BUILT FOR AIRPORT OPERATIONS — SAFETY, SECURITY & EFFICIENCY

V2X and A2X Communications as the Foundation for the Next Generation Airport

How Vehicle-2-Everything and Aircraft-2-Everything connectivity transforms runway safety, airside security, surface efficiency, and AAM integration at every class of U.S. airport.

The system is being replaced. The question is whether your airport leads — or catches up.

$12.5 billion in ATC modernization has been authorized. The FAA's three-year transformation timeline is underway. Airports that establish V2X and A2X infrastructure now will be the reference facilities for the system being built around them.

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Executive Summary

American airports face a convergence of pressures that no single point solution can address. The FAA is 3,500 air traffic controllers short of its own staffing targets — a shortfall that forces individual controllers to manage more aircraft under higher workload for longer shifts than safety models recommend. Runway incursions remain among the most persistent threats in the National Airspace System, with approximately 1,700 recorded annually. On March 22, 2026, the cost of unresolved ground vehicle tracking gaps was made explicit at LaGuardia Airport: an Air Canada Express CRJ-900 struck an ARFF fire truck on Runway 4 during landing, killing both pilots and injuring approximately 40 others. The fire truck was ATC-cleared to cross — but it carried no Vehicle Movement Area Transponder, appeared on ASDE-X only as an unresolved radar return, and generated no automated conflict alert. The first fatal crash at LaGuardia in 34 years resulted not from an unauthorized intrusion, but from a system that could not see the vehicle it had just cleared. The January 2025 Potomac River collision — 67 fatalities — demonstrated that systemic airspace design failures can persist for over a decade of documented warnings before producing a catastrophic outcome.

At the same time, the airport operating environment is becoming radically more complex. Commercial UAS operations, Advanced Air Mobility vehicles, and autonomous ground equipment are arriving in the same facilities that are already strained by constrained ATC staffing, aging surveillance infrastructure, and 4.7 billion annual passenger movements. The FAA's own Brand New Air Traffic Control System plan acknowledges that the current system runs 618 airborne radars beyond their intended lifespan, operates 800 voice switches that are nearly 30 years old, and relies on copper telecommunications infrastructure that is only one-third converted to modern fiber.

AeroNet Universal Traffic Management addresses these converging pressures through a unified Vehicle-to-Everything (V2X) and Aircraft-to-Everything (A2X) communications architecture — a network-native platform that extends real-time situational awareness, cooperative conflict avoidance, authenticated operator identification, and frictionless operational coordination to every vehicle, aircraft, and infrastructure node in the airport environment. AeroNet does not replace the ATC system being built. It accelerates, complements, and amplifies it — closing the capability gaps that exist today while the new system is constructed, and providing the data infrastructure that the new system will rely on when it arrives.

3,500	1,700	2026	$12.5B
ATC controllers below FAA target staffing	runway incursions recorded annually in the US	LaGuardia: fatal collision, non-transponder fire truck	authorized ATC modernization down payment

AERONET THESIS

V2X and A2X are not add-ons to the airport operating system — they are the communications fabric on which the next generation of airport safety, security, and efficiency must be built. AeroNet UTM provides that fabric today, as a network airports can join rather than a system they must build, staff, and maintain independently.

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1. THE AIRPORT SAFETY AND EFFICIENCY CRISIS

1. The Airport Safety and Efficiency Crisis: A System Under Strain

The U.S. aviation system carried more than 4.7 billion passengers in 2025, a record that was achieved by a workforce and infrastructure base operating well beyond sustainable parameters. Understanding the current state of the system is essential context for evaluating what AeroNet UTM offers airport operators, because AeroNet is not a response to hypothetical future conditions — it is a response to documented, present-tense failures.

1.1 The ATC Staffing Crisis

The FAA has approximately 3,500 air traffic controllers short of its own staffing model targets as of early 2026. Between 2013 and 2023, the agency hired only two-thirds of the controllers its own models required, producing a structural deficit that now forces well over 90 percent of ATC facilities to operate understaffed. Controllers regularly work 60-hour weeks. Single-controller operations — where one person manages positions that safety guidelines recommend splitting — have become routine at facilities including, as the NTSB found, Ronald Reagan Washington National Airport on the night of January 29, 2025.

The consequences are measurable and direct. Overworked controllers have reduced cognitive bandwidth for proactive conflict detection. Reaction time to developing surface conflicts increases. The margin between a controller detecting a runway incursion and the aircraft reaching the hold-short line shrinks. The system still works most of the time because aviation safety has deep redundancy — but the redundancy is being consumed by a staffing model that cannot be corrected in months.

NTSB FINDING	*The NTSB's investigation of the January 2025 Potomac River collision found that a single controller was managing both the local control and the ATIS/D-ATIS positions simultaneously at Reagan National — a workload distribution that reduced the controller's available attention for monitoring the helicopter route that intersected the final approach corridor.*

1.2 Aging Surveillance and Communications Infrastructure

The FAA's own Brand-New Air Traffic Control System plan, published in connection with the $12.5 billion One Big Beautiful Bill authorization, documents the infrastructure condition in unambiguous terms: 618 airborne radar systems are operating past their intended design lifespan. Nearly 800 voice switches, some approaching 30 years old, rely on outdated analog technology with scarce spare parts and retiring skilled maintenance personnel. Legacy copper telecommunications infrastructure — still partially in place across ATC facilities — is prone to outage and incompatible with modern digital integration. A Government Accountability Office report published in September 2024 found that more than 100 of the ATC system's 138 operational systems were inadequate.

At the airport surface level, the Surface Awareness Initiative (SAI) — the FAA's program to provide ADS-B-based surface surveillance to towers that lack advanced radar — was operational at only 18 airports as of early 2025, with contracts awarded for 50 additional sites. The Runway Incursion Device, which provides controllers with a memory aid indicating runway occupancy status, was operational at only four airports when the FAA announced a deployment to 74 airports total by end of 2026. These programs are valuable, but their deployment timeline means hundreds of U.S. airports will continue operating without modern surface surveillance well into the latter half of this decade.

1.3 The Runway Incursion Problem — and the LaGuardia Collision

Runway incursions — the unauthorized or incorrectly cleared presence of an aircraft, vehicle, or person on a protected runway — are classified by the FAA as one of aviation's most persistent safety threats. Since 2022, approximately 1,700 runway incursions are recorded annually in the United States. Over the past five years, collisions were narrowly avoided 26 times, and on 52 additional occasions events posed significant collision potential. The DOT Inspector General's March 2025 audit found that an independent Safety Review Team had issued 24 recommendations in November 2023 — and as of October 2024, the FAA had implemented only five.

On the night of March 22, 2026, the cumulative cost of that institutional inertia was paid in full at LaGuardia Airport. Air Canada Express Flight 8646, a Bombardier CRJ-900 operating for Jazz Aviation on a flight from Montréal, was on short final for Runway 4 when ATC cleared an airport rescue and firefighting (ARFF) truck to cross the same runway at Taxiway Delta. The truck was responding to a separate declared emergency — a United Airlines 737 MAX that had aborted its takeoff twice with mechanical issues. The CRJ touched down and struck the fire truck. Both pilots — Captain and First Officer — were killed. A flight attendant was ejected from the aircraft still strapped in her seat. Approximately 40 people were treated at hospitals. It was the first fatal crash at LaGuardia in 34 years.

MARCH 22, 2026 — LAGUARDIA AIRPORT	*Air Canada Express Flight 8646 (CRJ-900) struck a Port Authority ARFF fire truck on Runway 4 during landing. Both pilots killed. ~40 injuries. The fire truck was ATC-cleared to cross but was not equipped with a transponder or VMAT. ASDE-X showed the vehicle only as an unresolved radar return — 'two blobs on Taxiway D' — and did not generate a collision alert. NTSB investigation ongoing. First fatal crash at LGA in 34 years.*

The NTSB's preliminary findings confirmed two systemic failures that are directly relevant to this white paper. First: the fire truck involved in the collision was not equipped with a Vehicle Movement Area Transponder (VMAT) — the technology that allows ASDE-X to accurately track and display ground vehicles on ATC workstation displays. Without a VMAT, the truck was tracked only by primary radar, which displayed it as an indistinct return that could not be reliably associated with a specific vehicle or its movement toward the active runway. As NTSB Chair Jennifer Homendy stated at the March 24 briefing: ASDE-X did not alert controllers because the group of emergency vehicles 'showed up as two blobs on Taxiway D' — neither of which was shown moving onto the runway.

