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WHITE PAPER

Navigating the **Modern Contested Logistics Environment** with Artificial Intelligence

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Executive Summary

Logistics is the foundation of military power. The ability to deploy and sustain personnel and materiel across vast distances can be the deciding factor between success and failure on the battlefield. Consequently, logistics must operate across all domains—land, air, maritime, cyber, and space—in spite of adversarial attempts to disrupt and deny its operations. While the U.S. has not faced a contested logistics environment in decades, we can expect to be contested in the future fight. The contested logistics environment of the modern battlefield will be vastly different from what the U.S. and our allies have encountered in the past. Technological innovation is driving a paradigm shift in the operational environment, making it more challenging and more critical to preserve logistics operations under hostile conditions.

To succeed in the modern contested logistics environment, the U.S. must safeguard the integrity, resilience, and adaptability of the supply chain to unexpected shocks and disruptions. These outcomes will be made possible by artificial intelligence (AI) and machine learning (ML). To deliver these outcomes, Tagup developed Manifest, an AI-powered software platform that uses ML to dynamically optimize the supply and distribution of materiel across vast areas of responsibility. Manifest empowers commanders and logisticians to model and simulate threats to the supply chain and plan operations resistant to those threats.

As adversaries rapidly adopt AI to strengthen their logistics capabilities and undermine those of their rivals, the time to incorporate AI into our logistics enterprise is now. Manifest delivers the integrity, resilience, and adaptability our supply chain needs to secure our logistical advantage on the modern contested battlefield.

What is Contested Logistics?

As geopolitical tensions rise, military leaders and experts emphasize the U.S. must be prepared for logistics to be contested in the future fight.[1,2] While the Department of Defense (DOD) has not yet codified the terms "contested logistics" or "contested logistics environment" in doctrine,[3] Title 10 of the U.S. Code (10 U.S.C. § 2926) defines the term "contested logistics environment" as follows:

> an environment in which the armed forces engage in conflict with an adversary that presents challenges in all domains and directly targets logistics operations, facilities, and activities in the United States, abroad, or in transit from one location to the other.[4]

Under this definition, contested logistics is limited to times of conflict. However, as described in Army doctrine,[5] adversaries not only seek to disrupt and degrade logistics operations during times of conflict, but throughout the entire competition continuum. While the categories of the competition continuum vary from doctrine to doctrine (Army doctrine[6] categories are competition, crisis, and armed conflict while Joint doctrine[7] categories are cooperation, competition below armed conflict, and armed conflict), the message is the same: the U.S. must be ready for adversaries to target logistics operations during and outside of times of armed conflict. By targeting logistics operations in these other categories of the competition continuum, adversaries seek to establish a foundation for future success of their military operations.

To capture these nuances, an article published in *Army Sustainment* modifies the definition of "contested logistics environment" to the following:

> the environment in which an adversary or competitor intentionally engages in activities or generates conditions, across any domain, to deny, disrupt, destroy, or defeat friendly force logistics operations, facilities, and activities.[8]

While this article outlines areas in which this definition could be refined (such as the difficulty of proving adversarial intent), it provides the groundwork for how the U.S. should consider contested logistics as the operational environment evolves. Successfully operating in a contested logistics environment requires this nuanced understanding that adversaries will likely seek to undermine the logistical foundation of U.S. military power both during and outside of times of armed conflict.

U.S. Contested Logistics History

Though adversaries have largely not had the resources to threaten U.S. logistics operations during the post-9/11 period of conflict,[9] the U.S. has a notable history of navigating a contested logistics environment.

World War I

Germany used unrestricted submarine warfare to disrupt the flow of supplies in the North Atlantic and Mediterranean throughout World War I. In fact, continued attacks on U.S. merchant ships and civilian passenger carriers contributed to U.S. entry into the war in April 1917.[10] By the end of World War I, German submarines had destroyed more than 10 million tons of cargo.[11]

World War II

Germany also used unrestricted submarine warfare throughout World War II. Between January and August 1942, German U-boats sank 750 Allied cargo ships and 15 warships crossing the North Atlantic.[12] Additionally, denial of English channel ports meant thousands of Allied trucks had to haul over 400,000 tons of supplies across 500 miles to the advancing armies during the Battle of the Bulge.[13]

While the U.S. and its allies succeeded in previous contested logistics environments, the nature of contested logistics has evolved significantly since these conflicts.

