid-2000s, a range of Islamic Revolutionary Guard Corps (IRGC)-backed Iranian hacktivist organizations had begun carrying out computer network attack and exploitation operations against other nation-states. These escalated steadily over the ensuing decade: by 2012, Iranian hackers were conducting cyberattacks with kinetic effects against Saudi oil and gas infrastructure and engaging in sustained distributed denial-of-service (DDOS) campaigns against major US banks causing tens of millions of dollars in losses.¹¹² In 2013, hackers with apparent ties to the IRGC successfully penetrated critical infrastructure in the United States, temporarily gaining control over a dam in the New York suburbs.¹¹³ In late 2016 and early 2017, Iranian hackers engaged in a comprehensive cyber-espionage campaign aimed at identifying and gaining leverage over certain outgoing and incoming American officials, particularly those affiliated with the State Department.¹¹⁴ During the same time period, Iranian cyberattacks against Saudi Arabia resulted in mass-deletion of data across "dozens" of networks, both government-owned and private.¹¹⁵ In early 2018, cybersecurity firm Symantec announced that "Chafer," an Iran-based hacking group believed largely due to its choice of targets to be government-affiliated, had successfully penetrated a range of targets including defense contractors, aviation firms, a major Middle Eastern telecommunications provider, and a variety of networks in Israel, Jordan, the United Arab Emirates, Saudi Arabia, and Turkey, using both original tools and exploits previously stolen from the US National Security Agency (NSA) in 2017 by a third party.¹¹⁶ Given the consistent pattern of interest in and willingness to use offensive cyber capabilities, as well as the tactical and strategic context in which Iran finds itself, eventual deployment of such capabilities by the Iranian government against space-related infrastructure in at least limited ways appears highly likely, and may have already occurred.

North Korea's cyber capabilities appear to be even more sophisticated, and are likely to continue advancing rapidly, absent significant disruption on the Peninsula.¹¹⁷ It is perceived by North Korean officials to be an asymmetric capability that allows North Korea to offset its military weakness compared to its adversaries.¹¹⁸ Particularly prominent examples of offensive cyber operations

by North Korea-backed hackers include a highly-publicized 2014 hack of Sony Pictures Entertainment, intended to prevent the theatrical release of a film satirizing Kim Jong-un;¹¹⁹ hacks of US and South Korean civilian critical infrastructure and military networks, with outcomes ranging from insertion of digital kill-switches intended to paralyze power supplies on-demand to successful theft of war plans;¹²⁰ WannaCry, a global ransomware attack in May 2017 which made use of existing North Korean capabilities supplemented by stolen NSA tools and demonstrated a capability to shut down large swathes of the economy and critical industries around the world;¹²¹ and frequent and sustained cyber-espionage and cyber crime campaigns targeted at, among other things, large banks and financial institutions,¹²² cryptocurrency exchanges,¹²³ and defense and defense-adjacent companies.¹²⁴ A well-known North Korean hacker group, the “Lazarus Group” (also known as “Hidden Cobra”), has conducted cyber operations against aerospace and defense companies; for example, Operation Dream Job has focused on Australia, India, Israel, Russia, and the United States, as well as European drone manufacturers and defense contractors.¹²⁵ Many of these capabilities, especially those highlighted in the WannaCry incident, could cause tremendous damage if targeted at terrestrial infrastructure supporting space operations. Other cyber tools and techniques with counterspace implications likely either already exist or will in the not-too-distant future.

- 119 Sanger, Kirkpatrick, and Perlroth, “The World Once Laughed,” *ibid*.
- 120 Sanger, Kirkpatrick, and Perlroth, “The World Once Laughed,” *ibid*. It is worth noting that these operations are in no way one-sided: there is substantial evidence of similar operations by both the US and South Korean governments.
- 121 Thomas Bossert, “It’s Official: North Korea is Behind WannaCry,” *Wall Street Journal*, December 18, 2017, <https://www.wsj.com/articles/its-official-north-korea-is-behind-wannacry-1513642537>; Ellen Nakashima and Phillip Rucker, “US Declares North Korea Carried Out Massive WannaCry Cyberattack,” *Washington Post*, December 19, 2017, https://www.washingtonpost.com/world/national-security/us-set-to-declare-north-korea-carried-out-massive-wannacry-cyber-attack/2017/12/18/509deb1c-e446-11e7-a65d-1ac0fd7f097e_story.html; “Investigation: WannaCry Cyber Attack and the NHS,” *National Audit Office*, October 27, 2017, <https://www.nao.org.uk/wp-content/uploads/2017/10/Investigation-WannaCry-cyber-attack-and-the-NHS.pdf>.
- 122 David Sanger, David Kirkpatrick, and Nicole Perlroth, “The World Once Laughed at North Korean Cyberpower. No More,” *New York Times*, October 15, 2017, <https://www.nytimes.com/2017/10/15/world/asia/north-korea-hacking-cyber-sony.html>; Choe Sang-Hun, “North Korea Tries to Make Hacking a Profitable Center,” *New York Times*, July 27, 2017, <https://www.nytimes.com/2017/07/27/world/asia/north-korea-hacking-cybersecurity.html>.
- 123 Rosie Perper, “New Evidence Reportedly Puts North Korean Hackers Behind a List of High-Stakes Bitcoin Heists,” *Business Insider*, January 19, 2018, <http://www.businessinsider.com/north-korea-lazarus-group-behind-cryptocurrency-cyber-attack-wannacry-sony-2018-1>.
- 124 Joe Uchil, “North Korean Hackers Target US Military Contractors,” *The Hill*, August 15, 2017, <http://thehill.com/policy/cybersecurity/346594-with-leaders-talking-nuclear-war-north-korean-hackers-target-us-military>; Anthony Kasza, “The Blockbuster Saga Continues,” *Palo Alto Networks*, August 14, 2017, <https://researchcenter.paloaltonetworks.com/2017/08/unit42-blockbuster-saga-continues/>; Thomas Bossert, “It’s Official: North Korea is Behind WannaCry,” *Wall Street Journal*, December 18, 2017, <https://www.wsj.com/articles/its-official-north-korea-is-behind-wannacry-1513642537>; Ellen Nakashima and Phillip Rucker, “US Declares North Korea Carried Out Massive WannaCry Cyberattack,” *Washington Post*, December 19, 2017, https://www.washingtonpost.com/world/national-security/us-set-to-declare-north-korea-carried-out-massive-wannacry-cyber-attack/2017/12/18/509deb1c-e446-11e7-a65d-1ac0fd7f097e_story.html; “Investigation: WannaCry Cyber Attack and the NHS,” *National Audit Office*, October 27, 2017, <https://www.nao.org.uk/wp-content/uploads/2017/10/Investigation-WannaCry-cyber-attack-and-the-NHS.pdf>; David Sanger, David Kirkpatrick, and Nicole Perlroth, “The World Once Laughed at North Korean Cyberpower. No More,” *New York Times*, October 15, 2017, <https://www.nytimes.com/2017/10/15/world/asia/north-korea-hacking-cyber-sony.html>; Choe Sang-Hun, “North Korea Tries to Make Hacking a Profitable Center,” *New York Times*, July 27, 2017, <https://www.nytimes.com/2017/07/27/world/asia/north-korea-hacking-cybersecurity.html>; Rosie Perper, “New Evidence Reportedly Puts North Korean Hackers Behind a List of High-Stakes Bitcoin Heists,” *Business Insider*, January 19, 2018, <http://www.businessinsider.com/north-korea-lazarus-group-behind-cryptocurrency-cyber-attack-wannacry-sony-2018-1>.
- 125 “Operation Dream Job,” Mitre, last modified April 11, 2024, <https://attack.mitre.org/versions/v18/campaigns/C0022/>; “Lazarus Hackers Actively Attacking European Drone Manufacturing Companies,” *Cryptika*, January 26, 2026, <https://www.cryptika.com/lazarus-hackers-actively-attacking-european-drone-manufacturing-companies/>.

- 126 [translated from the original Spanish] @YourAnonHunters, "#BombaChilena #CyberHuntersOp cuts off the Venezuelan army's satellite signal to protect the population," *Twitter*, July 30, 2024, <https://x.com/YourAnonHunters/status/1818107752285171927>.
- 127 More on this line of thinking can be found here: Dennis Broeders, "Private active cyber defense and (international) cyber security—pushing the line?," *Journal of Cybersecurity*, Volume 7, Issue 1, 2021.
- 128 "NASA, Defense Ministry info at risk after JAXA cyberattacks," *The Asahi Shimbun*, June 21, 2024, <https://www.asahi.com/ajw/articles/15314492>.
- 129 Matt Brazil and Peter W. Singer, "China is turning to private firms for offensive cyber operations," *Defense One*, June 30, 2024, <https://www.defenseone.com/threats/2024/06/china-turning-private-firms-offensive-cyber-operations/397767/>.
- 130 Ibid.
- 131 "North Korea Cyber Group Conducts Global Espionage Campaign to Advance Regime's Military and Nuclear Programs," *Cybersecurity Advisory*, Alert CodeAA24-207A, US National Coordinator for Critical Infrastructure Security and Resilience, July 25, 2024, <https://www.cisa.gov/news-events/cybersecurity-advisories/aa24-207a>.
- 132 Carley Welch, "US, South Korea warn North Korean hacking group Andariel targets defense, aerospace firms," *Breaking Defense*, July 25, 2024, <https://breakingdefense.com/2024/07/us-south-korean-warn-north-korean-hacking-group-andariel-targets-defense-aerospace-firms/>.

In July 2024, the group known as "BombaChilena," associated with "CyberHuntersOp," announced they successfully disrupted the Venezuelan army's satellite communications to safeguard the civilian population. The group declared that they are committed to "protecting citizens from potential military surveillance or intervention."¹²⁶

As cyber-espionage and hostile cyber activities become more sophisticated, states are leveraging both private sector expertise and covert hacking units to target critical space, defence, and intelligence infrastructures. On the one hand, private firms can be appointed to conduct state-sponsored cyber operations for malicious purposes. On the other hand, faced with various types of threat agents targeting government sectors working on defence and aerospace, states are developing and strengthening their counterspace cyber capabilities.¹²⁷

In June 2023, the Japan Aerospace Exploration Agency (JAXA) experienced a significant cyberattack resulting in the leakage of over 10,000 files, some containing classified information. The breach potentially compromised data from entities such as NASA and Japan's Defense Ministry, all of which have nondisclosure agreements with JAXA. Investigations suggest that a Chinese hacker group exploited vulnerabilities in JAXA's virtual private networks to infiltrate research and business networks. Although networks used for rocket launches and transportation remained unaffected, the intruders collected information about sensitive space assets and activities which may be used to uncover vulnerabilities and support future hostile operations. The agency was unaware of the intrusion until alerted by authorities four months after the initial attack.¹²⁸

Recent reports have highlighted China's growing dependence on private firms to conduct offensive state-sponsored cyber operations.¹²⁹ In February 2024, a significant leak of 577 documents reportedly from the Chinese cybersecurity company iSOON provided unprecedented insight into this collaboration. These documents, which were briefly accessible on GitHub before being removed, detailed the company's clientele, pricing structures, and targeted entities that included "military and space technologies, whose secrets are increasingly held in digital form." Described as "privatisation with Chinese characteristics," observers noted that this incident is not an isolated case but rather indicative of a broader pattern whereby the Chinese government utilizes private sector capabilities to enhance its cyber warfare and intelligence-gathering efforts.¹³⁰

In July 2024, a joint advisory by the United States, United Kingdom, and South Korea revealed that "Andariel," a North Korean state-sponsored hacking group, has been conducting a global cyber-espionage campaign targeting defense and engineering firms' computer systems in attempts to gain access to contracts, design drawings, bills of materials and other engineering documents that would divulge information on a variety of systems, including satellites, satellite communications, and nano-satellite technology.¹³¹ Notably, Andariel has infiltrated computer systems of various organizations, aiming to access data on missile systems, submarines, and fighter aircraft. To fund these operations, the group has also engaged in ransomware attacks against critical infrastructure, such as healthcare providers. The US Department of Justice has indicted Rim Jong Hyok, a member of Andariel, on charges related to these cyber activities. Authorities underscore the importance of robust cybersecurity measures to protect sensitive information from such threats.¹³²

Potential Military Utility /

Cyber weapons offer tremendous utility as both a situational replacement for and complement to conventional counterspace capabilities. Several advantages are particularly noteworthy, although there are disadvantages as well.