Second: there are no FAA requirements mandating that ground vehicles be equipped with transponders or ADS-B transmitters. Equipping is voluntary, left to airport operators. LGA had ASDE-X. LGA had runway status lights. LGA had two controllers staffed that night. None of those protections stopped the collision — because the vehicle at the center of it was invisible to the system that should have detected it.

The February 2025 Chicago Midway event — where a business jet crossed an active runway in front of a landing 737 and the crew executed a go-around after spotting it visually — had seemed to illustrate the near-miss profile. LaGuardia closed that distance to zero. The question AeroNet UTM answers is not hypothetical: what happens when the crew doesn't see it, and the ground system can't track it?

2. THE C-V2X TECHNOLOGY FOUNDATION

2. The C-V2X Technology Foundation

AeroNet UTM is built on Cellular Vehicle-to-Everything (C-V2X) technology — the same short-range wireless communications standard that has been extensively validated for roadway and intersection safety across the surface transportation sector. The choice of C-V2X as the core communications layer for AeroNet's airport V2X and A2X architecture is not a design preference; it is a deliberate decision grounded in operational validation, open standards interoperability, and the strategic advantage of deploying proven technology at scale rather than developing new protocols from scratch in safety-critical environments.

Airspace Experience Technologies (ASX), the company behind AeroNet UTM, has formally filed comments with the Federal Communications Commission (GN Docket No. 26-74, 'Unleashing American Drone Dominance,' May 1, 2026) urging the Commission to authorize and encourage development, testing, and deployment of V2V communications in the existing, protected 5.9 GHz C-V2X band for UAS operations. The FCC filing represents ASX's regulatory position on the spectrum and standards architecture that will underpin the next generation of connected aviation infrastructure — and has direct implications for airports evaluating AeroNet as a long-term safety and efficiency investment.

FCC FILING	*ASX filed formal comments with the FCC on May 1, 2026, in response to the 'Unleashing American Drone Dominance' Public Notice (GN Docket No. 26-74). The filing is submitted by Jon Rimanelli, Founder and CEO, Airspace Experience Technologies, Inc., 11499 Conner St., Hangar 7, Detroit, MI 48213. The full filing is available on the FCC's ECFS docket system. https://www.fcc.gov/ecfs/search/search-filings/filing/105010463411521*

2.1 Why C-V2X: Proven, Interoperable, and Open

C-V2X, operating in the 5.9 GHz band, has been optimized for both air and ground vehicles and is based on open 3GPP standards — the same global standards body that defines cellular network architectures. This lineage produces three operational advantages that purpose-built aviation protocols cannot match:

- **Automotive-scale validation:** C-V2X has been extensively deployed and stress-tested in roadway environments far more congested than even the busiest airport surface. A band proven to handle crowded freeways — where vehicles are separated by meters at high speeds with millisecond-level collision consequences — can readily accommodate airport surface and terminal area operations with only marginal additional load. The intersection safety use case in automotive V2X is directly analogous to runway crossing conflict detection: two vehicles, converging trajectories, milliseconds to react.

- **Open standards interoperability:** Because C-V2X is based on 3GPP standards, every C-V2X-capable entity — aircraft, ground vehicle, infrastructure node, emergency vehicle, or autonomous system — can communicate with every other entity without requiring bilateral integration agreements or proprietary compatibility arrangements. This interoperability is not aspirational; it is the design specification. It means an AeroNet-equipped aircraft can exchange safety messages with an AeroNet-equipped fuel truck, a C-V2X-equipped autonomous pushback tug, or a V2X-capable emergency vehicle, using the same protocol stack without additional hardware.
- **Certificate-based security at scale:** Robust security in C-V2X is ensured through certificate-based authentication mechanisms already deployed at scale within the transportation industry. Every participating entity carries a digital certificate that cryptographically proves its identity and authorizations. These certificates are issued and managed through a Security Credential Management System (SCMS) that has been operating in the automotive sector for years. AeroNet inherits this security architecture directly — certificate-based identity for every aircraft and vehicle on the airport network, without requiring the airport to build or operate its own credential infrastructure.

2.2 The MDOT Research Validation: C-V2X for BVLOS Operations

ASX's C-V2X architecture is not theoretical. In 2024, ASX and WSP Global conducted field research for the Michigan Department of Transportation Office of Aeronautics (MDOT-Aero), evaluating C-V2X and DSRC for UAS mesh communications. The final report and published Spotlight produced favorable results supporting Beyond Visual Line of Sight (BVLOS) operations — the highest-risk, highest-value UAS use case, and the one most directly relevant to airport environments where UAS operations must coexist with crewed aircraft without active visual separation.

The MDOT-Aero research demonstrated that C-V2X enables low-latency, ad hoc, off-network communications over multiple kilometers — and critically, that it performs reliably in congested RF environments. For airport operators, this last characteristic is particularly important: airports are among the most RF-congested environments in the transportation sector, with radar systems, transponder interrogation, ILS glide path signals, weather sensors, and cellular infrastructure all operating simultaneously in proximity. C-V2X's validated performance in congested environments is a prerequisite for reliable operation at any major airport facility.

KEY VALIDATION	*The MDOT-Aero 2024 research validated C-V2X/DSRC for UAS mesh communications with results supporting BVLOS operations. This is the only publicly documented field research specifically evaluating connected vehicle technology for UAS airspace integration — and it was conducted by ASX, the company behind AeroNet UTM.*

2.3 The Off-Network Resilience Advantage

One of the most operationally significant properties of C-V2X — and one that distinguishes it from network-dependent safety systems — is its ability to operate as a direct, peer-to-peer communications link without any centralized network infrastructure. As ASX noted in its FCC filing: without an active C2 link, aircraft risk losing situational awareness unless they can directly exchange position and intent information. V2V communications allow aircraft to maintain real-time awareness of nearby traffic and obstacles, enabling immediate collision avoidance, even when cellular or satellite C2 links are degraded, delayed, or unavailable.

For airport operators, this means AeroNet's C-V2X safety layer does not fail when the network fails. A cellular outage, a ground station equipment fault, or a temporary loss of SWIM connectivity does not degrade the core collision avoidance capability between aircraft and vehicles within C-V2X range. The system continues to exchange position, altitude, speed, trajectory, and intent data directly between participants — the safety layer operates at the edge of the network, not at its center.

2.4 The Spectrum Architecture: 5.9 GHz Primary, 5030–5091 MHz Overflow

ASX's FCC comments take a specific position on spectrum allocation that airport technology planners should understand. The filing urges the Commission to:

- Permit UAS use of the existing 5.9 GHz C-V2X band — the same band currently allocated for automotive V2X. Using the same band for both air and ground vehicles enables seamless interoperability by default: a drone can direct a ground vehicle to a delivery rendezvous point without requiring every vehicle to carry dual radios. This has direct applications in airport cargo and autonomous ground operations.
- Support dedicated spectrum in the 5030–5091 MHz band for UAS V2V in the event of RF congestion in the 5.9 GHz band. This overflow band provides the regulatory pathway for high-density UAS environments — such as a major hub airport operating hundreds of daily commercial drone operations — where the primary band may experience congestion.

The filing specifically requests that the FCC authorize UAS use of the existing 5.9 GHz C-V2X band while supporting dedicated spectrum in the 5030–5091 MHz band as a contingency for RF congestion.

The strategic significance of this spectrum position for airports is that AeroNet's technology architecture is aligned with the spectrum bands for which authorization is being sought. Airports that deploy AeroNet now are deploying on the same frequency infrastructure that will be formally authorized as the regulatory process concludes — not on a proprietary band that may require re-engineering.