Contested Logistics on the Modern Battlefield

Advancements in Technology

While many of the tactics used to subvert logistics operations in past conflicts will continue on the modern battlefield, technological innovation is transforming contested logistics. Near-peer adversaries are rapidly adopting emerging technologies to advance their military power, including technology to undermine the logistics capabilities of their rivals.

Cyberattacks

Near-peer adversaries are conducting cyber-espionage campaigns to infiltrate global supply chains. For example, China and Russia are employing persistent malicious cyberattacks to compromise U.S. infrastructure.[14] China's May 2023 cyberattack on U.S. communication and transportation infrastructure raised concerns that it could disrupt or degrade the systems and networks in the logistics chain.[15]

Drones

Near-peer adversaries are developing drones to destroy logistics nodes and facilities from large distances. For example, Russia has deployed long-range unmanned aerial vehicles (UAVs) in Ukraine to hit targets hundreds of kilometers from the front lines, including factories and supply depots.[16] In December 2023, Ukraine reported Russia had launched 3,700 Shahed attack drones since the start of the invasion.[17]

Advanced Satellite & Radar Technology

Near-peer adversaries are developing advanced satellite and radar systems to detect and track the movements of logistics. For example, in December 2023, China launched a remote-sensing satellite into geostationary orbit called Yaogan-41.[18] While most remote-sensing satellites can only see a given spot on Earth for a few minutes, Yaogan-41 is expected to have a persistent view of the same place.[19] This persistency paired with an expected optical resolution around 2.5 meters[20] means that Yaogan-41 may dramatically improve China's ability to detect, classify, and track naval vessels and aircraft throughout the entire Indo-Pacific region.

Anti-Access/Area-Denial (A2/AD) Systems

Near-peer adversaries are developing anti-access/area-denial (A2/AD) systems to deny foreign entry to and operation within specific regions. For example, China has been building an extensive A2/AD system around the East China Sea, the South China Sea, and the Strait of Taiwan over the past twenty years. This system includes anti-ship, anti-air, and anti-ballistic weapons, submarines, and other naval and aerial capabilities designed to impede foreign access and intervention.[21]

Advanced Electronic Warfare (EW) Systems

Near-peer adversaries are developing more sophisticated electronic warfare (EW) systems to intercept, disrupt, and jam communications, radar, and GPS signals. For example, Russia's jamming technology has rendered multiple modern Western weapons ineffective in Ukraine, including Excalibur GPS-guided artillery shells and the High Mobility Artillery Rocket System (HIMARS).[22] By the time the Excalibur shells were retired, their success rate dropped to less than 10%.[23]

Contested Across Levels of Warfare

These technological advancements underscore another significant shift in contested logistics: while past adversarial efforts to undermine logistics were limited to the tactical-level of warfare, adversaries in the future fight will target logistics operations across the tactical, strategic, and operational levels.[24]

Level of Warfare	Definition from Joint Doctrine[25]	Logistics Threats
Tactical-Level	Level at which forces plan and execute battles and engagements to achieve military objectives (i.e., boots on the ground)	Destruction of supply depots, supply convoy ambushes, and improvised explosive devices
Operational-Level	Level at which forces plan, conduct, and sustain campaigns and operations to support achievement of strategic objectives (i.e., back office)	A2/AD systems, disruption of demand signals to misdirect resources, and corporate espionage of defense companies
Strategic-Level	Level at which the U.S. government formulates policy goals and ways to achieve these goals through synchronization with partners and employment of the instruments of national power	Cyberattacks, global trade disruptions (embargoes, sanctions, etc.), and coercion of allies to pull basing rights

Preparing for a Contested Logistics Environment

Numerous efforts are underway to prepare to operate in a contested logistics environment.

Shifting from Iron Mountains to Supply Networks

Traditional “iron mountains” of stockpiled materiel are a liability on a contested battlefield. These stockpiles are in direct opposition to the dynamic nature of modern warfare and are attractive enemy targets. In contrast to these large, centralized, static supply depots, the U.S. is increasingly moving towards a dispersed, flexible, interconnected supply network.[26] Such a network can rapidly adapt to evolving threats and operational changes.

Modernization & Rationalization of Logistics IT Systems

Not only does military logistics produce a massive amount of data, but this data is fragmented across siloed information systems, making it difficult to use at scale. For example, the Defense Logistics Agency (DLA) manages over 70 applications[27] and the Marine Corps logistics enterprise has over 100 information systems.[28] In February 2024, the DOD released the Logistics Information Technology (Log IT) Strategy outlining how the DOD will modernize and rationalize logistics IT systems from 2024 to 2029.[29] The strategy aims to deliver a secure and interoperable logistics information environment by retiring hundreds of logistics systems, improving data visibility and quality, and protecting logistics data.