The first advantage is the flexibility and nature of producible effects. Extant cyber and electronic warfare capabilities can produce a range of effects, including theft, alteration, or denial of information, as well as control or destruction of satellites, their subcomponents, or supporting infrastructure. This allows the type and degree of counterspace operation to be narrowly tailored to the desired objective, in contrast to the comparatively blunt and single-note instrument that a kinetic ASAT represents. No other capability can fulfill such an espionage or data manipulation role, while the ability to reliably produce kinetic outcomes of the desired severity and permanence holds obvious appeal. Hostile cyber activities can be used to collect data from space infrastructure through various means, including hacking into ground stations or into the servers of a space organization (space agency, company, institution...) or intercepting satellite communications. Threat agents may use an APT to infiltrate networks, gaining unauthorized access to data and exfiltrate critical information. The cyber architecture of space infrastructures can be tested for malicious cyber activities through penetration testing and vulnerability assessments to help evaluate how well security measures protect against unauthorized access, data breaches, or system disruptions.

The second advantage for cyberattacks in a counterspace role is access. Unlike conventional weapons which typically require either proximate positioning or closing to target, both of which necessarily involve penetration of defended space, some types of cyberattacks require little or no direct access or can be effectuated by gaining access far in advance or targeting less closely-guarded nodes.¹³³

The third advantage is the difficulty of attributing cyberattacks. Cyberattacks are often substantially more difficult to trace and confidently attribute than conventional counterspace weapons, particularly kinetic weapons. This can be valuable, but also carries some risk of unintended escalation. The military value of being able to carry out operations either undetected or in a deniable fashion is clear. However, many strategic theorists have noted the danger of quick escalation that can attend such deliberately opaque approaches, as the difficulty of guaranteeing a reliable and proportional response can create structural incentives for each side to move first in the event of an impending crisis.¹³⁴ These dangers are magnified by the potential for misattribution, whether incidental or deliberately engineered by actors intending to provoke a hostile response against another state.

Fourth, a rudimentary cyber capability can be dramatically faster, easier, and less expensive to procure than kinetic alternatives. The barrier to entry for basic capabilities can be exceptionally low as evidenced by the increased number of hobbyists and students researching cyber vulnerabilities in space systems. Advanced capabilities remain challenging to develop but will almost certainly become easier for new nation-states and even non-state actors to acquire in the coming years. In contrast, conventional counterspace operations require expensive, time-consuming, and highly-visible development of an extensive space program, including systems for space situational awareness and space tracking, telemetry, and command operations, as well as the counterspace capability itself and its supporting infrastructure.¹³⁵ Thus, cyber capabilities provide newcomers with an especially asymmetric means of access-denial or cost infliction when confronting established space powers.

133 Eric Sterner and Jennifer McArdle, "Cyber Threats to the Space Domain," *The American Foreign Policy Council*, March 2016, <https://www.afpc.org/uploads/documents/Defense%20Brief%20Issue%2015.pdf>.

134 Todd Harrison et al, "Escalation and Deterrence in the Second Space Age," *Center for Security and International Studies*, October 2017, <https://www.csis.org/analysis/escalation-and-deterrence-second-space-age>.

135 For example, even the most rudimentary KKV capability requires a comprehensive, reliable, and ideally relatively rapid and resilient launch infrastructure, launch vehicles, rocket engines, onboard sensors and guidance systems, and a warhead or highly-maneuverable satellite.

136 "China's Advanced Weapons," *Hearing Before the US-China Economic and Security Review Commission*, February 23, 2017, <https://www.uscc.gov/sites/default/files/transcripts/China's%20Advanced%20Weapons.pdf>.

137 Kevin Pollpeter et al, "China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States," *US-China Economic and Security Review Commission*, March 2, 2015, <https://www.uscc.gov/research/china-dream-space-dream-chinas-progress-space-technologies-and-implications-united-states>; "China's Advanced Weapons," *Hearing Before the US-China Economic and Security Review Commission*, February 23, 2017, <https://www.uscc.gov/sites/default/files/transcripts/China's%20Advanced%20Weapons.pdf>; Daniel Coats, "Statement for the Record Worldwide Threat Assessment of the US Intelligence Community - Senate Select Committee on Intelligence," *Office of the Director of National Intelligence*, May 11, 2017, <https://www.intelligence.senate.gov/sites/default/files/documents/os-coats-051117.pdf>.

The main disadvantages of cyber capabilities are similar to that of other non-kinetic counterspace methods: lack of ability to do strategic signaling, and challenges in doing battle damage assessment. The inherent challenges in attributing cyber capabilities also have the effect of making it difficult to use the existence or use of offensive cyber counterspace for deterrence, signaling intent, or preventing escalation. And it can also be difficult for an attacker to know if their cyberattack will succeed, particularly in a militarily useful timeframe, and if it will have the desired effect. It is always possible that the target has detected the preparations, or patched the vulnerability, and may even be able to deceive the attacker into thinking the attack worked, thus potentially undermining the broader military campaign it supported.

A final point of note is the potential for joint "combined arms" anti-satellite operations, leveraging ASAT interoperability to produce a multiplier effect on the scale and effectiveness of counterspace operations.¹³⁶ This approach seeks to leverage cyber capabilities in ways complementary to physical ASATs and vice-versa by, for example, using co-orbital KKV as a delivery vehicle for EW capabilities, or using pre-installed back doors to deactivate sensors or countermeasures in advance of a kinetic operation. China and Russia have both explored such an idea from both the technical and doctrinal sides, and there is clear evidence of interest and significant evidence pointing to actual development on the part of the former.¹³⁷

The March 2022 cyberattack against Viasat exemplifies all of these advantages and disadvantages. It was on the surface an extremely successful, and relatively low-cost, attack that was expertly timed to synchronize with a joint combined arms offensive and eliminate a critical space service in order to cripple Ukrainian defenses. However, there is mixed evidence as to its actual impact on the military operation and unlikely that those impacts lasted more than a few weeks into the war. Within a month of the attack, Ukraine had procured access to another satellite broadband communications system, Starlink, that has so far proven much more resistant to cyberattacks.

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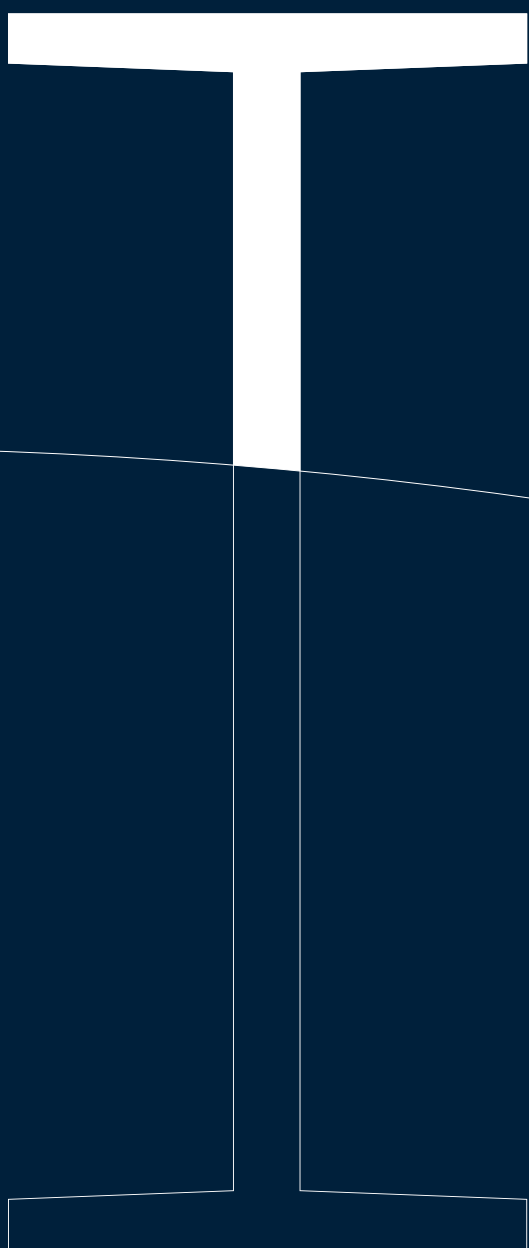
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Appendix One



HISTORI- CAL ANTI- SATELLITE TESTS IN SPACE

Historical Anti-Satellite Tests in Space by Country /

This appendix lists known or suspected anti-satellite (ASAT) tests in space by country. It provides known information about each test, including the date it was conducted, launch site, launch vehicle, interceptor, and target (if known). It also provides a short summary of the outcome of the test and whether it generated any orbital debris.

Note that there may be different definitions for “success.” In some cases, the goal of the test was to have an actual intercept of another space object, but in other cases, the objective of the test was to track a specific star or pass within a specific distance of another space object without an actual collision or detonation of the warhead of the kill vehicle.

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TABLE 16-1 – HISTORICAL US ASAT TESTS IN SPACE

DATE	ASAT SYSTEM	ASAT TYPE	LAUNCH SITE	TARGET	NOTES
Sept. 22, 1959	High Virgo (TX-20)	Direct-Ascent	Unknown	None	Unknown results due to loss of telemetry
Oct. 13, 1959	Bold Orion	Direct-Ascent	Unknown	Explorer VI	Success (passed within kill radius)
Oct. 1, 1961	SIP (NOTS-EV-2)	Direct-Ascent	San Nicholas Island	None	Successful rocket test
Oct. 5, 1961	HiHo (NOTS-EV-1)	Direct-Ascent	F4D-I	None	Rocket failure
Mar. 26, 1962	HiHo (NOTS-EV-1)	Direct-Ascent	F4D-I	None	Rocket failure
May 5, 1962	SIP (NOTS-EV-2)	Direct-Ascent	San Nicholas Island	None	Successful rocket test
Aug. 26, 1962	HiHo (NOTS-EV-1)	Direct-Ascent	F4-C	None	Successful rocket test
Dec. 17, 1962	Program 505 (Nike Zeus)	Direct-Ascent	WSMR	None	Success (reached designated point in space)
Feb. 15, 1963	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Successful intercept of designated point in space
Mar. 21, 1963	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Unsuccessful attempt to intercept simulated satellite target
Apr. 19, 1963	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Unsuccessful attempt to intercept simulated satellite target
May 24, 1963	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	Agena D	Successful close intercept
Jan. 4, 1964	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Successful intercept of a simulated satellite target
Feb. 14, 1964	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Transit 2A Rocket Body	Success (passed within kill radius)
Mar. 1, 1964	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Success (primary missile scrubbed, backup missile passed within kill radius)
Apr. 21, 1964	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Success (passed within kill radius)
May 28, 1964	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Failed (missed intercept point)
Nov. 16, 1964	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Successful Combat Test Launch (passed within kill radius)
March 1965	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	–
Apr. 5, 1965	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Transit 2A Rocket Body	Successful Combat Test Launch (passed within kill radius)
June-July 1965	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Four test intercepts, of which three were successful
Jan. 13, 1966	Program 505 (Nike Zeus)	Direct-Ascent	Kwajalein	None	Successful intercept with simulated target
Mar. 30, 1967	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown piece of space debris	Successful Combat Evaluation Launch (passed within kill radius)
May 15, 1968	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Successful Combat Evaluation Launch (passed within kill radius)
Nov. 21, 1968	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown	Successful Combat Evaluation Launch (passed within kill radius)
Mar. 28, 1970	Program 437 (Thor)	Direct-Ascent	Johnston Atoll	Unknown satellite	Success (passed within kill radius)
Jan. 21, 1984	ASM-135	Direct-Ascent	Aircraft	None	ASM-135 missile fired from F-15 fighter, successful missile test
Nov. 13, 1984	ASM-135	Direct-Ascent	Aircraft	Star	Failed test
Sept. 13, 1985	ASM-135	Direct-Ascent	Aircraft	Solwind	Successful test, created 285 pieces of trackable orbital debris
Sept. 5, 1986	Delta 180 PAS	Co-Orbital	Cape Canaveral	Delta 2 R/B	Successful collision, debris generated
Aug. 22, 1986	ASM-135	Direct-Ascent	Aircraft	Star	Successful test in tracking
Sept. 29, 1986	ASM-135	Direct-Ascent	Aircraft	Star	Successful test in tracking
Feb. 20, 2008	SM-3	Direct-Ascent	USS Lake Erie	USA 193	Successful test, debris generated