2.5 Why Alternative Technologies Are Insufficient

ASX's FCC filing directly addresses the alternatives to C-V2X for tactical deconfliction, and the analysis applies with equal force to the airport operating environment. Airport operators evaluating technology options should understand why the alternatives are inadequate:

Alternative Technology	Why It Falls Short for Airport V2X/A2X
Radar systems	Heavy, costly, and poorly suited to detecting and responding to the diverse speeds, trajectories, and altitudes associated with UAV operations in complex, congested environments. Existing airport

	Surface Movement Radar (ASDE-X) is reaching end of lifespan and has coverage gaps; adding UAS-specific radar for every aircraft class would require infrastructure investment that exceeds the C-V2X approach by orders of magnitude.
Optical solutions (video, LiDAR)	Expensive, weight-constrained, and unproven in dense airspace and adverse weather conditions. Airport environments include fog, rain, snow, glare, and nighttime operations that degrade optical detection reliability. A safety system that performs less reliably in adverse conditions is architecturally inverted — safety margins are needed most when conditions are worst.
ADS-B	While useful for current deconfliction needs, ADS-B lacks security safeguards and is not scalable to accommodate the anticipated growth of UAV operations and overall aviation activity in the low-altitude airspace. ADS-B is a broadcast-only, unauthenticated protocol — position data can be spoofed, and there is no mechanism for cooperative intent negotiation or resolution advisory exchange. It also carries no data for the UAS fleet, which is not required to equip.
Cellular-only UTM (no V2V)	UTM frameworks that rely exclusively on cellular C2 links for tactical deconfliction fail in exactly the scenarios where deconfliction is most critical: high aircraft density, network congestion, and C2 link degradation. As ASX noted in its FCC filing, tactical deconfliction via V2V is an essential complement to UTM services, not a substitute — and is specifically necessary when C2 links are degraded, delayed, or unavailable.

3. V2X AND A2X IN AIRPORT OPERATIONS: WHAT THEY DELIVER

3. V2X and A2X in Airport Operations: What They Deliver

With the C-V2X technology foundation established, this section maps the operational capabilities that V2X and A2X communications deliver across the airport environment. These are not theoretical capabilities — they are the direct operational outputs of the C-V2X protocol operating in the configurations validated by ASX's MDOT-Aero research and field deployments.

3.1 V2X: The Connected Ground Environment

Vehicle-to-Everything in the airport context means continuous, low-latency exchange of position, speed, heading, identity, and intent data between every equipped vehicle in the movement area and every infrastructure node and system that needs to know their location. Aircraft taxiing, ground service vehicles, fuel trucks, tugs, catering vehicles, maintenance equipment, airport operations vehicles, and emergency response apparatus — all broadcasting their real-time state into a shared surface awareness layer at 10 Hz update rates.

The operational significance of V2X is what it replaces: the current system relies on controller visual observation, pilot position reporting, and aging transponder-based radar returns. V2X provides independent, cryptographically authenticated, continuous position data for every equipped participant — including vehicles that carry no transponder, that operate in radar shadow zones, and that may be invisible to a controller managing multiple responsibilities simultaneously. Importantly, as ASX's FCC filing emphasizes, V2V communications enable direct vehicle-to-vehicle exchange without reliance on centralized network connectivity — the safety layer operates even when the network is unavailable.

3.2 A2X: The Connected Air Environment

Aircraft-to-Everything extends the same C-V2X connectivity to the airborne environment. Every equipped aircraft broadcasts position, altitude, velocity, heading, and operational intent — simultaneously, to all other aircraft in range, to AeroNet ground stations, to ATC displays, and to the network's conflict prediction engine. Unlike ADS-B, which is a one-way broadcast without security credentials or cooperative resolution capability, A2X supports two-way, authenticated, cooperative communication: aircraft exchange intent data, receive conflict advisories, and confirm resolution maneuvers through a direct C-V2X datalink rather than voice-mediated ATC relay.

Capability	C-V2X Delivers (V2X Surface)	C-V2X Delivers (A2X Airborne)
Continuous position tracking	Every surface vehicle and ground-phase aircraft at 10 Hz;	Every airborne aircraft from pushback to landing; independent of aging radar

	independent of radar and visibility; authenticated identity per 3GPP certificate	infrastructure; military and UAS where C-V2X equipped
Conflict prediction	Surface movement conflict alerts 15-30 sec before hold-short crossing; crossing conflict at taxiway intersections	Airborne conflict detection at 60-90 second pre-tactical horizon; advisory generation at 15-20 second tactical horizon
Identity authentication	Cryptographic certificate per 3GPP SCMS; unauthorized vehicle alerts; decommissioned vehicle detection	Aircraft identity correlated with flight plan and ATC clearance; unauthorized airspace entry flagged; Remote ID correlation
Cooperative resolution	Crossing conflict advisory transmitted directly to vehicle C2 link via C-V2X; no controller relay required	Avoidance advisory via direct A2A C-V2X datalink; both aircraft receive coordinated advisories simultaneously; no altitude floor
Off-network resilience	V2V continues between vehicles even if cellular backhaul fails; no single point of failure for safety layer	Direct aircraft-to-aircraft C-V2X exchange continues in cellular outage; safety independent of network availability
ATC workload contribution	Automated alerts replace manual controller detection for surface conflicts; pre-filtered conflict picture	Pre-filtered conflict display reduces monitoring burden; controller sees what requires attention, not raw surveillance data

4. THE AERONET COMMON OPERATING PICTURE FOR AIRPORTS

4. The AeroNet Common Operating Picture (COP) for Airports

The AeroNet Common Operating Picture is the unified, real-time operational display that aggregates V2X and A2X data streams into a single, actionable situational awareness product available to every authorized stakeholder in the airport environment: ATC facility displays, airport operations centers, security operations centers, ground handling coordinators, airline operations control, and emergency response command.

The COP is not a second radar display or a supplementary map layer. It is the integrated data fusion product that no single existing system produces: a picture that shows every aircraft on the surface and in the terminal area, every ground vehicle on movement areas, every active runway occupancy, every pending crossing clearance, every approaching flight's position and ETA, every conflict predicted within the next 90 seconds, and every unidentified participant that lacks a correlated authorization. Simultaneously. On one display. Updated ten times per second.

Surface layer	Terminal area layer	Security layer
• All aircraft on movement areas • All ground vehicles with V2X • Active runway occupancy status • Cleared vs. actual position audit • Hot spot proximity alerts	• All inbound aircraft with ETA • Departure sequence queue • Missed approach paths active • Holding pattern management • Weather impact on corridors	• All airspace participants identified • Unmatched Remote ID flags • Restricted area proximity alerts • Priority and emergency operations • Incident forensic archive

The COP is multi-stakeholder by design: different users see different views calibrated to their operational role, but all views are derived from the same underlying fused data product. The tower cab's display shows surface conflicts and runway occupancy optimized for controller use. The airport operations center display shows the full surface picture plus airside security status. The airline ops center display shows gate assignments, pushback queues, and departure flow. Emergency management sees priority routing and hazard zones. All from one network-delivered data source — no proprietary integration required between stakeholders.

WORKLOAD DESIGN PRINCIPLE	*AeroNet's COP is built on the premise that controllers and operations staff are at maximum sustainable workload. The system is designed to reduce the cognitive burden of maintaining situational awareness — not add another display to manage. Conflict alerts are pre-filtered, prioritized, and actionable. Routine traffic is shown, not narrated. Exceptions are surfaced automatically. The goal is a controller who sees exactly what demands attention, and nothing that doesn't.*

4. SAFETY: RUNWAY INCURSION PREVENTION VIA V2X

5. Safety: Runway Incursion Prevention via V2X

Runway incursion prevention is the highest-priority safety function in AeroNet's airport V2X architecture. The current system relies on multiple protective barriers — controller visual observation, ASDE-X radar, pilot awareness, and stop bar lighting — each of which has documented failure modes. AeroNet's V2X layer provides an independent protective barrier that operates regardless of radar coverage, lighting conditions, controller workload, and pilot compliance — because it is based on continuous cooperative position broadcast from the vehicles themselves.

4.1 Hold-Short Conflict Detection

AeroNet's V2X surface management module continuously models the position and trajectory of every equipped aircraft and ground vehicle against the active clearance database. When a vehicle is approaching a hold-short line for an active runway, AeroNet:

- Detects the approaching trajectory at sufficient range to generate an alert before the vehicle reaches the hold-short point — typically 15 to 30 seconds of warning at normal taxi speeds;
- Transmits a direct V2X safety message to the approaching aircraft's cockpit or vehicle C2 link — a notification that does not depend on the controller seeing the conflict and transmitting a voice warning on the correct frequency;
- Generates a visual and aural alert on the ATC workstation display, color-coded by proximity and time-to-conflict severity;
- Notifies any aircraft on approach or departure that a potential runway incursion is developing, enabling the crew to begin a go-around or abort sequence before the incursion is confirmed.

This multi-channel alert architecture is the critical difference between AeroNet's surface management capability and existing SAI deployments. SAI, as the NBAA noted in its 2025 review, does not include conflict-alerting capability at most of its initial deployment locations — it provides display information to controllers but does not generate automated conflict warnings. AeroNet generates the warning independently, simultaneously, to all relevant parties, without requiring a controller to detect the developing conflict first.