Unified Action

Unified action will be key to overcoming the challenges posed by the contested logistics environment.[30] Joint Publications (JP) 1-1, Joint Warfighting defines unified action as:

> the synchronization, coordination, and alignment of the activities of governmental and nongovernmental entities with military operations to achieve unity of effort.[31]

Unified action provides the framework for integrating and coordinating the diverse efforts of all involved governmental, nongovernmental, and military entities to maximize effectiveness and responsiveness amid constrained resources.

Army Contested Logistics Cross-Functional Team

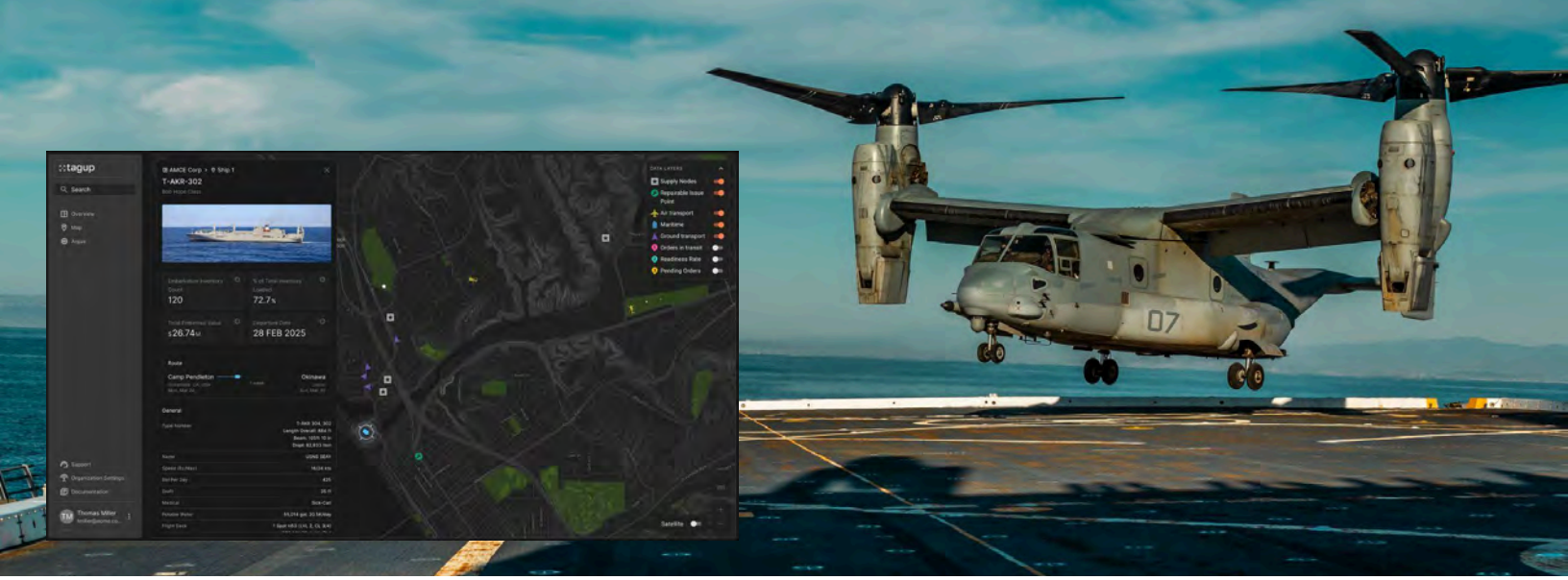
In 2023, Army Futures Command in partnership with Army Materiel Command launched a cross-functional team dedicated to contested logistics.[32] Four areas of focus the service is pursuing are predictive logistics, autonomous resupply, alternative fuel sources, and batteries.

Adopting Emerging Technologies

The U.S. has increasingly been adopting AI solutions for military applications. From 2022 to 2023, U.S. military AI spending nearly tripled from $261 million to $675 million.[33] For FY2025, the Pentagon requested $1.8 billion for AI for defense.[34]

Despite these investments, adversaries outpace the U.S. in the adoption of AI for defense logistics. For example, China is investing in AI for military logistics at a rate nearly three times that of the U.S., with 16% of its military AI contracts awarded for logistics compared with 6% for the U.S.[35] Such an imbalance would be crucial to address in an uncontested logistics environment, but is absolutely essential in a contested logistics environment.