TABLE 16-2 – HISTORICAL RUSSIAN ASAT TESTS IN SPACE

DATE	ASAT SYSTEM	ASAT TYPE	LAUNCH SITE	TARGET	NOTES
Nov. 1, 1963	Polyot 1	Co-orbital	Baikonur	None	Engine and maneuvering test
Apr. 12, 1964	Polyot 2	Co-orbital	Baikonur	None	Engine and maneuvering test
Oct. 27, 1967	IS	Co-orbital	Baikonur	None	First launch of KKV
Oct. 20, 1968	IS	Co-orbital	Baikonur	Cosmos 248	Two successful intercepts, debris created
Oct. 23, 1970	IS	Co-orbital	Baikonur	Cosmos 373	Two successful intercepts, debris created
Feb. 25, 1971	IS	Co-orbital	Baikonur	Cosmos 394	Intercept, debris created
Mar. 18, 1971	IS	Co-orbital	Baikonur	Cosmos 400	No intercept, different approach of target
Dec. 3, 1971	IS	Co-orbital	Baikonur	Cosmos 459	Successful intercept, debris created
Feb. 16, 1976	IS	Co-orbital	Baikonur	Cosmos 803	Two successful intercepts, no debris created
July 9, 1976	IS	Co-orbital	Baikonur	Cosmos 839	Potential intercept, no debris created
Dec. 17, 1976	IS	Co-orbital	Baikonur	Cosmos 880	Successful intercept, debris created
May 23, 1977	IS	Co-orbital	Baikonur	Cosmos 909	Two unsuccessful intercepts, no debris created
Oct. 26, 1977	IS	Co-orbital	Baikonur	Cosmos 959	Successful intercept, no debris created
Dec. 21, 1977	IS	Co-orbital	Baikonur	Cosmos 967	Successful intercept, debris created
May 19, 1978	IS-M	Co-orbital	Baikonur	Cosmos 967	Successful intercept, no debris created
Apr. 18, 1980	IS-M	Co-orbital	Baikonur	Cosmos 1171	Unsuccessful intercept, debris created
Feb. 2, 1981	IS-M	Co-orbital	Baikonur	Cosmos 1241	Two failed intercepts, no debris created
June 18, 1982	IS-M	Co-orbital	Baikonur	Cosmos 1375	Successful intercept, debris created
Nov. 20, 1990	Naryad	Co-orbital	Baikonur	None	No intercept
Dec. 20, 1991	Naryad	Co-orbital	Baikonur	None	No intercept
Dec. 26, 1994	Naryad	Co-orbital	Baikonur	None	Potential intercept, debris created
Aug. 12, 2014	Nudol	Direct-Ascent	Plesetsk	None	Rocket test (unsuccessful)
Apr. 22, 2015	Nudol	Direct-Ascent	Plesetsk	None	Rocket test (unsuccessful)
Oct. 18, 2015	Nudol	Direct-Ascent	Plesetsk	None	Rocket test (successful)
May 25, 2016	Nudol	Direct-Ascent	Plesetsk	None	Rocket test (successful)
Dec. 16, 2016	Nudol	Direct-Ascent	Central Russia	None	Rocket test (successful)
Oct. 30, 2017	Cosmos 2521 (Burevestnik?)	Co-orbital	–	–	Released subsatellite at relatively high speed
Mar. 26, 2018	Nudol	Direct-Ascent	Plesetsk	None	First test from TEL
Dec. 23, 2018	Nudol	Direct-Ascent	Plesetsk	None	Potential KKV, no intercept
June 14, 2019	Nudol	Direct-Ascent	Plesetsk	None	Potential KKV, no intercept
September 2019?	Cosmos 2536 (Burevestnik?)	Co-orbital	Plesetsk	Cosmos 2535	High speed RPO pass, potential ASAT test or collision
Apr. 15, 2020	Nudol	Direct-Ascent	Plesetsk	None	Potential intercept, debris created
July 15, 2020	Cosmos 2536 (Burevestnik?)	Co-orbital	Plesetsk	None	Released subsatellite at relatively high speed
Dec. 16, 2020	Nudol	Direct-Ascent	Plesetsk	None	Potential KKV, no intercept
April 2021	Nudol	Direct-Ascent	Plesetsk	None	Unknown
Nov. 15, 2021	Nudol	Direct-Ascent	Plesetsk	Cosmos 1408	Successful intercept, debris created

TABLE 16-3 – HISTORICAL CHINESE ASAT TESTS IN SPACE

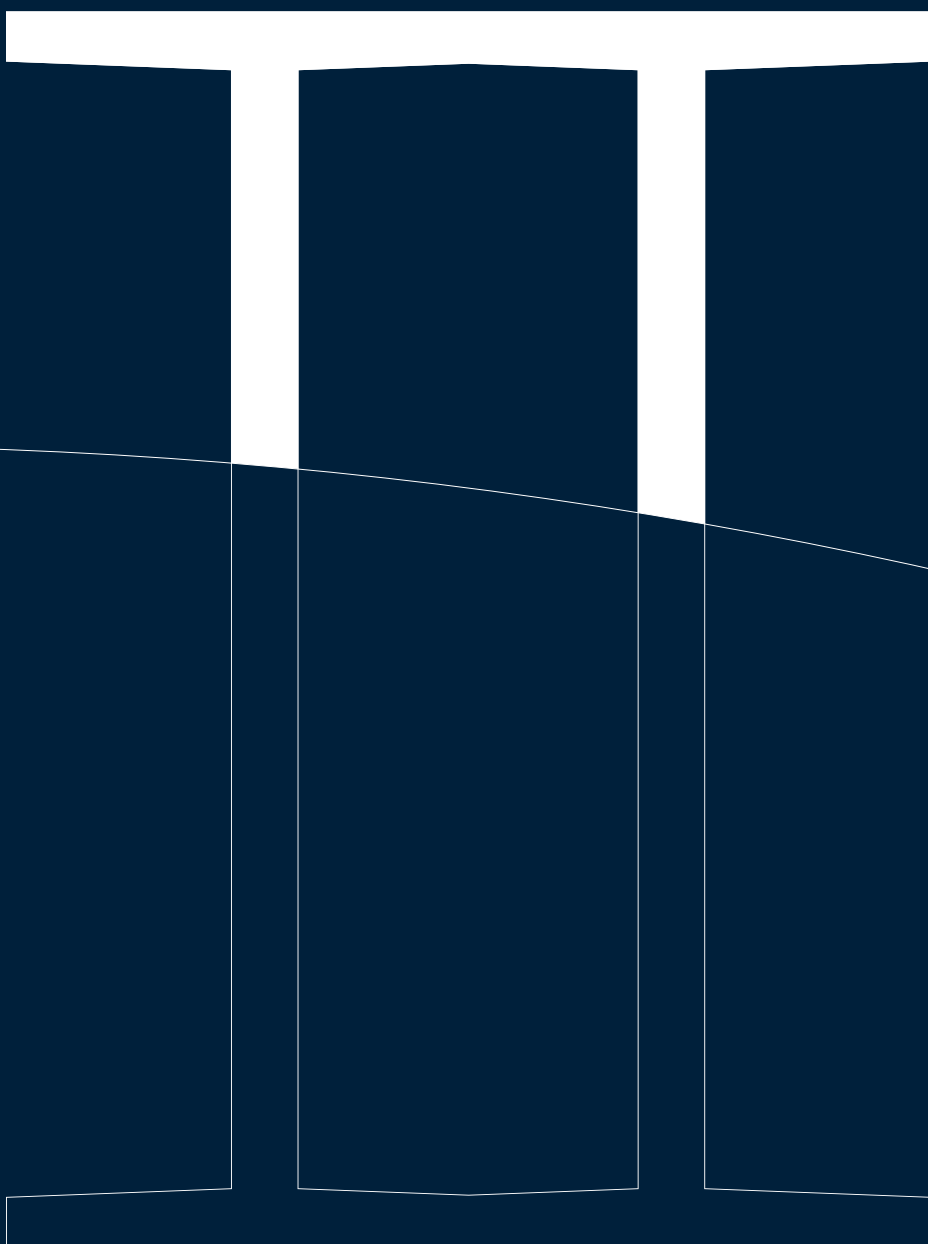
DATE	ASAT SYSTEM	ASAT TYPE	LAUNCH SITE	TARGET	NOTES
July 5, 2005	SC-19	Direct-Ascent	Xichang	None known	Likely rocket test
Feb. 6, 2006	SC-19	Direct-Ascent	Xichang	None known	Likely near-miss of orbital target
Jan. 11, 2007	SC-19	Direct-Ascent	Xichang	FY-1C satellite	Destruction of orbital target, debris created
Jan. 11, 2010	SC-19	Direct-Ascent	Korla	CSS-X-11 ballistic missile launched from Jiuquan	Destruction of target
Jan. 27, 2013	Possible SC-19	Direct-Ascent	Korla	Unknown ballistic missile launched from Jiuquan	Destruction of target
May 13, 2013	Possible DN-2	Direct-Ascent	Xichang	None known	Likely rocket test
July 23, 2014	Possible DN-2	Direct-Ascent	Korla? (Jiuquan?)	Likely ballistic missile launched from Jiuquan	Likely intercept test
Oct. 30, 2015	Possible DN-3	Direct-Ascent	Korla	None known, possible ballistic missile	Likely rocket test
July 23, 2017	Possible DN-3	Direct-Ascent	Jiuquan?	Likely ballistic missile	Likely intercept test
Feb. 5, 2018	Possible DN-3	Direct-Ascent	Korla	CSS-5 ballistic missile	Likely intercept test
Feb. 4, 2021	Possible DN-3	Direct-Ascent	Likely ballistic missile	Suborbital	Likely intercept test
Jun. 21, 2022	Possible DN-3	Direct-Ascent	Likely ballistic missile	Suborbital	Likely intercept test
Apr. 14, 2023	Possible DN-3	Direct-Ascent	Likely ballistic missile	Suborbital	Likely intercept test
Apr. 15, 2023	Possible DN-3	Direct-Ascent	Likely ballistic missile	Suborbital	Likely intercept test

TABLE 16-4 – HISTORICAL INDIAN ASAT TESTS IN SPACE

DATE	ASAT SYSTEM	ASAT TYPE	LAUNCH SITE	TARGET	NOTES
Feb. 12, 2019	PDV-MK II	Direct-Ascent	Abdul Kalam Island	Microsat-R	Unsuccessful intercept
Mar. 27, 2019	PDV-MK II	Direct-Ascent	Abdul Kalam Island	Microsat-R	Successful intercept, debris created



Appendix Two



IMAGERY OF COUNTER- SPACE RELATED FACILI- TIES

LAUNCH COMPLEXES /

UNITED STATES >

Fort Greely

63.953987°N -145.725365°W

(GBI Silos—image shown)

FIGURE 17-1 — FORT GREELY GBI FIELD



Fort Greely, located in Alaska, possesses 40 silos for the GBI missile, the interceptor component for the GMD system.

Function: ABM Field

Associated Programs: GBI

Key Dates: —

LAUNCH COMPLEXES /

UNITED STATES >
Vandenberg Air Force Base

34.751622°N -120.619366°W
(SLC 2E)

34.755560°N -120.622473°W
(SLC2W)

34.640221°N -120.589544°W
(SLC 3E)

34.581422°N -120.626792°W
(SLC 6—image shown)

34.739657°N -120.619205°W
(LC 576-E)

FIGURE 17-2 – VANDENBERG SPACE LAUNCH COMPLEX 6



Vandenberg Air Force Base in California houses various launch facilities used to deliver military payloads into orbit. Shown here is Space Launch Complex 6 (“Slick Six”) that was planned to support the Manned Orbital Laboratory (MOL) and West Coast Space Shuttle launches. Most recently, it has supported Athena and Delta IV launches.

Function: Space Launch Complex

Associated Programs: —

Key Dates: —

LAUNCH COMPLEXES /

UNITED STATES >

Cape Canaveral

28.583414°N -80.582891°W
(SLC 41)

28.532311°N -80.566601°W
(SLC 37)

28.532311°N -80.566601°W
(X-37B Hangar—image shown)

FIGURE 17-3 — CAPE CANAVERAL X-37B HANGAR



Cape Canaveral Space Force Station in Florida houses various launch facilities used to deliver military payloads into orbit and is co-located with the Kennedy Space Center, which supports NASA's human spaceflight program. Most recently, Cape Canaveral has become the home of the USSF's X-37B spaceplane. It launches from SLC 41 and began landing at the Kennedy Space Center's Shuttle Landing Facility with OTV-4 in May 2017.