5.2 Ground Vehicle Management: The LaGuardia Gap

The March 22, 2026 LaGuardia collision is the definitive case study for why ground vehicle tracking is the most critical unresolved gap in airport surface safety. The fire truck that crossed Runway 4 in front of the landing CRJ-900 was not equipped with a VMAT — the Vehicle Movement Area Transponder that would have provided ASDE-X with a precise, identified track. Without it, the group of emergency vehicles responding to the United incident was visible to

ASDE-X only as indistinct radar returns. As NTSB Chair Homendy stated: neither target was shown moving onto the runway. No conflict alert was generated. No warning reached the crew.

There are no FAA regulations requiring ground vehicles at U.S. airports to carry transponders or ADS-B transmitters. Equipping is entirely voluntary. The LaGuardia fire truck's absence of a VMAT was not a violation — it was the norm. AeroNet's V2X ground vehicle integration changes that norm by design: every V2X-equipped vehicle broadcasts its precise position, identity, and velocity continuously, independent of whether it carries a transponder. The V2X transmitter is lightweight, low-cost, and does not require aircraft-grade certification — it is the same automotive-validated C-V2X hardware that equips millions of road vehicles. At airports, it provides:

- Precise, identified position tracking of every equipped vehicle on the movement area — not a radar blob, but a named vehicle with a heading, speed, and trajectory;
- Crossing conflict detection that generates an alert when any vehicle's trajectory will intersect an active runway — regardless of whether the vehicle has an aircraft transponder, regardless of ASDE-X radar confidence, and regardless of the number of nearby vehicles that may cause tracking ambiguity;
- A direct V2X safety message to the vehicle's cab C2 link — the driver receives an alert independent of the controller, independent of voice communication on the correct frequency, and independent of whether the controller's attention is divided between the vehicle and another developing situation;
- Simultaneous notification to the landing aircraft, the controller, and the operations center — a three-channel alert architecture that provides the reaction time the LaGuardia crew never had.

Incursion Scenario	AeroNet V2X Response
ARFF vehicle cleared to cross runway while aircraft on short final (LaGuardia, March 22 2026)	V2X transmitter on fire truck tracked from fire station to runway. Conflict with landing CRJ detected before truck reaches hold-short. Alert to truck cab, controller display, and landing crew simultaneously — multiple seconds before impact point. Alert generated regardless of ASDE-X radar confidence level.
Aircraft taxis past hold-short line during low visibility	V2X cockpit alert generated when aircraft approaches hold-short; simultaneous controller display alert; approach aircraft notified; reaction time 15-30 seconds before line crossing
Multiple emergency vehicles converging near runway — ASDE-X loses track confidence	V2X transmitter on each vehicle maintains individual identity and position broadcast independently of radar. No track merging or confidence degradation. Each vehicle tracked discretely regardless of proximity to others.
Controller misses crossing conflict due to split workload	AeroNet alert operates independently of controller attention; conflict notification reaches crew and operations center simultaneously without voice relay dependency
Low visibility / night operations reduce visual detection	V2X position tracking is sensor-independent; no degradation in alert capability in IMC, fog, darkness, or snow obscuration
Wrong runway lineup on departure	Aircraft position tracked from lineup through roll; AeroNet detects departure roll on other-than-cleared runway; alert generated within seconds; simultaneous notification to crew and controller

5.3 The C-V2X Ground Vehicle Advantage: Capability and Cost Comparison

The LaGuardia collision crystallized a comparison that airport technology planners should make explicit: the existing surface surveillance ecosystem — ASDE-X, VMAT transponders, and the Surface Awareness Initiative — was designed to track aircraft and transponder-equipped vehicles using radar and ADS-B infrastructure. AeroNet's C-V2X ground vehicle layer is designed from the ground up for every vehicle, with capabilities the existing ecosystem fundamentally cannot provide, at a fraction of the infrastructure cost. The comparison is not close.

SURFACE SURVEILLANCE COST COMPARISON

Cost Element	ASDE-X (radar-based)	VMAT / ADS-B (transponder)	AeroNet C-V2X (ground vehicle)
Infrastructure installation per airport	$15–28M per site (35 airports: $550M total program)	$0 new radar (integrates into existing ASDE-X/SAI)	**Low-cost AGS nodes (fraction of radar install)**
Per-vehicle hardware cost	N/A — tracks transponder equipped vehicles via radar	~$1,000–$3,000 per VMAT unit (ADS-B UAT)	**Automotive-grade C-V2X transmitter; commercial COTS pricing**
Vehicle coverage	Radar-equipped aircraft and transponder-equipped vehicles only	Only VMAT-equipped vehicles (voluntary; no mandate)	**Every C-V2X-equipped vehicle regardless of transponder status**
In-cab driver alert	None — alert to ATC display only	None — broadcast only; no in-cab alert capability	**Audible and visual in-cab alert direct to vehicle operator**
Two-way digital messaging	None	None — one-way broadcast only	**Full bidirectional digital messaging to vehicle cab**
Brake controller integration	None — cannot interface with vehicle systems	None — ADS-B is a broadcast protocol only	**CAN bus integration enables automatic braking at hold-short**
Non-transponder vehicle tracking	Primary radar only; subject to blob/confidence issues (LGA)	No — requires transponder on vehicle	**Yes — C-V2X transmitter is independent of transponder**
Off-network resilience	Requires ground infrastructure; outages documented at DFW, ORD, LAX	Requires ASDE-X/SAI infrastructure to be operational	**Direct V2V; operates when cellular/network unavailable**
Ongoing maintenance	Specialized radar maintenance; 160+ days offline at LAX 2016–2018	Minimal; 5-year useful life per FAA AIP	**Commercial-grade; automotive scale supply chain**
Airport coverage (US)	43 of 450+ commercial service airports	Eligible at ASDE-X/ASSC/SAI airports only; voluntary	**Deployable at any airport; no radar infrastructure required**

In-Vehicle Audible and Visual Alerts: Closing the Last-Meter Gap

Every existing ground vehicle safety system — VMAT transponders, ASDE-X radar, SAI displays — is designed to alert air traffic controllers and pilots. None of them alert the vehicle operator. The person driving the fire truck that crossed Runway 4 at LaGuardia received no automated warning. There was no alert in the cab. No light. No tone. No message. Only an ATC radio call on a frequency the driver may or may not have been monitoring with full attention, in the seconds before impact.

AeroNet's C-V2X ground vehicle integration includes direct in-cab alerting as a core capability — not an add-on, not a separate system. Using the same C-V2X sidelink communications channel that broadcasts vehicle position to the network, the AeroNet vehicle module delivers:

- **Audible alert:** A distinct, high-priority audio tone in the vehicle cab, generated the moment the vehicle's trajectory is predicted to intersect an active runway hold-short boundary — calibrated to cut through ambient vehicle noise at sufficient volume to command immediate driver attention, timed to provide stopping distance at normal operating speed.
- **Visual alert:** A visible warning on the vehicle's cab-mounted C-V2X display — color-coded by urgency (amber for approaching hold-short, red for imminent crossing conflict) — displaying the conflicting aircraft's position, altitude, speed, and estimated seconds to the conflict point. The driver sees not just that there is a conflict, but what the conflict is and how much time remains.
- **Two-way digital messaging:** Unlike ADS-B, which is a one-way broadcast protocol, C-V2X supports full bidirectional digital messaging. The AeroNet network can transmit a direct safety message to the vehicle cab: a hold-short instruction, a runway clearance status update, a priority aircraft notification, or an emergency evacuation directive — all delivered as authenticated digital messages to the driver's display without requiring voice radio contact. The driver can acknowledge receipt digitally, creating a confirmed communication record that voice radio cannot provide.

Brake Controller Integration: The Last Line of Defense

The most consequential capability that distinguishes AeroNet's C-V2X ground vehicle architecture from every existing airport surface safety system is brake controller integration — the ability to connect the C-V2X conflict detection logic directly to the vehicle's braking system via the Controller Area Network (CAN) bus, enabling automatic intervention to prevent unintended acceleration across a hold-short boundary.

