5G—A key enabler for Air Traffic Control

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Executive summary

The airspace is undergoing a profound digital transformation, driven by advancements in aviation communication technologies and the rise of next-generation aircraft, such as Unmanned Aerial Vehicles (UAVs) and Advanced Air Mobility (AAM) platforms like air taxis and eVTOLs. This emerging sector promises to revolutionize urban logistics, transportation, and public services by integrating drones, air taxis, helicopters and commercial aircraft.

Realizing this potential requires a robust, scalable Air Traffic Control (ATC) framework [1] to safely manage increasing operational volumes across low and medium altitudes, aligning with the Federal Aviation Administration's (FAA) Brand New Air Traffic Control System initiative to modernize the National Airspace System (NAS) by 2029.

Traditional ATC systems, designed for high-altitude aircraft and large airports, are ill-equipped for the high volume of drones and UAMs at low and medium altitudes. The rapid proliferation of these vehicles demands real-time air traffic data for electronic conspicuity and collision avoidance, with advanced situational awareness to integrate UAS with manned aircraft. The June 11, 2025, US Government Executive Orders emphasize accelerating domestic drone and eVTOL innovation, streamlining regulations, and enhancing airspace security [2]. 5G Standalone technology is pivotal to this vision, enabling:

- **High-throughput, low-latency communication:** Reduces latency to under 10 ms, enabling real-time collision avoidance for a swarm of UAVs.
- **Precise positioning:** Supports the FAA's Remote ID and Detect-and-Avoid (DAA) requirements with sub-meter accuracy.
- **Robust security:** Ensures data protection through NIST-compliant encryption and network slicing.
- **Ubiquitous coverage:** Leverages over 430,000 U.S. cellular sites [3], enhanced with uptilt antennas, for connectivity up to 10,000 feet.
- **Programmable networks:** Facilitates AI-driven automation for dynamic airspace management, supporting the FAA's prime integrator model for rapid deployment and subcontractor coordination.

This vision aligns with the FAA's goal to replace legacy systems with IP-based infrastructure and consolidate automation platforms by 2029. Three deployment models offer flexible, scalable solutions to meet diverse operational and regulatory needs, ensuring safety and efficiency without vendor lock-in:

- FAA Private Network
- MNO Network Slicing
- Hybrid approach

Emerging technologies like Integrated Sensing and Communication (ISAC) and 6G will further enhance airspace safety by 2030, with ISAC enabling accurate detection of unconnected drones and 6G delivering ultra-dense networks for seamless coverage.

Ericsson recommends collaborating with Mobile Network Operators (MNOs) and the FAA to pilot 5G-enabled use cases, upgrade cellular infrastructure, and develop scalable Unmanned Traffic Management (UTM) systems, fostering a safer, smarter, and more sustainable digital airspace.

Features enabled by 5G Standalone

- High-throughput, low-latency communication
- Precise positioning
- Robust security
- Ubiquitous coverage
- Programmable networks

Vision of Air Traffic Control in low and medium altitudes

The low and medium altitudes (up to 10,000 feet) are seeing rapid growth in drones, UAM, and supporting infrastructure, transforming urban mobility. A robust ATC framework is essential to address current limitations and support the FAA's modernization goals.

Use cases of the ATC system

The ATC system for the low and medium Altitudes should support:

- **Electronic conspicuity:** Implement geo-awareness capabilities to identify and track all airspace users, including their purpose (e.g., commercial, recreational, or emergency), ensuring real-time visibility for enhanced safety and compliance with U.S. government priorities.
- **UTM and ATM integration:** Seamlessly integrate Unmanned Traffic Management (UTM) with Air Traffic Management (ATM) systems to enable efficient coexistence of drones, eVTOLs, and manned aircraft, minimizing conflicts and optimizing airspace usage.
- **Urban Air Mobility (UAM):** Air taxis and eVTOLs in controlled Class B, C, D, and E airspace.
- **Drone services:** Commercial UAS for delivery, agriculture, surveying, and inspection.
- **Airspace management:** UTM systems to coordinate low-altitude traffic, complementing traditional ATC.
- **Supporting infrastructure:** Vertiports, charging stations, and 5G networks for seamless operations.
- **Recreational and industrial applications:** UAS for tourism, emergency services, and public safety.