Function: Space Launch Complex

Associated Programs: X-37B

Key Dates: —

LAUNCH COMPLEXES /

RUSSIA >
Kapustin Yar

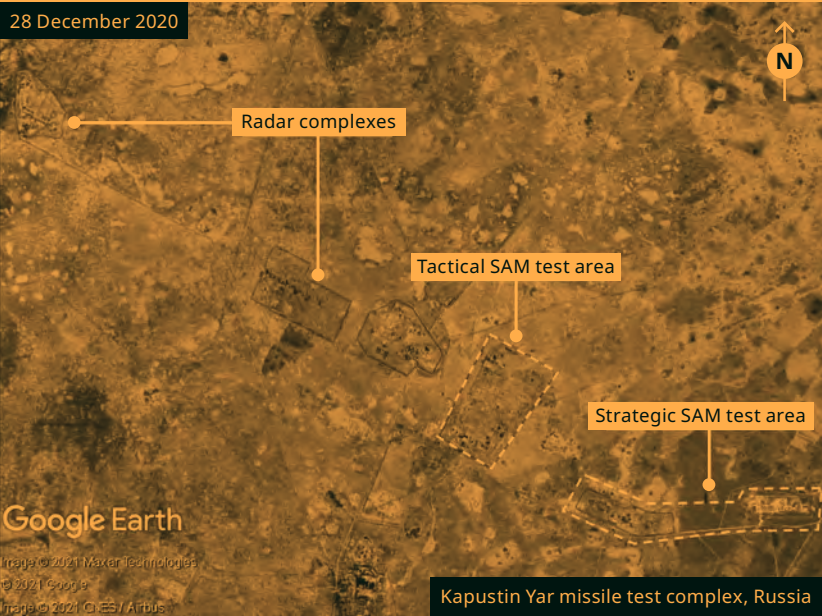
48.794055°N 45.734890°E
(SAM test complex)

48.662984°N 45.685747°E
(SAM checkout complex)

48.569969°N 45.903070°E
(Ballistic missile test complex—
image shown)

48.770544°N 46.303367°E
(Missile test complex)

FIGURE 17-4 — KAPUSTIN YAR MOBILE MISSILE LAUNCH SITE



Kapustin Yar, located in Astrakhan Oblast, has long supported Russian ballistic missile and missile defense testing as well as some early space launches. The mobile ICBM training and launch area at Kapustin Yar is a possible location for the December 16, 2016, Nudol ASAT test.

Function: Missile test and training complex

Associated Programs: Nudol

Key Dates:

December 16, 2016
(Possible Nudol ASAT test)

LAUNCH COMPLEXES /

RUSSIA >
Plesetsk

63.008092°N 41.551308°E
(Mobile missile launch complex—
image shown)

FIGURE 17-5 — PLESETSK SPACE LAUNCH CENTER MOBILE MISSILE LAUNCH COMPLEX



The Plesetsk mobile missile launch complex consists of a TEL garage with a retractable roof for conducting mobile ICBM launches and a separate launch pad. Either location represents a possible site for the Nudol ASAT tests conducted at Plesetsk.

Function: Missile launch complex

Associated Programs: Nudol

Key Dates:

August 12, 2014
(Nudol ASAT test)

April 22, 2015
(Nudol ASAT test)

November 18, 2015
(Nudol ASAT test)

May 25, 2016
(Nudol ASAT test)

November 15, 2021
(Nudol ASAT test)

LAUNCH COMPLEXES /

RUSSIA >
Plesetsk

62.887012°N 40.847235°E
(Site 133—image shown)

FIGURE 17-6 — PLESETSK SPACE LAUNCH CENTER SITE 133



Site 133 at Plesetsk contains the launch pad for the Rockot booster, which was used to launch the first set of Russian RPO payloads into LEO in 2013-2015.

Function: Space launch complex

Associated Programs: Nivelir

Key Dates:

November 20, 1990
(Potential Naryad-V launch)

December 20, 1991
(Potential Naryad-V launch)

December 26, 1994
(Potential Naryad-V launch)

December 25, 2013
(Launch of Cosmos 2491)

May 23, 2014
(Launch of Cosmos 2499)

March 31, 2015
(Launch of Cosmos 2504)

LAUNCH COMPLEXES /

RUSSIA >
Plesetsk

62.927217°N 40.449530°E
(Site 43, Pads 3 and 4—image shown)

FIGURE 17-7 — PLESETSK SPACE LAUNCH CENTER SITE 43



Site 43 at Plesetsk contains the launch pad for the Soyuz-2-1v rocket, which was used launch multiple Russian RPO payloads into LEO since 2017, including Cosmos 2519, Cosmos 2535, and Cosmos 2542 that were involved in potential co-orbital ASAT tests.

Function: Space launch facility

Associated Programs: Nivelir, Burevestnik

Key Dates:

June 23, 2017

(Launch of Cosmos 2519)

July 10, 2019

(Launch of Cosmos 2535 and Cosmos 2536)

November 25, 2019

(Launch of Cosmos 2542)

LAUNCH COMPLEXES /

RUSSIA >
Plesetsk

62.769056°N 40.373730°E
(Burevestnik construction —image shown)

FIGURE 17-8 – PLESETSK AREA 141 BUREVESTNIK FACILITIES



Area 141 at Plesetsk is under construction to support the Burevestnik program, which is believed to include an air-launched co-orbital ASAT.

Function: Support facility
Associated Programs: Burevestnik
Key Dates: —

LAUNCH COMPLEXES /

RUSSIA >
Sary Shagan

46.443219°N 72.849398°E
(Site 35 ABM test complex—image shown)

FIGURE 17-9 – SARY SHAGAN ABM SILOS



Sary Shagan is a long-standing Russian anti-ballistic missile testing facility located in Kazakhstan. Site 35 possesses two silos for conducting tests and training launches of the 53T6 ABM.

Function:
Support facility

Associated Programs: 51T6, 53T6, 53T6M

- Key Dates:**
- November 2, 1999**
(ABM test launch, 53T6)
 - October 2, 2002**
(ABM test launch, 51T6)
 - November 29, 2004**
(ABM test launch, 53T6)
 - December 5, 2006**
(ABM test launch, 53T6)
 - October 11, 2007**
(ABM test launch, 53T6)
 - October 30, 2007**
(ABM test launch, 53T6)
 - October 29, 2009**
(ABM test launch, 53T6)
 - December 20, 2011**
(ABM test launch, 53T6M)
 - October 30, 2013**
(ABM test launch, 53T6)
 - May 8, 2014**
(ABM test launch, 53T6)
 - June 9, 2015**
(ABM test launch, 53T6)
 - June 21, 2016**
(ABM test launch, 53T6)
 - June 16, 2017**
(ABM test launch, 53T6 or 53T6M)

LAUNCH COMPLEXES /

RUSSIA >
Baikonur

46.079749°N 62.932500°E
(Site 90, IS launch complex—image shown)

FIGURE 17-10 – BAIKONUR COSMODROME SITE 90



While the Baikonur Cosmodrome in Kazakhstan is most famous as the historical launch site for Russia’s human spaceflight program, it has also supported many military launches. Site 90 was operated as a test launch site for the IS co-orbital ASAT program, using the UR-200 and Tsyklon-2A boosters.

Function: Space launch complex

Associated Programs: IS, IS-M

Key Dates:
October 27, 1967
(First test launch of IS ASAT)

LAUNCH COMPLEXES /

CHINA >
Jiuquan

41.281777°N 100.306390°E
(ASAT/ABM target launch site—image shown)

FIGURE 17-11 – JIUQUAN SUBORBITAL LAUNCH COMPLEX



A launch complex at the Jiuquan Space Launch Center in the Gobi Desert, Inner Mongolia, is used for testing mobile ballistic missiles. The image shows two TEL launch pads that may be used to launch suborbital targets for ASAT testing.

Function: Missile launch complex

Associated Programs: SC-19, DN-1, DN-3

Key Dates:

January 11, 2010

(Target launch supporting SC-19 launch from Korla)

January 20, 2013

(Target launch supporting SC-19 launch from Korla)

July 23, 2014

(Target launch supporting DN-2 or SC-19 launch from Korla)

October 31, 2015

(Possible target launch supporting DN-3 launch from Korla)

December 9, 2016

(Possible target launch supporting DN-3 launch from Korla,

July 23, 2017

(Possible target launch supporting DN-3 launch from Korla)

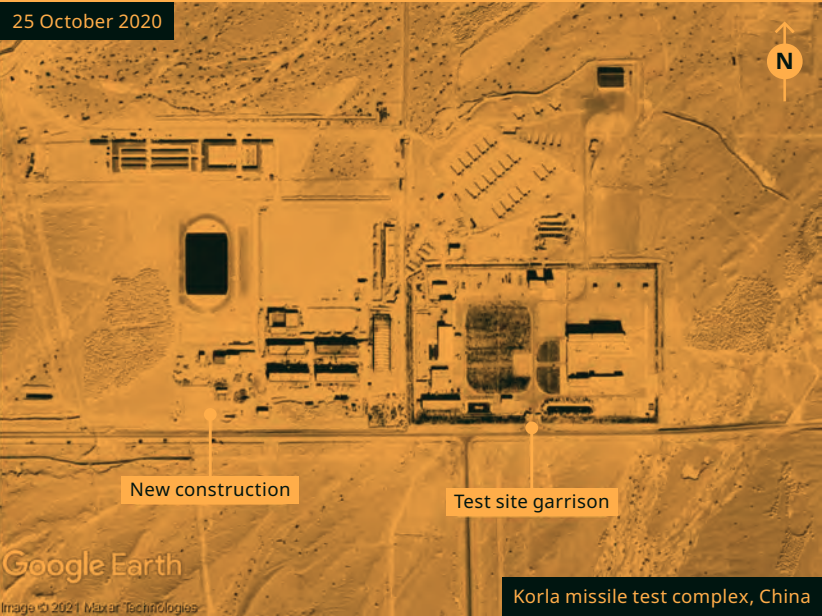
LAUNCH COMPLEXES /

CHINA >
Korla West

41.537300°N 86.353317°E
(Garrison complex—image shown)

41.537667°N 86.372073°E
(ABM/ASAT launch pad)

FIGURE 17-12 – KORLA WEST GARISSON COMPLEX



The Korla West test complex near the city of Korla in Xinjiang is used for testing various ASAT and ABM/ATBM systems. A garrison complex serves the facility, with ASAT launches occurring from a launch pad to the east.

Function: ASAT complex

Associated Programs: SC-19/DN-1, DN-3

Key Dates:

January 11, 2010
(SC-19 ASAT test)

January 20, 2013
(SC-19 ASAT test)

July 23, 2014
(SC-19 ASAT test)

October 31, 2015
(DN-3 ASAT test)

December 9, 2016
(DN-3 ASAT test)

July 23, 2017
(DN-3 ASAT test)

LAUNCH COMPLEXES /

CHINA >
Korla West

41.537667°N 86.372073°E
(ABM/ASAT launch pad—image shown)

FIGURE 17-13 – KORLA WEST LAUNCH PAD



The ASAT launch pad at Korla West employs a relocatable shelter for TEL concealment. The image shows a TEL shelter placed on the launch pad.

Function: —

Associated Programs: —

Key Dates:

January 11, 2010

(SC-19 ASAT test)

January 20, 2013

(SC-19 ASAT test)

July 23, 2014

(DN-2 or SC-19 ASAT test)

October 31, 2015

(DN-3 ASAT test)

December 9, 2016

(DN-3 ASAT test)

July 23, 2017

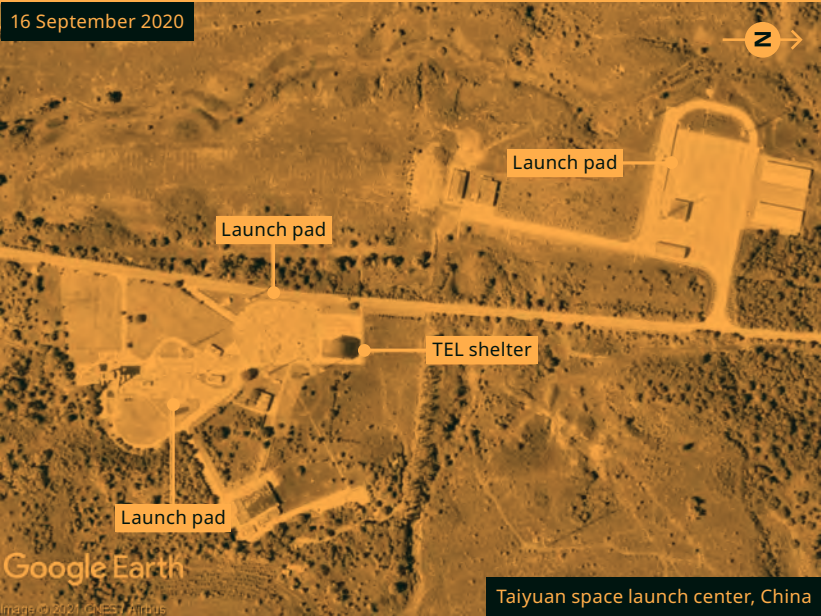
(DN-3 ASAT test)

LAUNCH COMPLEXES /

CHINA >
Taiyuan

38.840519°N 111.604648°E
(Possible ASAT/ABM target launch site—
image shown)

FIGURE 17-14 – TAIYUAN SPACE LAUNCH CENTER MOBILE LAUNCH PAD



Taiyuan Space Launch Center in Shanxi Province possesses multiple launch pads serving mobile missile development. The northern pad, constructed between 2012 and 2013, possesses a TEL shelter translating on rails for launches. Of the southern pads, the northernmost one possesses a large relocatable shelter for concealing ICBM-sized TELs. The TEL shelter is large enough to permit erecting of the missile tube under cover.