C-V2X brake integration is not a theoretical concept — it is a validated automotive safety architecture. As demonstrated in peer-reviewed research published in 2025, V2X communication provides early warning of non-line-of-sight hazards at intersections and can trigger an automated braking system before the driver's own sensors or reaction time would permit intervention. The V2X-triggered brake operates as a two-stage system: an initial deceleration warning stage that primes the braking system for intervention, followed by automatic emergency braking if the driver does not respond. Applied to the airport runway hold-short scenario, this architecture creates a safety barrier that operates even in the failure case where the driver does not respond to the audible and visual alerts.

In the LaGuardia scenario: the fire truck driver had just been dispatched to a declared emergency aboard the United 737 MAX — a high-stress, high-urgency situation in which attention was directed forward toward the aircraft being responded to, not toward the runway hold-short line of the runway being crossed. Under those conditions, human response to an in-cab alert is less reliable than normal. AeroNet's brake integration provides the backstop: if the vehicle reaches the hold-short boundary without decelerating, the braking system intervenes automatically, stopping the vehicle before it enters the protected area.

THE ARCHITECTURAL DISTINCTION	*ASDE-X, VMAT, and SAI all share a fundamental architecture: they detect the vehicle's position and alert someone else — ATC, pilots, the operations center. None of them talk to the vehicle itself. None of them can stop the vehicle. AeroNet's C-V2X integration is the first airport ground vehicle safety architecture that closes the loop: detect the conflict → alert the driver → if the driver doesn't respond, stop the vehicle. This is the difference between a warning system and a prevention system.*

C-V2X Ground Vehicle Capability vs. Existing Standards: Summary

Capability	ASDE-X + VMAT (Current Standard)	AeroNet C-V2X (AeroNet UTM)
Controller display alert	Yes — primary output of ASDE-X	Yes — COP alert to controller workstation
Pilot cockpit alert	Partial — ADS-B In equipped aircraft only	Yes — direct A2A alert to all AeroNet-equipped aircraft
In-cab audible driver alert	No	Yes — direct C-V2X alert to vehicle cab
In-cab visual driver alert	No	Yes — color-coded display with conflict details
Two-way digital messaging to vehicle	No	Yes — bidirectional C-V2X; acknowledgment logging
Brake controller integration	No — cannot interface with vehicle systems	Yes — CAN bus integration; automatic hold-short braking
Non-transponder vehicle tracking	Limited — radar blob only (LaGuardia failure mode)	Yes — C-V2X independent of transponder
Off-network fallback	No — infrastructure dependent	Yes — direct V2V in network outage
Infrastructure cost per airport	$15–28M for ASDE-X; additional VMAT per vehicle	Fraction of radar cost; no tower-mounted radar required
Deployable at non-ASDE-X airports	No — requires ASDE-X or SAI infrastructure	Yes — C-V2X operates at any airport

COST AND SAFETY CASE	*AeroNet's C-V2X ground vehicle architecture delivers capabilities that the $550 million ASDE-X program — deployed at 43 airports over two decades — does not: in-cab alerts to vehicle operators, two-way digital messaging, brake controller integration, and non-transponder-dependent tracking. It does so using automotive-scale commercial hardware at costs that make deployment viable at all 450+ commercial service airports, not just the 43 largest. The LaGuardia collision did not occur because airport safety technology failed to detect a threat. It occurred because the detection architecture was never designed to communicate that threat to the person who could have stopped it.*

5. SAFETY: AIRBORNE CONFLICT DETECTION AND A2X INTEGRATION

6. Safety: Airborne Conflict Detection and A2X Integration

AeroNet's A2X architecture extends conflict detection and resolution advisory capability beyond the airport surface into the terminal area — the airspace within approximately 30 to 50 miles of the airport where approach, departure, missed approach, and holding operations produce the highest density of aircraft in close proximity with the least margin for error.

5.1 TCAS Augmentation in the Low-Altitude Gap

As established in the context of the January 2025 Reagan collision, the TCAS Resolution Advisory system is architecturally disabled below approximately 1,000 feet above ground level. This altitude floor is precisely the environment of the most dangerous close proximity events near airports: final approach, initial climb, missed approach, and go-around scenarios. AeroNet's A2X conflict detection operates with no altitude floor restriction — the same cooperative conflict prediction and advisory generation capability that functions at cruise altitude operates identically at 300 feet on final approach.

For airports in the AeroNet network, every aircraft in the terminal area that is equipped with the AeroNet Avionics Module (AAM) broadcasts its position, altitude, velocity vector, and intent state at 10 Hz directly to all other equipped aircraft and to the AeroNet ground station network. Conflicts are detected at the 60-90 second pre-tactical horizon, advisories are delivered at the 15-20 second tactical horizon, and the full three-dimensional cooperative avoidance advisory is transmitted at sub-200 millisecond latency — directly between aircraft, without waiting for voice relay from ATC.

5.2 Missed Approach and Go-Around Conflict Management

One of the most complex and poorly managed conflict scenarios in the terminal area is the simultaneous missed approach or go-around, where a landing aircraft executes a climb-out on the approach course while a departing aircraft is climbing on the same or adjacent course. ATC voice coordination is required, but at high-workload moments — precisely when go-arounds tend to occur — the coordination delay creates exposure. AeroNet's A2X architecture detects the developing conflict from both aircraft's intent broadcasts the moment the go-around is initiated, generates pre-tactical advisories to both crews, and notifies the relevant ATC position simultaneously — compressing the coordination timeline from voice-dependent to near-instantaneous.

5.3 Wake Turbulence and Separation Management

AeroNet's A2X network provides the data infrastructure for enhanced wake turbulence separation management. By tracking the precise position and departure timing of every aircraft with high-resolution accuracy, AeroNet can compute and display the actual wake turbulence corridor generated by each departure and arrival — a capability that moves separation management from conservative category-based fixed intervals toward performance-based dynamic separation that increases throughput without compromising safety margins. This is consistent with the ICAO Re-categorization (RECAT) wake turbulence separation standards that the FAA has been implementing progressively since 2015.

OPERATIONAL IMPACT	*A 2026 analysis of runway throughput at high-density U.S. hub airports found that dynamic wake turbulence separation management based on real-time position tracking — as A2X enables — can increase effective runway throughput by 8-12% at airports where wake separation is the binding constraint. At an airport conducting 800 daily operations, a 10% throughput improvement represents 80 additional departure slots per day — a capacity increase that requires no physical infrastructure investment.*

6. SECURITY: AUTHENTICATED AIRSPACE AND SURFACE ACCESS

7. Security: Authenticated Airspace and Surface Access

Airport security in the traditional sense focuses on the passenger terminal perimeter: access control, screening, baggage handling. The airside security challenge is fundamentally different and increasingly acute: how do you know that every vehicle on your movement area is authorized to be there, every aircraft in your approach corridor has a validated identity, and every UAS in your airspace either has permission or is being tracked? The current answer — a combination of badged vehicle access, controller-issued clearances, and ADS-B transponder correlation — has well-documented gaps that AeroNet's V2X and A2X authentication layer is designed to close.

6.1 Airside Vehicle Authentication

AeroNet's V2X implementation includes cryptographically authenticated identity for every vehicle on the network. Each V2X-equipped vehicle carries a unique AeroNet identity credential — analogous to a digital certificate — that is verified against the airport's authorized vehicle database every time the vehicle broadcasts its position. Any vehicle broadcasting a position on the movement area without a valid, current credential generates an immediate alert to airport security and operations.

This capability addresses a gap that physical badging systems cannot close: a vehicle that has been physically removed from authorized service (decommissioned, sold, or reported missing) but whose key or access credential has not been deactivated continues to pass physical access checks. AeroNet's continuous credential verification catches the anomaly in real time, the moment the unauthorized vehicle enters the movement area, regardless of what access card it carried through the gate.

6.2 Aircraft Identity Correlation

Every aircraft in AeroNet's A2X coverage has its transmitted identity — ADS-B squawk code, Remote ID, AeroNet broadcast identity — correlated against its filed flight plan, its ATC clearance, and its authorized route. Discrepancies generate flags: an aircraft squawking a code that does not match its filed plan, an aircraft on a route that was not cleared, or an aircraft operating in airspace for which it has not received authorization. These correlation failures are surfaced to the tower and to security operations automatically, without requiring a controller to manually detect the discrepancy.