To secure our logistical advantage and safeguard national security, we must adopt AI for defense logistics. AI and ML will deliver the flexibility and endurance our logistics enterprise needs in a contested environment. We built Manifest for defense logistics to deliver the predictive, precise logistics our enterprise needs to maximize combat power and mission success on the contested modern battlefield.



Manifest for Defense Logistics: Artificial Intelligence for Supply Chain Integrity, Resilience, and Adaptability

Delivering Next-Generation Defense Logistics

Tagup's Manifest platform combines novel ML methods with the military's wealth of historical supply and maintenance data to dynamically optimize the supply and distribution of materiel. Manifest was tested and refined in close collaboration with the U.S. Marine Corps and U.S. Navy, and with on-the-ground, intimate knowledge of the defense supply chain.

Manifest unifies data from decentralized information systems into a common logistics operating picture to provide commanders and logisticians with unprecedented visibility into the status of equipment and materiel. Manifest then uses this rich historical data to train ML models on difficult-to-predict logistics variables, including demand, consumption, and expiration. With Manifest, users can simulate outcomes across thousands of scenarios to guide strategic, mission-critical planning efforts, such as where materiel should be pre-positioned across supply nodes and which blocks should be mobilized for a given operation.

Manifest has demonstrated the following outcomes in the defense sector:

>13%
increase in force readiness at fixed budget

>20%
reduction in purchasing costs at constant readiness

>40%
reduction in materiel handled at constant readiness

>6%
increase in order fill rate at fixed budget

Manifest for Contested Logistics

While the predictive, precise logistics Manifest delivers is powerful in any operational environment, it is especially powerful in a contested environment.

Manifest improves supply chain integrity, resilience, and adaptability in a contested logistics environment by empowering commanders and logisticians to:

- Improve situational awareness to make informed, real-time decisions in complex, contested, dynamic operational environments;
- Model and simulate the impact of shocks to supply, demand, or availability of transport;
- Forecast scenarios to wargame daily and evaluate unit and materiel locations in the midst of conflict against adversarial forces;
- Optimize the distribution of materiel across supply nodes to maximize readiness under worst-case scenarios; and
- Identify optimal equipment sets for deployment to maximize mission success.

The resulting logistics enterprise is more resilient to unexpected losses of transport or supply and more adaptable to rapidly changing conditions on the ground. Manifest helps ensure our logistics enterprise can effectively operate under hostile conditions to anticipate warfighter requirements ahead of need and deliver precision sustainment at the right time and place.

> “
>
> This technology has been an absolute game changer for us. In my 20+ years in military supply, I've never seen technology that can do anything close to what you're doing.
>
> Commander, U.S. Navy
> Medical Logistics Officer

Additionally, Manifest’s models improve in response to observed data. This continuous improvement allows the models to learn unmodeled dynamics over time, further improving the robustness of the supply chain.

Accelerating Logistics Modernization Efforts

With adversaries rapidly advancing their capabilities to undermine the logistical foundation of U.S. military power, the time to modernize and safeguard our logistics operations is now. Manifest is an operational AI/ML optimization platform proven within the defense sector that can accelerate currently underway initiatives, eliminate existing vulnerabilities in the supply chain, and ensure we are prepared to compete in a contested logistics environment. Manifest makes the logistics enterprise of tomorrow possible today.

Conclusion

The contested logistics environment of the future fight will look vastly different from those previously encountered by the U.S. and our allies. Near-peer adversaries are continuously advancing their capabilities to deny and disrupt logistics operations, some of which have already thwarted U.S. weapons systems in Ukraine.

To secure U.S. and allied logistical superiority, we must preserve our ability to deploy and sustain forces and materiel in the modern contested logistics environment. AI will be instrumental in preserving and enhancing these capabilities.

We developed Manifest for defense logistics to deliver the predictive, precise logistics our enterprise needs to ensure supply chain integrity, resilience, and adaptability in a contested environment. Just as technological innovation is redefining contested logistics, Manifest is redefining defense logistics. We're determined to use AI to render adversarial attempts to thwart our logistics operations useless and ensure the security and prosperity of the U.S. and our allies.

About Tagup

Tagup is a Boston-based defense technology company founded at MIT that is redefining logistics superiority with next-generation AI. The company's platform, Manifest, combines human expertise with proprietary Generative Reinforcement Learning™ to optimize complex, high-stakes decision-making, delivering a decisive operational advantage in contested, degraded, and data-sparse environments.

For more information:

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