Function: Missile test complex

Associated Programs: DN-3

Key Dates:

December 9, 2016
(Possible target launch supporting DN-3 launch from Korla)

July 23, 2017
(Possible target launch supporting DN-3 launch from Korla)

LAUNCH COMPLEXES /

CHINA >
Wenchang

19.614533°N 110.951151°E
(LM-5 launch pad)

19.618657°N 110.955415°E
(LM-7 launch pad)

FIGURE 17-15 – WENCHANG SPACE LAUNCH CENTER



Wenchang Space Launch Center on the island of Hainan is China’s newest space launch complex, with the benefits of being nearest to the Equator and a greater range of allowable launch azimuths.

Function: Space launch complex

Associated Programs: SJ-23

Key Dates:

January 18, 2023
Launch of SJ-23 to GEO

LAUNCH COMPLEXES /

CHINA >
Xichang

28.249140°N 102.022942°E
(Northern ABM/ASAT and target
launch pad—image shown)

FIGURE 17-16 – XICHANG SPACE LAUNCH CENTER NORTH ASAT PAD



Xichang Space Launch Center in Sichuan possesses launch pads at the northwest and southeast end of the facility possibly supporting SC-19 and DN-2 ASAT tests. This image shows the pad to the NW, which has a relocatable shelter and ongoing construction.

Function: Missile test complex

Associated Programs: SC-19

Key Dates:

July 5, 2005
(SC-19 ASAT test)

February 6, 2006
(SC-19 ASAT test)

January 11, 2007
(SC-19 ASAT test)

LAUNCH COMPLEXES /

CHINA >
Xichang

28.242775°N 102.032946°E
(Southern ABM/ASAT and target launch
pad—image shown)

FIGURE 17-17 – XICHANG SPACE LAUNCH CENTER SOUTH ASAT PAD



This image shows the SE ASAT launch pad at Xichang, which was the likely launch site for the ASAT test on May 13, 2013, that went nearly to GEO.

Function: Missile test complex

Associated Programs: DN-2

Key Dates:

July 5, 2005
(SC-19 ASAT test)

February 6, 2006
(SC-19 ASAT test)

January 11, 2007
(SC-19 ASAT test)

May 13, 2013
(DN-2 ASAT test)

LAUNCH COMPLEXES /

INDIA >
Satish Dhawan

13.733280°N 80.234840°E
(First Launch Pad—image shown)

13.719751°N 80.230431°E
(Second Launch Pad)

FIGURE 17-18 – SATISH DHAWAN SPACE CENTRE



Satish Dhawan Space Centre, located in Sriharikota in Andhra Pradesh, is India's primary space launch center.

Function: Space launch complex

Associated Programs: PSLV

Key Dates: —

LAUNCH COMPLEXES /

INDIA >

Abdul Kalam Island

20.755135°N 87.088511°E

(Launch Complex IV—image shown)

FIGURE 17-19 – ABDUL KALAM ISLAND LAUNCH COMPLEX



The Integrated Test Range complex at Abdul Kalam Island (formerly Wheeler Island) is the primary test site for India's antiballistic missile systems. It was also the launch site for both of India's DA-ASAT tests in February and March 2019.

Function: Missile test complex**Associated Programs:** PDV**Key Dates:****February 12, 2019**

(Unsuccessful DA-ASAT test)

March 27, 2019

(Successful DA-ASAT test)

LAUNCH COMPLEXES /

IRAN >
Semnan

35.23472°N 53.92083°E
(Safir Launch Pad—image shown)

35.2583°N 53.9547°E
(Imam Khomeini Spaceport)

FIGURE 17-20 – SEMNAN SPACE CENTER



Semnan Space Center is Iran’s primary space launch facility, located 50 kilometers southeast of the city of Semnan in the north of the country. The image shows the Imam Khomeini Spaceport, which is the site for the Simorgh SLV.

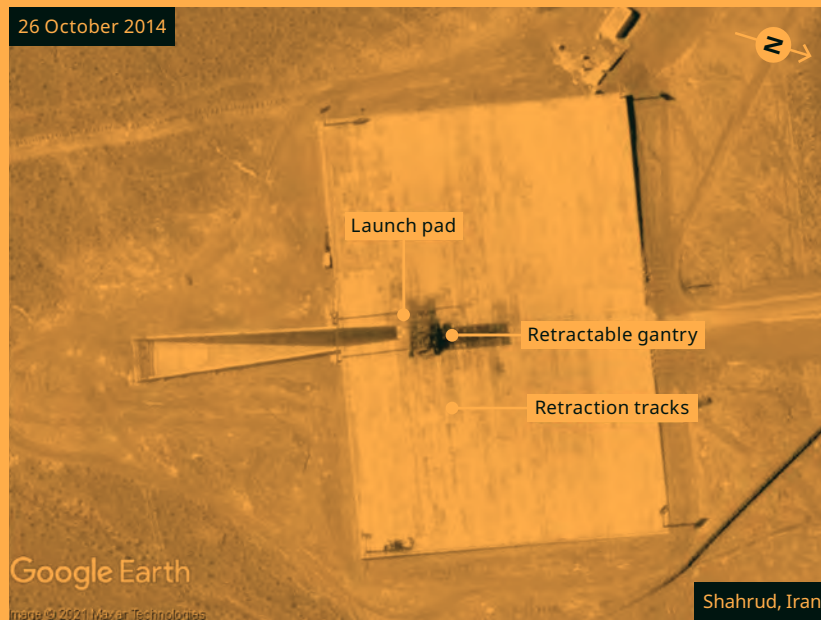
Function: Space launch complex
Associated Programs: Safir, Simorgh
Key Dates: —

LAUNCH COMPLEXES /

IRAN >
Shahrud

36.200599°N 055.333928°E

FIGURE 17-21 – SHAHRUD LAUNCH SITE



Shahrud space launch facility was built approximately 40 kilometers SE from the town of Shahrud in Semnan province and appears to be the launch site for Iran's military space launches.

Function: Space launch complex

Associated Programs: Qassed

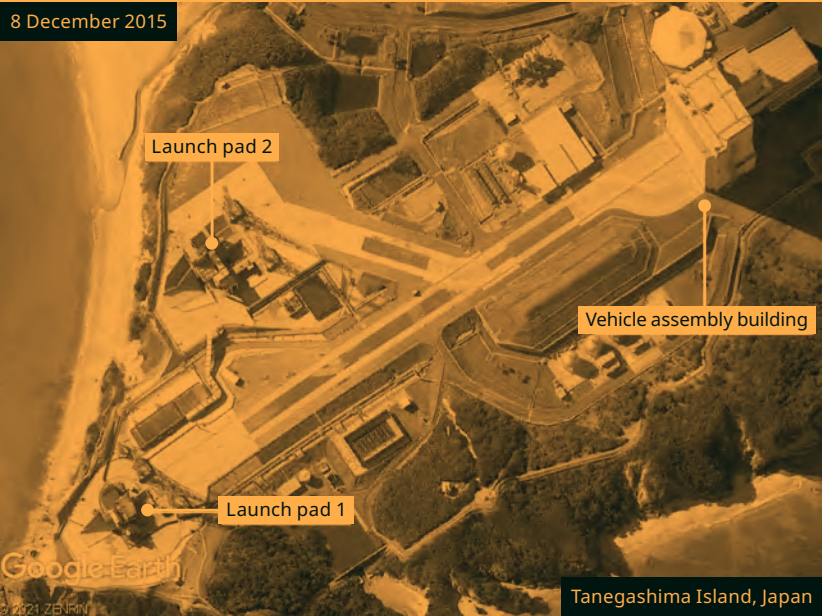
Key Dates: —

LAUNCH COMPLEXES /

JAPAN >
Tanegashima

30.402291°N 130.974102°E

FIGURE 17-22 – TANEGASHIMA SPACE CENTER



Tanegashima Space Center is Japan's largest space launch facility and is located on the southeast coast of Tanegashima island, just south of Kyushu.

Function: —
Associated Programs: —
Key Dates: —

LAUNCH COMPLEXES /

NORTH KOREA >
Tonghae

40.85°N 129.666667°E

FIGURE 17-23 – TONGHAE SATELLITE LAUNCHING GROUND



Tonghae Satellite Launching Ground, also known as Musudan-ri, is a ballistic missile and space launch site in North Korea.

Function: Space launch complex

Associated Programs: TD-1

Key Dates: —

LAUNCH COMPLEXES /

NORTH KOREA >
Sohae

39.660°N 124.705°E

FIGURE 17-24 – SOHAE SATELLITE LAUNCHING STATION



Tonghae Satellite Launching Ground, also known as Tongch'ang-dong Space Launch Center and Pongdong-ri, is a ballistic missile and space launch site in North Korea.

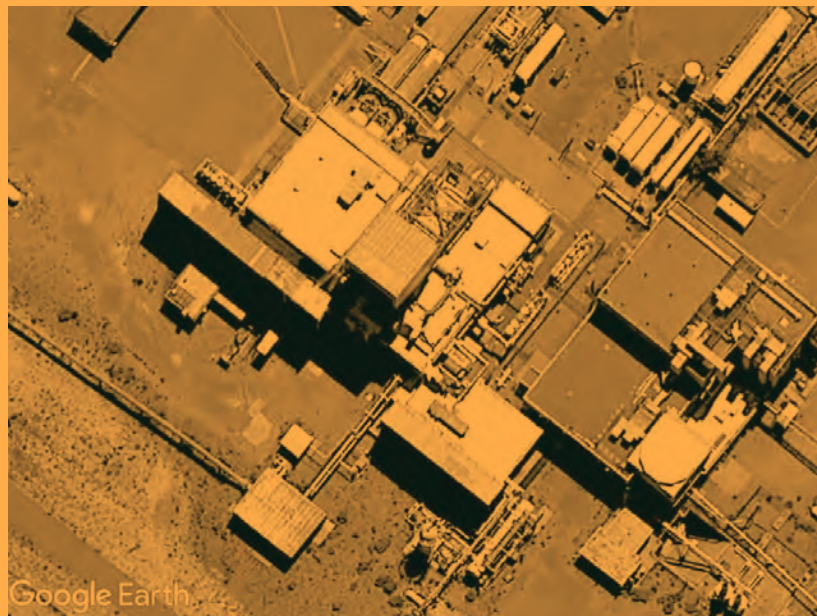
Function: Space launch complex
Associated Programs: Unha
Key Dates: —

**DIRECTED ENERGY WEAPONS
AND ELECTRONIC WARFARE
COMPLEXES /**

UNITED STATES >
Fixed laser sites

32.632037°N -106.333804°W

FIGURE 17-25 – MIRACL LASER



The Mid-Infrared Advanced Chemical Laser (MIRACL) is a megawatt-class laser weapon research and test facility located at White Sands Missile Range in New Mexico. It first became operational in 1980 and in 1997 was used to attempt to blind the MSTI-3 satellite in an Air Force test.

Function: Fixed laser site

Associated Programs: MIRACL

Key Dates: —

DIRECTED ENERGY WEAPONS
AND ELECTRONIC WARFARE
COMPLEXES /

RUSSIA >
Mobile laser
deployment sites

56.899222°N 40.578117°E
(Teykovo)

56.573328°N 48.039010°E
(Yoshkar Ola)

58.133634°N 60.522106°E
(Svobodnyy)

55.270300°N 83.017993°E
(Novosibirsk)

53.555585°N 83.825132°E
(Barnaul—image shown)

FIGURE 17-26 – PERESVET DEPLOYMENT SITE NEAR BARNNAUL



Russia has recently deployed its new Peresvet mobile laser dazzler system to five sites, all of which are located near mobile ICBM garrisons. The above image shows the Peresvet shelter near Barnaul in the Altai Krai region, with the Peresvet vehicle itself partially emerging from the building.