6.3 UAS Identity and Geofence Enforcement

The growing volume of commercial UAS operations in and around airport environments creates an identity challenge that existing systems do not address: Remote ID broadcasts identify who is operating a drone, but only if the operator registered and equipped correctly, and only if someone is actively monitoring the Remote ID display. AeroNet ingests all Remote ID signals across its coverage area continuously, correlates them against its authorization database, and generates alerts for:

- Remote ID signals with no corresponding filed LAANC authorization or AeroNet flight plan;
- Operations in the airport's defined security buffer zones without explicit facility authorization;
- Absence of any Remote ID signal from a track detected by other sensors — indicating a potentially unregistered or non-compliant platform.

SECURITY NOTE	*AeroNet's authentication architecture is designed to identify what is authorized and flag what is not — but does not include active counter-UAS mitigation capability, which remains the legal domain of authorized federal agencies. AeroNet provides the precise identification, track history, and RF profile data that authorized interdiction agencies require to act within their legal authority. The detection and identification function; the mitigation decision and execution remain with the appropriate authority.*

7. EFFICIENCY: SURFACE MOVEMENT OPTIMIZATION

8. Efficiency: Surface Movement Optimization

Airport ground delay is the single largest source of avoidable fuel burn, carbon emissions, passenger delay, and airline operating cost in the aviation system. A 2026 industry analysis found that airports deploying integrated AI-powered analytics platforms with real-time surface data reported 33 percent reduction in ground equipment downtime and 28 percent improvement in on-time departure performance. These outcomes are downstream of a single prerequisite: accurate, high-frequency, network-delivered ground truth on the position and state of every vehicle on the movement area. That is what AeroNet's V2X surface layer provides.

7.1 Taxi Sequence and Conflict-Free Routing

AeroNet's surface management module provides controllers and airline operations staff with a continuously updated model of the taxi queue: every aircraft's position, its cleared route, its estimated taxi time to departure runway or arrival gate, and any conflicts predicted between its route and the routes of other aircraft. Pre-departure sequence optimization — using AeroNet's four-dimensional surface model to assign departure sequences that minimize taxi conflicts and maximize throughput — is available to both ATC and airline operations as a decision support tool, reducing controller workload for routine sequencing while maintaining human authority over all clearance decisions.

7.2 Gate and Stand Management

AeroNet's V2X integration with the airport's gate management systems provides a real-time picture of gate occupancy, aircraft pushback status, and incoming arrival ETA — enabling dynamic gate assignment optimization that reduces the frequency of gate conflicts, hot turns held for late gate availability, and pushback delays caused by conflicting taxi movements on adjacent stands. Airlines operating at AeroNet-integrated airports receive automated pushback clearance advisory based on the real-time surface model — a capability that the current voice-coordination system cannot provide at the speed and granularity required for high-frequency hub operations.

7.3 Ground Service Equipment Coordination

Ground service equipment — the fleet of vehicles that supports every aircraft turnaround — is the hidden throughput variable in airport efficiency. A fuel truck that is delayed because its route crosses an active pushback movement, a catering vehicle that cannot approach a gate because the jetway is still connected to a departing aircraft, a de-icing truck queued behind vehicles that have no visibility into the aircraft's actual turnaround state — each adds minutes to the turnaround cycle. AeroNet's V2X coordination layer gives ground service coordinators and GSE dispatchers a real-time surface picture that enables proactive routing, reducing the reactive conflict resolution that drives GSE delay.

Efficiency Metric	AeroNet V2X Contribution
Aircraft taxi time from gate to runway	Optimized conflict-free routing issued pre-pushback; real-time rerouting when surface conditions change; 3-5 minute average taxi time reduction at hub airports
Runway throughput at capacity airports	A2X-enabled dynamic wake separation; departure sequence optimization; simultaneous operations coordination; 8-12% throughput improvement versus static separation
Ground vehicle delay in movement areas	Continuous V2X tracking of all GSE; crossing conflict alerts prevent reactive holding; routing optimization around active aircraft movements
On-time departure performance	Integrated pushback sequencing, surface conflict-free routing, and departure queue management; 28% OTP improvement reported at fully integrated facilities
Fuel burn and emissions on surface	Reduced taxi time and eliminated unnecessary holding reduces fuel burn 4-7% per operation at optimized facilities; supports ICAO CORSIA and ESG reporting
ATC workload for surface management	Automated conflict detection and advisory generation reduces controller active monitoring burden; pre-filtered alerts surface only conflicts requiring intervention

8. EFFICIENCY: ARRIVAL AND DEPARTURE FLOW MANAGEMENT

9. Efficiency: Arrival and Departure Flow Management

Terminal area flow management — the sequencing, merging, and spacing of arriving and departing aircraft in the airspace surrounding the airport — determines the upper bound on runway throughput at capacity-constrained airports. AeroNet's A2X network provides the data foundation for a qualitative improvement in terminal area flow management that existing ATC infrastructure cannot achieve: a real-time, high-resolution, network-delivered trajectory picture of every aircraft in the terminal area, combined with a direct aircraft-to-aircraft datalink that enables ATC-issued speed and path instructions to be confirmed, acknowledged, and executed without voice relay latency.

8.1 Continuous Descent Operations (CDO)

Continuous Descent Operations — where arriving aircraft descend in a smooth, fuel-efficient profile rather than stepped level-off segments — require precise trajectory prediction and tight coordination between multiple aircraft in the arrival stream. AeroNet's A2X trajectory tracking provides the precise position and speed data that CDO management requires, and its pre-tactical conflict detection ensures that CDO clearances can be issued with confidence that the resulting trajectory will not produce a conflict with other traffic. CDO implementation at major hub airports is estimated to reduce fuel burn by 50 to 150 kilograms per arrival — a meaningful environmental and operating cost benefit at airports handling hundreds of daily arrivals.

8.2 Departure Queue Management and Miles-in-Trail

AeroNet's A2X network provides departure flow management capabilities that supplement EDCT (Expect Departure Clearance Time) programs with real-time gate and surface data. By integrating the departure queue model with the A2X terminal area picture, AeroNet can compute the optimal departure sequence that meets miles-in-trail requirements while minimizing taxi holding time — issuing advisory push times to airlines that align with actual runway availability rather than static estimated departure windows.

8.3 Weather Impact Management

Weather-driven flow constraints — convective activity on departure routes, low ceiling and visibility on approach, wind shift events that require runway changes — produce the most severe departure delays in the system. AeroNet's A2X integration with weather data services provides the airport operations center with predictive impact modeling: given the current weather picture and the next 60 minutes of forecast, which arriving aircraft will be affected, which departure slots will be unusable, and what is the optimal re-sequencing to minimize delay propagation. This moves weather impact management from reactive response to proactive planning.

9. AAM AND UAS INTEGRATION: MANAGING THE NEW ENTRANTS

10. AAM and UAS Integration: Managing the New Entrants

Every major U.S. airport is preparing for, or already managing, the arrival of new classes of airspace users that the ATC system was not designed to accommodate: commercial delivery drones, eVTOL air taxis, medical logistics UAS, and public safety platforms. These new entrants do not replace traditional aviation — they add to it, sharing the same terminal area airspace and, in many cases, the same surface movement areas. The question for airport operators is not whether to manage them, but with what tools.

9.1 UTM Integration for Airport Drone Operations

AeroNet serves as the UTM platform for commercial drone operations at and around airports — the system through which authorized operators file flight plans, receive LAANC-equivalent airspace authorizations, broadcast position data, and access deconfliction services. For airport operators, AeroNet's UTM integration provides:

- A complete picture of all authorized drone operations in the airport's vicinity — cargo delivery drones, inspection platforms, medical supply carriers, and public safety UAS — on the same COP display that shows crewed aircraft;
- Automated notification to the tower when a UAS operation is authorized in the airport's Class B, C, or D airspace shell — replacing the current system of phone calls and manual coordination;
- Geofence enforcement for facility-defined exclusion zones — drone operators attempting to file a flight plan that enters a restricted zone around the airport are automatically blocked at the authorization stage.

9.2 eVTOL and Advanced Air Mobility Infrastructure

Airports that are developing or hosting vertiport infrastructure — either on-airport pad locations or adjacent vertiport facilities — gain a direct AeroNet integration that connects their vertiport sequencing, pad availability broadcasts, and eVTOL arrival/departure procedures into the airport's existing AeroNet COP. An eVTOL on approach to an on-airport vertiport is visible on the tower COP in the same layer as the fixed-wing aircraft on final approach — enabling the controller to manage the two traffic streams with full situational awareness of both.

As FAA eIPP pilot projects begin operations through the summer of 2026 and commercial eVTOL operations begin scaling, the airports that have established AeroNet integration will be positioned to manage these operations without requiring dedicated ATC resources, new surveillance infrastructure, or separate coordination procedures for each eVTOL operator.

9.3 Autonomous Ground Equipment

Autonomous ground vehicles — self-driving baggage tractors, robotic fueling systems, autonomous pushback tugs — are entering airport operations as cost-reduction and labor-constraint solutions. A 2026 industry report noted that airports with self-driving baggage tractors and autonomous pushback vehicles report 35 to 50 percent fewer unplanned stoppages. These vehicles require V2X connectivity to integrate safely into the surface management layer: their autonomous navigation systems need awareness of the positions and clearances of crewed aircraft and other vehicles, and the surface management system needs awareness of their position and routing.

AeroNet's V2X layer supports both directions of this data exchange — providing the autonomous vehicle with real-time awareness of the complete surface picture, and providing the surface management COP with real-time tracking of every autonomous vehicle on the movement area.

10. THE SPECTRUM FOUNDATION: ASX FCC COMMENTS ON DRONE DOMINANCE

10. The Spectrum Foundation: ASX/AeroNet FCC Comments on UAS V2V Communications

The operational capabilities described throughout this white paper — V2X surface management, A2X conflict detection, cooperative avoidance advisories, authenticated airspace access — all depend on one foundational prerequisite: the right communications spectrum, standardized and available to every vehicle in the network. On May 1, 2026, Airspace Experience Technologies, Inc. (ASX), the company behind AeroNet UTM, filed formal comments with the Federal Communications Commission in the matter of Unleashing American Drone Dominance (GN Docket No. 26-74), making the definitive regulatory case for C-V2X spectrum authorization for UAS. Those comments directly inform and technically anchor every capability claim in this white paper.

REGULATORY FILING

Before the Federal Communications Commission

In the Matter of Unleashing American Drone Dominance

GN Docket No. 26-74 | WT Docket No. 22-323 | WT Docket No. 24-629

Comments filed May 1, 2026 by Airspace Experience Technologies, Inc. (ASX)

Jon Rimanelli, Founder and CEO | www.AeroNetUTM.com | 11499 Conner St., Hangar 7, Detroit, MI 48213

10.1 The Core Spectrum Argument

ASX's filing to the FCC makes three interconnected arguments that establish the communications architecture underlying AeroNet's entire airport safety and efficiency platform. Understanding these arguments explains why AeroNet's V2X and A2X capabilities are technically superior to the alternatives, and why the FCC's spectrum decision will be determinative for the scalability of everything described in this paper.

Argument 1: C-V2X in the 5.9 GHz Band is the Correct Foundation

ASX's filing argues that short-range wireless communications — specifically C-V2X operating in the existing 5.9 GHz C-V2X band — should be authorized and encouraged for immediate UAS deployment. This is not a theoretical recommendation: C-V2X has been extensively validated for roadway and intersection safety. In 2024, ASX and WSP Global conducted research for the Michigan Department of Transportation – Office of Aeronautics (MDOT-Aero) evaluating C-V2X and DSRC for UAS mesh communications, with favorable results supporting BVLOS operations.

The airport context is precisely the use case the filing highlights: smooth coordination between crewed and uncrewed air and ground vehicles is essential to avoiding conflicts — and C-V2X is the proven standard that makes that coordination technically achievable at scale.

The filing specifically requests that the FCC authorize UAS use of the existing 5.9 GHz C-V2X band while supporting dedicated spectrum in the 5030–5091 MHz band as a contingency for RF congestion. Using the same band for both air and ground vehicles is not an incidental convenience — it is the architectural choice that enables native interoperability without requiring every vehicle to carry dual radios. A drone directing a ground vehicle to a delivery rendezvous point, an autonomous pushback tug receiving position data from a taxiing aircraft, an airport operations vehicle being alerted to an active runway by an approaching aircraft — all of these V2X interactions become technically seamless when both participants operate in the same spectrum.

Argument 2: Tactical Deconfliction via V2V is Indispensable — UTM Alone is Not Enough

The filing makes an argument of direct relevance to every airport operator evaluating UTM and V2X investments: UTM strategic deconfliction and conformance monitoring, while necessary, are insufficient for scaled BVLOS operations. Tactical deconfliction — V2V direct aircraft-to-aircraft communication — is an essential complement, particularly in high-density environments and when C2 links are degraded, delayed, or unavailable.

This distinction maps precisely to AeroNet's three-layer conflict management architecture described in Section 7 of this white paper. Strategic deconfliction (the UTM layer) handles pre-flight planning. Pre-tactical deconfliction (the network management layer) handles developing conflicts. But tactical deconfliction — the V2V direct message that one aircraft sends to another in under 200 milliseconds when a conflict is imminent — is the layer that closes the gap when every other system has not resolved the conflict in time. The filing states this explicitly: without an active C2 link, aircraft risk losing situational awareness unless they can directly exchange position and intent information. V2V is the safety net under the safety net.

AIRPORT IMPLICATION	*For airports specifically, the C2 link degradation scenario is not theoretical. RF congestion in the terminal environment, interference from ground equipment, multipath effects in urban canyon environments around airports, and the sheer density of simultaneous transmissions during peak operations all create conditions where C2 reliability is reduced. AeroNet's V2V direct link provides safety-critical avoidance capability that operates regardless of network availability — meaning the airport's safety infrastructure does not have a single point of failure in the communications layer.*

Argument 3: Alternative Technologies are Inadequate at Scale

The ASX filing systematically evaluates the alternative approaches to tactical deconfliction that exist in the current market and explains why none of them scales to the operational density that commercial UAS integration at airports requires:

- **Radar:** Heavy, costly, and poorly suited to detecting and responding to the diverse speeds, trajectories, and altitudes associated with UAV operations in complex, congested environments. Primary radar remains essential for large aircraft surveillance, but it is not a viable tactical deconfliction tool for the mixed-fleet, high-density UAS environment that airports are now managing.
- **Optical / LiDAR:** Expensive, weight-constrained for small UAS, and unproven in dense airspace and adverse weather conditions. The sensor-fusion architecture that makes autonomous ground vehicles viable in controlled environments does not translate reliably to the three-dimensional, weather-exposed, high-speed closure-rate environment of terminal area airspace.
- **ADS-B:** Useful for current deconfliction needs but lacks security safeguards and is not scalable to accommodate the anticipated growth of UAV operations in low-altitude airspace. ADS-B is a broadcast-only, unauthenticated protocol — it tells you where aircraft are, but it cannot verify that the position report is genuine, and it does not support the cooperative two-way exchange that Cooperative Avoidance Advisory generation requires. AeroNet ingests ADS-B as one data layer precisely because it is the currently deployed standard, while operating the V2V/C-V2X layer as the cooperative safety-critical communications channel.

10.2 Why the FCC Decision Matters for Airport Operators

The FCC's ruling in GN Docket 26-74 will establish the spectrum framework within which V2X and A2X aviation communications operate for the next decade. For airport operators evaluating AeroNet integration, this regulatory proceeding has three direct consequences:

- **Technology certainty:** Authorization of C-V2X in the 5.9 GHz band for UAS confirms the communications standard on which AeroNet's V2V architecture is built. Airports that have deployed or are planning AeroNet ground station infrastructure are investing in a platform whose communications layer is aligned with the FCC's own proceeding — not a proprietary band with uncertain regulatory status.
- **Interoperability protection:** The filing's argument for a shared air-ground band directly protects the interoperability that makes airport V2X deployments valuable. An airport that equips its ground vehicle fleet with C-V2X transmitters gains V2X interoperability with every C-V2X-capable aircraft in its airspace — without any additional integration work — if the FCC authorizes the shared band. A fragmented spectrum decision that separates air and ground vehicle bands would require dual-radio solutions that increase cost and reduce adoption, directly reducing the safety coverage of the network.
- **Regulatory positioning:** Airports that are operating C-V2X-based V2X infrastructure when the FCC rules will be demonstrably ahead of the regulatory curve. ASX's filing positions AeroNet UTM as the platform that demonstrates the value of effective, well-managed C-V2X communications in the aviation environment. Airport partners in the AeroNet network are, by extension, participants in that demonstration — contributing operational data that supports the regulatory case.

10.3 Certificate-Based Security: The Authentication Architecture

The ASX FCC filing specifically highlights the security architecture underlying C-V2X communications: robust security is ensured through certificate-based authentication mechanisms already deployed at scale within the transportation industry. This is not an aspirational claim — the Security Credential Management System (SCMS) that governs automotive C-V2X deployments has been operating at scale across the U.S. transportation system for years, processing hundreds of millions of vehicle-to-infrastructure and vehicle-to-vehicle messages daily.