Function: Mobile laser deployment site

Associated Programs: Peresvet

Key Dates: —

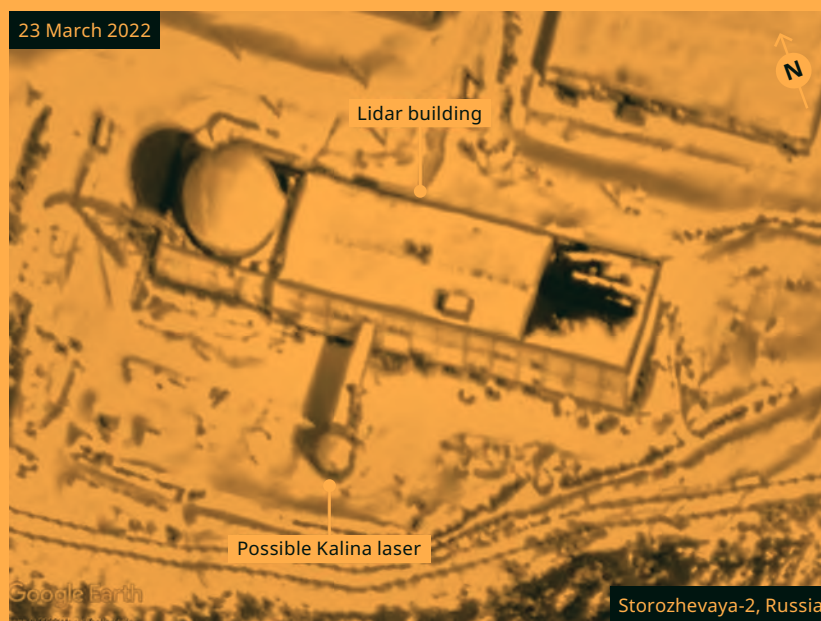
DIRECTED ENERGY WEAPONS AND ELECTRONIC WARFARE COMPLEXES /

RUSSIA >

Fixed laser site

43.717130°N 041.227706°E

FIGURE 17-27 – KALINA LASER COMPLEX NEAR ZELENCHUKSKAYA



Russia is constructing a new laser system called Kalina at the site of the Krona space surveillance complex, located several kilometers west of Zelenchukskaya.

Function: Fixed laser site

Associated Programs: Kalina

Key Dates: —

DIRECTED ENERGY WEAPONS
AND ELECTRONIC WARFARE
COMPLEXES /

RUSSIA >
Tobol Electronic
Warfare sites

56.014836°N 38.006669°E
(8282/1—Shcholkovo)

51.856779°N 107.986240°E
(8282/3—Ulan-Ude—image shown)

44.019977°N 131.756142°E
(8282/4—Ussuriysk Primorskiy)

58.445332°N 092.269218°E
(8282/5—Yeniseisk)

54.939364°N 20.240636°E
(8282/6— Mobile site near Pionerskiy)

44.931381°N 40.989706°E
(8282/7— Mobile site near Armavir)

FIGURE 17-28 — TOBOL ELECTRONIC WARFARE COMPLEX NEAR ULAN-UDE



The Tobol complexes contain multiple satellite antennas that can be used for both offensive and defensive electronic warfare purposes. Two of the sites, 8282/6 near Pionerskiy and 8282/7 near Armavir, are parking locations for mobile sensors.

Function: Fixed EW complex

Associated Programs: Tobol

Key Dates: —

DIRECTED ENERGY WEAPONS AND ELECTRONIC WARFARE COMPLEXES /

CHINA >

Laser test sites

31.532158°N 104.740708°E

(Mianyang—image shown)

31.901428°N 117.162222°E

(Hefei)

41.761422°N 87.418331°E

(Bohu)

34.7475°N 113.781767°E

(Zhengzhou)

43.790506°N 125.442814°E

(Changchun)

FIGURE 17-29 — LASER TEST SITE NEAR MIANYANG



China currently has five potential facilities for conducting research and development of high-power directed energy weapons in a counterspace role. The image above shows one suspected facility near Mianyang in Sichuan Province.

Function: Fixed laser site

Associated Programs: —

Key Dates: —

DIRECTED ENERGY WEAPONS
AND ELECTRONIC WARFARE
COMPLEXES /

CHINA >
Fixed laser sites

31.532158°N 104.740708°E
(Mianyang)

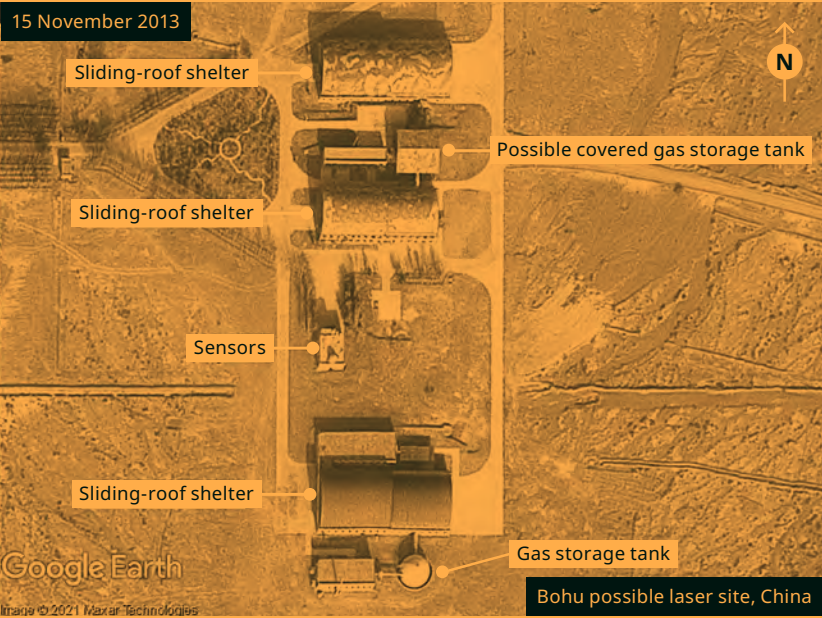
31.901428°N 117.162222°E
(Hefei)

41.761422°N 87.418331°E
(Bohu—image shown)

34.7475°N 113.781767°E
(Zhengzhou)

43.790506°N 125.442814°E
(Changchun)

FIGURE 17-30 – LASER TEST SITE NEAR BOHU



The above image shows a second suspected laser test site near Bohu, which is close to the Korla West missile test facility that is prominent in Chinese DA-ASAT testing.

Function: Fixed laser site
Associated Programs: —
Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >

Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod—image shown)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

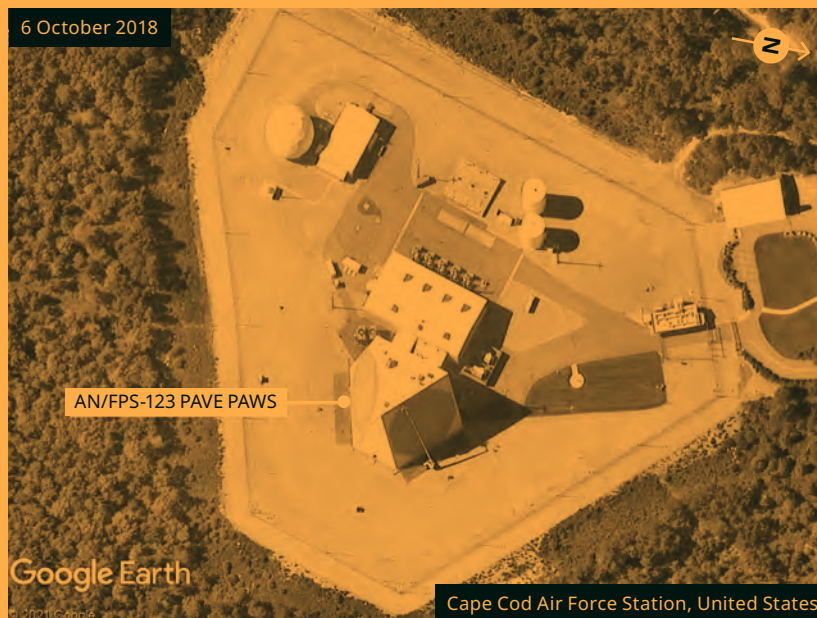
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-31 — CAPE COD MISSILE WARNING RADAR



The US military operates multiple phased array radars with the primary purpose of missile warning but also with a space situational awareness secondary function. The above image shows one of these radars, the AN/FPS-123 PAVE PAWS, located at Cape Code Space Force Station in Massachusetts, from which it has coverage over much of the northeastern coast of the United States.

Function: Radar**Associated Programs:** SSN**Key Dates:** —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales—image shown)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

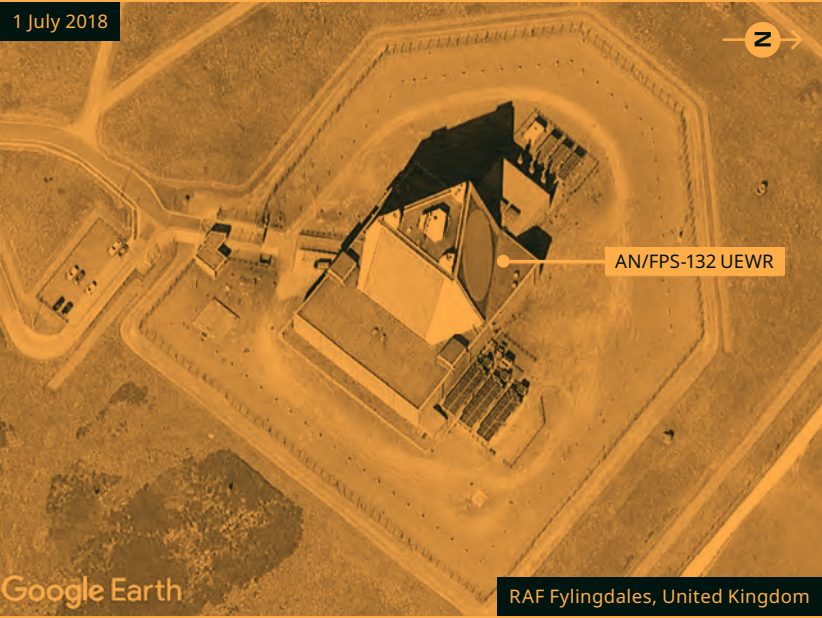
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-32 – FYLINGDALES MISSILE WARNING RADAR



The above image shows the AN/ FPS-126 radar located at Royal Air Force (RAF) Fylingdales in North Yorkshire, England. Note that the RAF Fylingdales radar has three faces, giving it 360-degree coverage, compared to the two faces of the Cod radar.

Function: Radar
Associated Programs: SSN
Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >

Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin—image shown)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-33 — EGLIN SPACE SURVEILLANCE RADAR



The above image shows the AN/FPS-85 phased array radar located at Eglin Air Force Base in Florida. It has one face but can track objects at altitudes up to 36,000 kilometers.

Function: Radar

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence—image shown)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

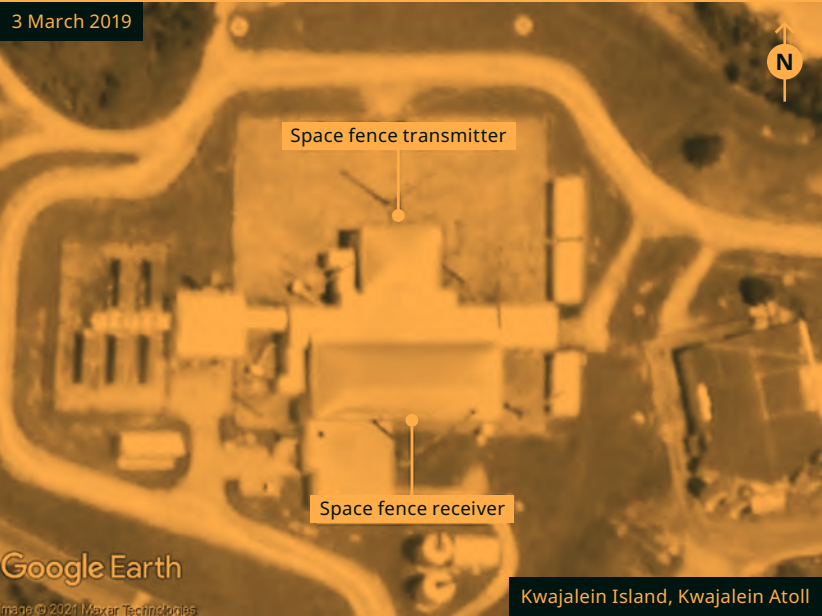
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-34 — KWAJALEIN S-BAND SPACE FENCE



The above image shows the S-Band Space Fence located on Kwajalein Atoll in the South Pacific. This system became operational in 2020 and can track objects as small as a few centimeters in size out to 36,000 kilometers.