For airports, this certificate-based authentication is the technical foundation of the airside security capabilities described in Section 6 of this white paper. Every V2X-equipped vehicle's position broadcast carries a cryptographically signed identity credential. The authentication is not performed by a human checking a badge — it is performed by the network, automatically, on every message, at 10 Hz. The security properties of the system are inherited from a battle-tested automotive PKI infrastructure that processes more transactions in a day than any airport will generate in years.

REGULATORY REFERENCE	*ASX's FCC filing (GN Docket 26-74, filed May 1, 2026) is available in the public record at the FCC's Electronic Comment Filing System. Airport operators, aviation authorities, and policy stakeholders are encouraged to review the filing in full and to consider submitting reply comments supporting the authorization of C-V2X in the 5.9 GHz band for UAS applications. The proceeding record will inform a spectrum decision that shapes aviation communications infrastructure for the next generation of airspace operations.*

11. AERONET, THE FCC PROCEEDING, AND THE FAA MODERNIZATION AGENDA

11. AeroNet, the FCC Proceeding, and the FAA Modernization Agenda

The $12.5 billion authorized in the One Big Beautiful Bill for ATC modernization, combined with the FAA's stated goal of completing a Brand New Air Traffic Control System within three years under Peraton's prime integrator contract, defines the most consequential transformation of the U.S. airspace management infrastructure since the creation of the FAA in 1958. For airport operators, this creates both an opportunity and a strategic choice.

The opportunity is that the new system will be built around modern digital communications, fiber and satellite telecommunications, next-generation radar, and cloud-based automation — infrastructure that is fundamentally more compatible with V2X and A2X data integration than the legacy copper-and-analog system it replaces. The strategic choice is whether to wait for the new system's capabilities to be built and deployed — a timeline measured in years — or to establish AeroNet's V2X and A2X infrastructure now, closing safety gaps that exist today while the new system is under construction.

11.1 How AeroNet Complements the BNATCS Program

AeroNet is designed to be compatible and complementary with the Brand New Air Traffic Control System program, not competitive with it. Specifically:

- **SWIM integration:** AeroNet's A2X platform integrates with the FAA's System Wide Information Management (SWIM) data exchange, which is a cornerstone of the modernization program. AeroNet consumes SWIM data feeds — flight plans, NOTAM data, weather products, traffic flow management advisories — and publishes AeroNet sensor data back to SWIM for consumption by ATC automation systems.

- **Surface movement data contribution:** AeroNet's V2X surface data — the comprehensive ground truth of every vehicle position on the movement area — is a direct input to the Enterprise Information Display Systems (EIDS) program funded at $300 million in the BNATCS authorization. EIDS is designed to replace paper-based methods with a digital solution that centralizes information across FAA facilities; AeroNet's surface data provides the real-time inputs that make EIDS displays actionable rather than static.

- **Controller workload bridging:** The FAA's 3,500-controller staffing shortfall will not be resolved in the near term. AeroNet's automated conflict detection and advisory generation is a workload relief tool that is deployable today — providing the controller with a pre-filtered, pre-prioritized conflict picture that reduces the cognitive burden of maintaining surface and terminal area situational awareness under conditions of resource constraint.

MODERNIZATION ALIGNMENT	*FAA Administrator Bryan Bedford described the ATC modernization program's three-year timeline as compressing a 15-year radar modernization roadmap. AeroNet UTM provides airports with capabilities today — V2X surface management, A2X conflict detection, and cooperative avoidance — that the BNATCS program will eventually integrate as core system features. Airports that are already operating with these capabilities will be the reference implementations, not the late adopters, when those features are standardized.*

12. CAPABILITY SUMMARY AND PARTNERSHIP PATHWAYS

12. Capability Summary and Partnership Pathways

The following table maps each airport operational challenge identified in this white paper to the specific AeroNet V2X or A2X capability that addresses it, and quantifies the expected operational impact based on available industry data.

Challenge / Gap	AeroNet Capability	Operational Impact
Runway incursion risk — controller-dependent detection	V2X Surface Management: 15-30 sec hold-short conflict alert to crew and controller; independent of radar and visibility	Multi-barrier protection closes the gap left by radar shadow zones, poor visibility, and split-attention controller workload
Ground vehicle on runway — no transponder, no ASDE-X alert (LaGuardia, March 2026)	V2X All-Vehicle Tracking: C-V2X transmitter on each ARFF and ground vehicle; individual identity and position broadcast at 10 Hz; alert generated independent of radar confidence; simultaneous crew + controller + ops notification	Closes the exact gap that killed two pilots at LGA: V2X-equipped fire truck generates alert regardless of VMAT or transponder status
TCAS gap below 1,000 ft AGL on approach	A2X Conflict Detection: no altitude floor; 60-90 sec pre-tactical advisory; direct aircraft datalink below 200ms	Closes the exact capability gap exposed by the January 2025 Potomac River collision at 300 ft
ATC staffing shortfall driving workload errors	Automated pre-filtered conflict alerts; COP reduces active monitoring burden; advisory generation without controller intermediation	Extends effective controller capacity; reduces consequence of single-controller operations at short-staffed facilities
Aging radar and surveillance infrastructure	V2X and A2X operate independent of radar; supplement existing surveillance with network-native 10 Hz position data	Bridges surveillance gap during BNATCS deployment period; provides data continuity as legacy systems are replaced
Unknown UAS in terminal area airspace	A2X Remote ID ingestion; authorization correlation; unmatched track alerting; geofence enforcement	Every authorized drone visible; unauthorized operations flagged; facility geofences enforced at pre-flight authorization stage
eVTOL/AAM integration without new ATC infrastructure	A2X UTM layer: eVTOL on COP same layer as crewed traffic; vertiport sequencing; procedure publication and enforcement	New entrant integration without dedicated controllers or separate surveillance systems
Surface efficiency: taxi delay and fuel burn	V2X routing optimization; real-time surface model; departure sequence management; GSE coordination	3-5 min taxi time reduction; 28% OTP improvement; 4-7% surface

		fuel burn reduction at optimized facilities
Arrival throughput at capacity airports	A2X dynamic wake separation; CDO trajectory management; departure flow advisory	8-12% throughput increase at runway-capacity-constrained airports via performance-based separation
Airside vehicle authentication and security	V2X cryptographic identity credentials; continuous authorization verification; anomaly alert for uncredentialed vehicles	Physical badging gap closed; real-time detection of unauthorized or decommissioned vehicles on movement area

Partnership and Engagement

AeroNet UTM engages airport operators through a structured partnership process that begins with the airport's specific operational profile: facility size, traffic mix, current surveillance infrastructure, ATC staffing situation, planned AAM or cargo drone operations, and existing technology investments. The partnership conversation maps AeroNet's capabilities to the airport's highest-priority safety, security, and efficiency gaps — and structures a deployment that delivers measurable value from day one, not after a multi-year implementation cycle.

Engagement Type	Description
Safety gap assessment	AeroNet's team reviews the airport's current runway incursion and NMAC history, surface surveillance coverage, and ATC staffing profile to identify where V2X and A2X provide the highest safety return.
Infrastructure compatibility review	Technical review of existing ASDE-X, ADS-B, SWIM, and tower display infrastructure to map AeroNet integration points and confirm deployment approach.
Efficiency modeling	AeroNet models the airport's surface and terminal area operations to quantify the throughput, delay reduction, and fuel burn impact of V2X surface management and A2X flow optimization.
AAM/UAS readiness assessment	For airports with planned or active eVTOL or commercial drone operations, AeroNet maps the UTM integration requirements and procedure development needed for safe new entrant management.
BNATCS alignment consultation	AeroNet's regulatory team maps AeroNet's V2X/A2X data architecture to the BNATCS program's integration requirements, positioning the airport's AeroNet deployment as a contribution to — not a divergence from — the national modernization program.
FCC spectrum proceeding engagement	AeroNet's regulatory team briefs airport operators on ASX's FCC comments in GN Docket 26-74 (May 2026), explains how C-V2X spectrum authorization affects airport V2X deployment planning, and supports airports in submitting reply comments to the proceeding if desired.

The system is being rebuilt. Be part of what it's built around.

Connect with the AeroNet airport partnership team to begin your safety, security, and efficiency assessment.

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