Function: Radar
Associated Programs: SSN
Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >

Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex
—image shown)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

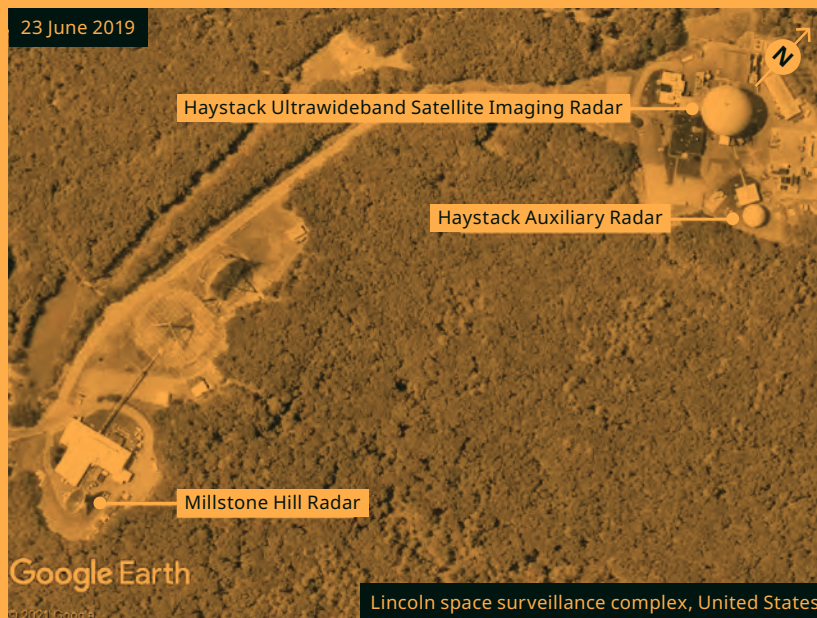
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-35 — LINCOLN SPACE SURVEILLANCE COMPLEX



The above image shows the Lincoln Space Surveillance Complex located near Boston, Massachusetts, which has multiple dish and phased array radars for tracking and characterizing space objects out to 36,000 kilometers.

Function: Radar complex

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II—image shown)

9.394789°N 167.47925°E
(Reagan Test Site)

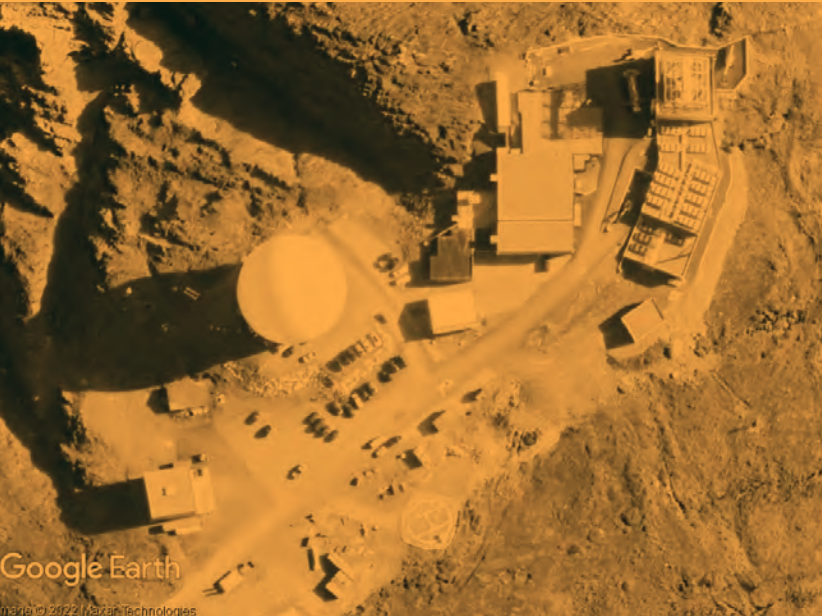
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-36 – GLOBUS II RADAR



The above image shows the Globus II radar, located in Vardø, on the island of Vårberget in Norway. It is a single dish mechanical tracking radar for tracking and characterizing space objects out to 36,000 kilometers and contributes to the US SSN.

Function: Radar
Associated Programs: SSN
Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site—image shown)

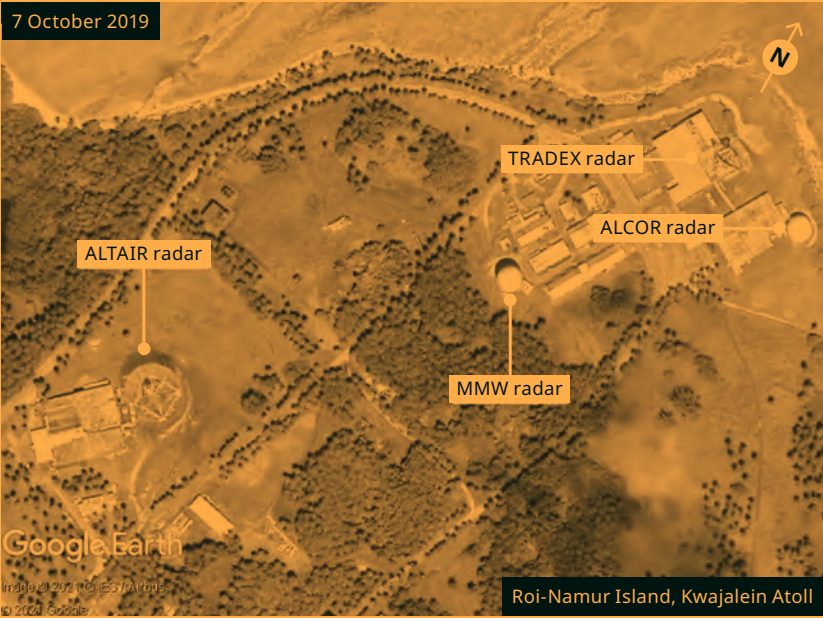
7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-37 — REAGAN TEST SITE



The image above shows the Reagan Test Site on Kwajalein Atoll, which contains multiple radars that were originally used for missile defense testing and currently support both missile defense and SSA missions.

Function: Radar complex

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

7.41227222°S 72.45240556°E
(GEODSS Diego Garcia—image shown)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-38 — GEODSS DIEGO GARCIA



The above image shows the Ground-based Electro-Optical Deep Space Surveillance (GEODSS) complex located on Diego Garcia, British Indian Ocean Territory, which includes a 1-meter optical telescope. The Diego Garcia installation is one of three GEODSS sites, the other two are located in Socorro, New Mexico, and on the island of Maui, Hawaii.

Function: Optical telescope complex

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >
Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar—image shown)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-39 — HOLT C-BAND RADAR IN EXMOUTH



The image above shows the C-Band radar moved from Antigua Island in the Atlantic to Naval Communication Station Harold E. Holt near Exmouth, Western Australia, to augment the SSN's coverage in the Southern Hemisphere.

Function: Radar

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >

Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope—image shown)

20.7088°N 156.2578°W
(Air Force Maui Optical and
Supercomputing Observatory)

FIGURE 17-40 — SPACE SURVEILLANCE TELESCOPE IN EXMOUTH



The image above shows the Space Surveillance Telescope (SST), which is a 3.5-meter wide field of view telescope originally developed by DARPA in New Mexico before being relocated to Naval Communication Station Harold E. Holt near Exmouth, Western Australia, to augment the SSN's coverage in the Southern Hemisphere.

Function: Optical telescope

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

UNITED STATES >

Space surveillance network

39.136111°N 121.350831°W
(Beale)

41.752219°N 70.538061°W
(Cod)

76.570308°N 68.299256°W
(Thule)

64.290006°N 149.191381°W
(Clear)

54.3616°N 0.6697°W
(Fylingdales)

52.736644°N 174.091617°E
(Cobra Dane)

48.724475°N 97.899864°W
(PARCS)

30.573°N 86.215°W
(Eglin)

8.723375°N 167.718564°E
(Space Fence)

42.620033°N 71.490289°W
(Lincoln Space Surveillance Complex)

70.36639722°N 31.12687500°E
(Globus II)

9.394789°N 167.47925°E
(Reagan Test Site)

7.41227222°S 72.45240556°E
(GEODSS Diego Garcia)

21.816631°S 114.165617°E
(Holt C-Band Radar)

-21.895703°S 114.089939°E
(Space Surveillance Telescope)

20.7088°N 156.2578°W

(Air Force Maui Optical and Supercomputing Observatory—image shown)

FIGURE 17-41 – AIR FORCE MAUI OPTICAL AND SUPERCOMPUTING OBSERVATORY



The image above shows the Air Force Maui Optical and Supercomputing Observatory located on the island of Maui in Hawaii. It includes multiple electro-optical sensors for tracking objects in deep space, including the Advanced Electro Optical System (AEOS) telescope that can image objects in LEO.

Function: Optical telescope complex

Associated Programs: SSN

Key Dates: —

SENSOR COMPLEXES /

RUSSIA >
Radar complexes

60.275210°N 30.545593°E
(77Ya6M)

51.273673°N 58.959036°E
(77Ya6M—image shown)

58.506337°N 92.045261°E
(77Ya6DM)

53.139759°N 83.680803°E
(77Ya6DM)

54.857482°N 20.182510°E
(77Ya6DM)

44.925428°N 40.983915°E
(77Ya6DM)

52.855571°N 103.232513°E
(77Ya6VP)

67.613910°N 63.752342°E
(under construction)

FIGURE 17-42 – VORONEZH RADAR AT ORSK



The image above shows the Voronezh-VP array near Orsk, one of several such radars in operational use or under construction.

Function: Radar
Associated Programs: Voronezh
Key Dates: —

SENSOR COMPLEXES /

RUSSIA >

Radar complexes

65.209966°N 57.285247°E

(Daryal—image shown)

52.848887°N 26.470524°E

(Volga)

FIGURE 17-43 — DARYAL RADAR AT PECHORA

The image above shows the Daryal bistatic array near Pechora.

Function: Radar**Associated Programs:** Daryal/Volga**Key Dates:** —

SENSOR COMPLEXES /

RUSSIA >
Radar complexes

52.874943°N 103.260566°E
(Dnestr)

52.877874°N 103.272584°E
(Dnepr—image shown)

46.603278°N 74.530860°E
(Dnepr—image shown)

68.113720°N 33.910522°E
(Daugava)

FIGURE 17-44 — DNEPR SITE RADAR AT SARY SHAGAN



The image above shows a Dnepr radar array at Sary Shagan.

Function: Radar
Associated Programs: Dnepr/Dnestr
Key Dates: —

SENSOR COMPLEXES /

RUSSIA >

Radar complexes

56.173299°N 37.769327°E

(Don-2N—image shown)

55.219146°N 37.294505°E

(Dunai-3M)

FIGURE 17-45 — DON-2N SITE AT SOFRINO

The image above shows the Don-2N radar, whose NATO codename is Pill Box, near Sofrino outside of Moscow. It is a critical part of the A-135 ABM system.

Function: Radar**Associated Programs:** A-135**Key Dates:** —

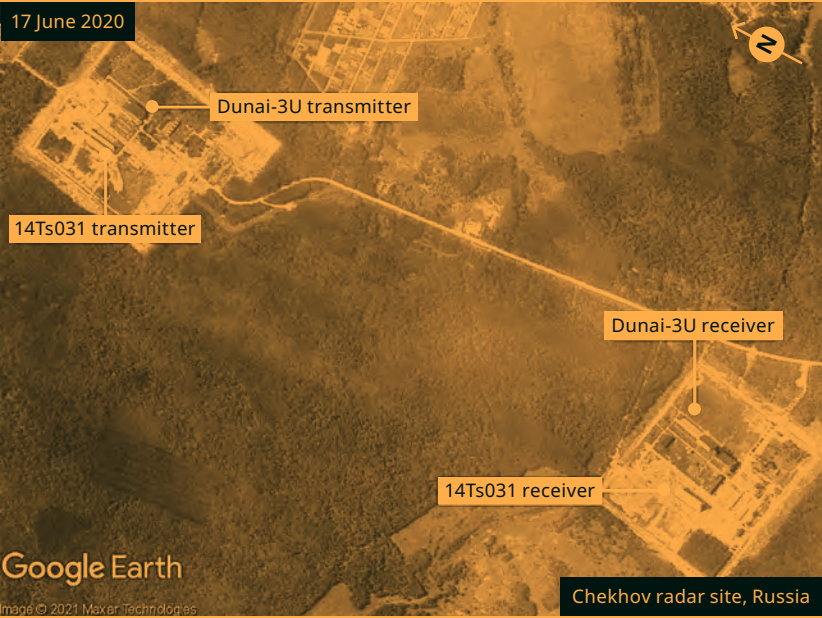
SENSOR COMPLEXES /

RUSSIA >
Radar complexes

56.173299°N 37.769327°E
(Don-2N)

55.219146°N 37.294505°E
(Dunai-3M—image shown)

FIGURE 17-46 – DUNAI-3M RADAR AT CHEKHOV



The image above shows a Dunai-3M radar at Chekhov, which was part of the A-135 ABM system.

Function: Radar
Associated Programs: A-135
Key Dates: —

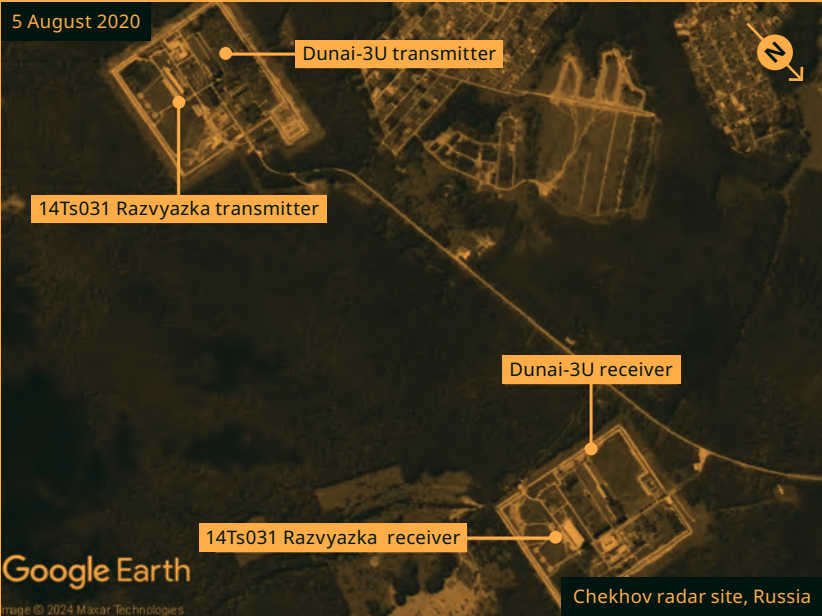
SENSOR COMPLEXES /

RUSSIA >
Radar complexes

55.231292°N 37.298513°E
(Receiver)

55.205850°N 37.295953°E
(Transmitter)

FIGURE 17-47 – RAZVYAZKA RADAR AT CHEKHOV



The image above shows the new Razvyazka radar located near the town of Chekhov southwest of Moscow.

Function: Radar

Associated Programs: —

Key Dates: —

SENSOR COMPLEXES /

RUSSIA >
Radar and optical
telescope complexes

43.826155°N 41.343355°E
(Radar—image shown)

42.935368°N 132.576247°E
(Radar)

43.718100°N 41.227653°E
(30J6 Electro-optical)

FIGURE 17-48 — KRONA RADAR COMPLEX NEAR STOROZHEVAYA



The above image shows the KRONA complex near Storozhevaya. KRONA employs both electro-optical and radar sensors for satellite identification and tracking. Pictured are the decimeter and centimeter band radar antennas.

Function: Radar
Associated Programs: KRONA
Key Dates: —

SENSOR COMPLEXES /

RUSSIA >

Radar and optical
telescope complexes

43.826155°N 41.343355°E

(Radar)

42.935368°N 132.576247°E

(Radar)

43.718100°N 41.227653°E

(30J6 Electro-optical—image shown)

FIGURE 17-49 — KRONA 30J6 OPTICAL COMPLEX NEAR STOROZHEVAYA



The above image shows the 30J6 component of the Krona complex near Storozhevaya, which contains the optical telescopes and lasers.

Function: Optical telescope

Associated Programs: Krona

Key Dates: —

SENSOR COMPLEXES /

RUSSIA >
Optical telescope complexes

38.280551°N 69.224786°E

FIGURE 17-50 – OKNO COMPLEX NEAR NUREK



The above image shows the Okno complex near Nurek in Tajikistan. It is part of Russia’s Centre for Outer Space Monitoring and uses a variety of electro-optical sensors to track space objects, mainly in the geosynchronous region.

Function: Optical telescope complex
Associated Programs: Okno
Key Dates: —

SENSOR COMPLEXES /

CHINA >

Radar complexes

46.527890°N 130.755269°E
(Huanan)

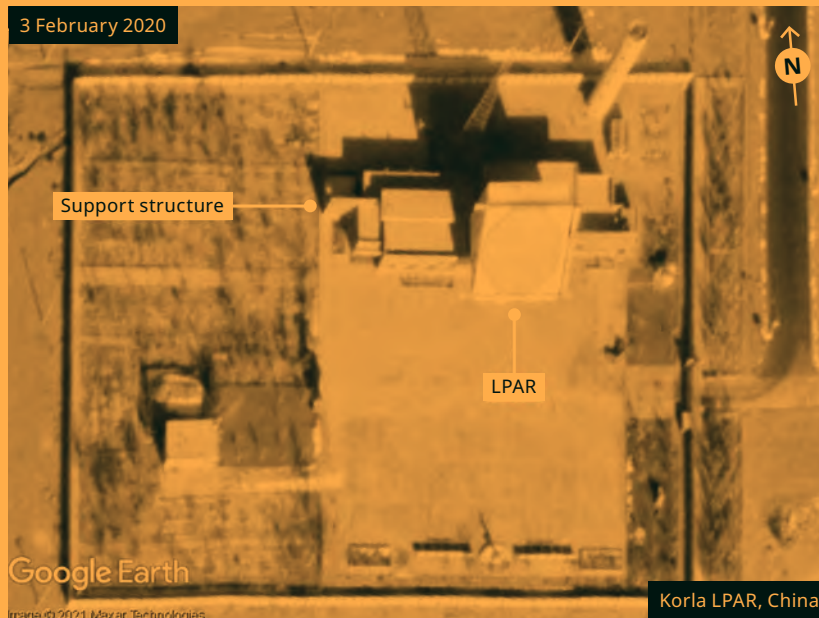
36.024737°N 118.091972°E
(Yiyuan)

30.286623°N 119.128566°E
(Hangzhou)

41.641212°N 86.236834°E
(Korla—image shown)

35.482983°N 106.571819°E
(Kongtong)

FIGURE 17-51 — LPAR SITE NEAR KORLA



China operates numerous LPARs which provide SSA data and could serve as acquisition sensors for ABM and/or ASAT systems. The image shows the LPAR site near Korla.

Function: Radar

Associated Programs: LPAR

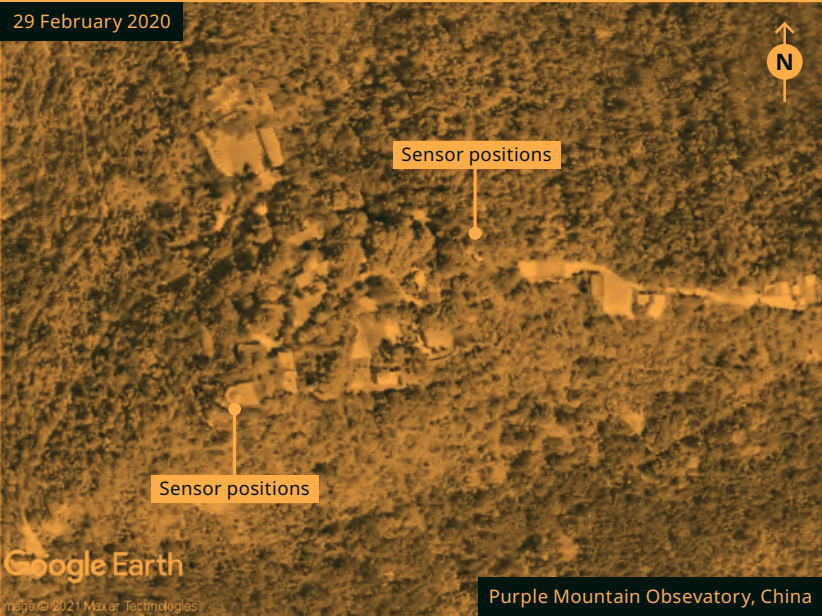
Key Dates: —

SENSOR COMPLEXES /

CHINA >
Optical telescope complexes

32.065°N 118.8297°E

FIGURE 17-52 – PURPLE MOUNTAIN OBSERVATORY



China’s main optical SSA capabilities are operated by the Purple Mountain Observatory (PMO), which operates multiple telescopes in seven separate locations that can track satellites throughout all orbital regimes.

Function: Optical telescope complex
Associated Programs: Purple Mountain Observatory
Key Dates: —

SENSOR COMPLEXES /

FRANCE >

Radar complex

47.3480°N 5.5151°E

(Transmitter—image shown)

44.0715°N 5.5346°E

(Receiver)

FIGURE 17-53 — GRAVES RADAR TRANSMITTER



The image above shows the Grand Réseau Adapté à la Veille Spatiale (GRAVES) system operated by the French military for SSA. It is a bistatic radar, consisting of a geographically separated transmitter and receiver and is capable of tracking objects in LEO.

Function: Radar**Associated Programs:** GRAVES**Key Dates:** —

SENSOR COMPLEXES /

FRANCE >
Radar complex

47.3480°N 5.5151°E
(Transmitter)

44.0715°N 5.5346°E
(Receiver—image shown)

FIGURE 17-54 – GRAVES RADAR RECEIVER



The image above shows the Grand Réseau Adapté à la Veille Spatiale (GRAVES) system operated by the French military for SSA. It is a bistatic radar, consisting of a geographically separated transmitter and receiver and is capable of tracking objects in LEO.

Function: Radar
Associated Programs: GRAVES
Key Dates: —

SENSOR COMPLEXES /

FRANCE >
Optical telescope complex

6.92388889°N 43.75222222°E

FIGURE 17-55 – TAROT-CALERN TELESCOPE



The image above shows the
Télescope à Action Rapide pour les
Objets Transitoires (Rapid Action
Telescope for Transient Objects,
TAROT) a pair of 25 centimeters
optical telescopes near the Calern
Observatory in France that are used
to track deep space objects.

Function: Optical telescope complex

Associated Programs: TAROT-CALERN

Key Dates: —

SENSOR COMPLEXES /

INDIA >
Radar complex

19.854052°N 85.969496°E
(Image shown)

13.195549°N 78.173603°E

FIGURE 17-56 – SWORDFISH RADAR NEAR GARHBANGOR



The image above shows the
SWORDFISH radar installation near
Garhbangor, India.

Function: Radar
Associated Programs: SWORDFISH
Key Dates: —

SENSOR COMPLEXES /

IRAN >

Space surveillance complex

34.119728°N 50.877829°E

FIGURE 17-57 – DELIJAN SPACE TRACKING CENTER



The image above shows the Delijan Space Tracking Center, located in Varn, Iran, about 200 kilometers south of Tehran. The site includes multiple radar and electro-optical sensors for tracking space objects.

Function: Space surveillance complex

Associated Programs:

Key Dates: —

SENSOR COMPLEXES /

JAPAN >
Optical telescope complex

34.672225°N 133.544089°E
(Bisei—image shown)

35.3123°N 133.941364°E
(Kamisaibara)

FIGURE 17-58 – BISEI SPACEGUARD CENTER



The image above shows the Bisei Spaceguard Center at Bisei-chō in Okayama, which is Japan’s main optical tracking facility for SSA.

Function: Optical telescope complex
Associated Programs: Spaceguard
Key Dates: —

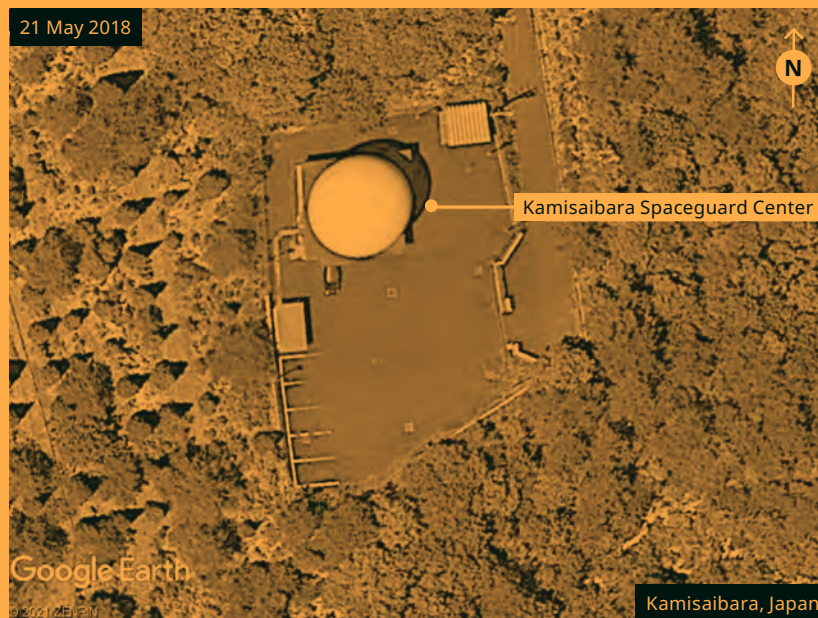
SENSOR COMPLEXES /

JAPAN >

Radar complex

34.672225°N 133.544089°E
(Bisei)

35.3123°N 133.941364°E
(Kamisaibara—image shown)

FIGURE 17-59 – KAMISAIBARA SPACEGUARD CENTER

The image above shows the Kamisaibara Spaceguard Center, which is also in Okayama, and is the location of a radar that can track objects in LEO.

Function: Radar**Associated Programs:** Spaceguard**Key Dates:** —



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SWF Publication: 26.04
Published: 26.04



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