These components reflect the diversity of operations, necessitating a unified and scalable ATC framework to ensure safety and efficiency.

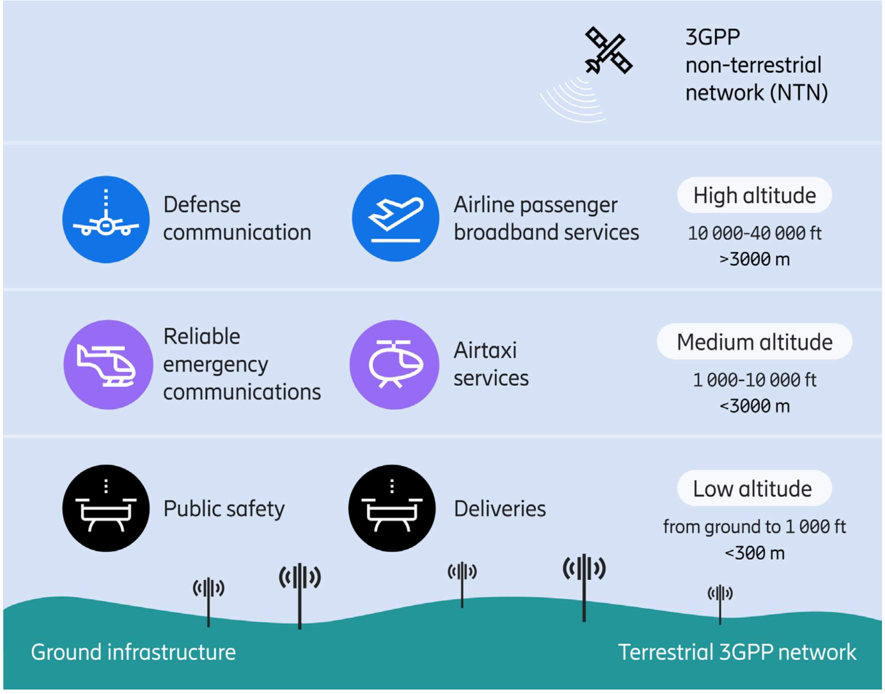
Challenges in airspace management

Managing airspace presents key challenges compared to traditional aviation:

- **Limited oversight:** Traditional ATC focuses on higher altitudes, leaving Class G airspace underserved. 5G's precise positioning and network slicing enable automated UTM systems to manage high-density UAS traffic in Class G without overburdening FAA resources.
- **Real-time information needs:** High volumes of drones and UAM vehicles require real-time data and automation to prevent collisions.
- **Integration with manned aviation:** Coordinating UAS with manned aircraft demands advanced situational awareness and automated conflict resolution.
- **Regulatory gaps:** The June 11, 2025 executive orders prioritize streamlined UAS regulations, which 5G supports through real-time Remote ID and DAA compliance.

Addressing these challenges is critical to enabling airspace safety while maintaining pace with the widespread adoption of low and medium-altitude operations [4] (see Figure 1).

Figure 1: Various altitudes require different deployment options for connectivity



Role of 5G Standalone technology

The integration of 5G Standalone with UTM and flight management systems is pivotal to overcoming these challenges and realizing the vision of a connected low and medium-altitude airspace. 5G Standalone offers several capabilities tailored to the needs of ATC:

- **High-Throughput and Low-Latency Communication:** Supports real-time data exchange for mission-critical operations, such as UAM, ensuring seamless coordination between ground stations, UAS, and UTM systems.
- **Precise Positioning:** Enhances situational awareness by providing accurate location data, which is critical for tracking UAS. 5G location technology offers advantages over ADS-B by providing more precise, real-time aircraft positioning with lower latency and enhanced coverage, especially in areas with limited radar infrastructure.
- **Robust Security:** Features like encryption and network slicing protect sensitive data, reducing risks in the digital airspace.
- **Mobile Network Remote ID:** Leverages telecom infrastructure to collect data from transponders and flight alarms (FLARM), enabling real-time identification and tracking of UAS.

By addressing the limitations of traditional data links—such as limited range and slow processing—5G Standalone ensures the safe and efficient coordination of UAS with manned aircraft, aligning with the FAA's goal of integration within the National Airspace System (NAS).

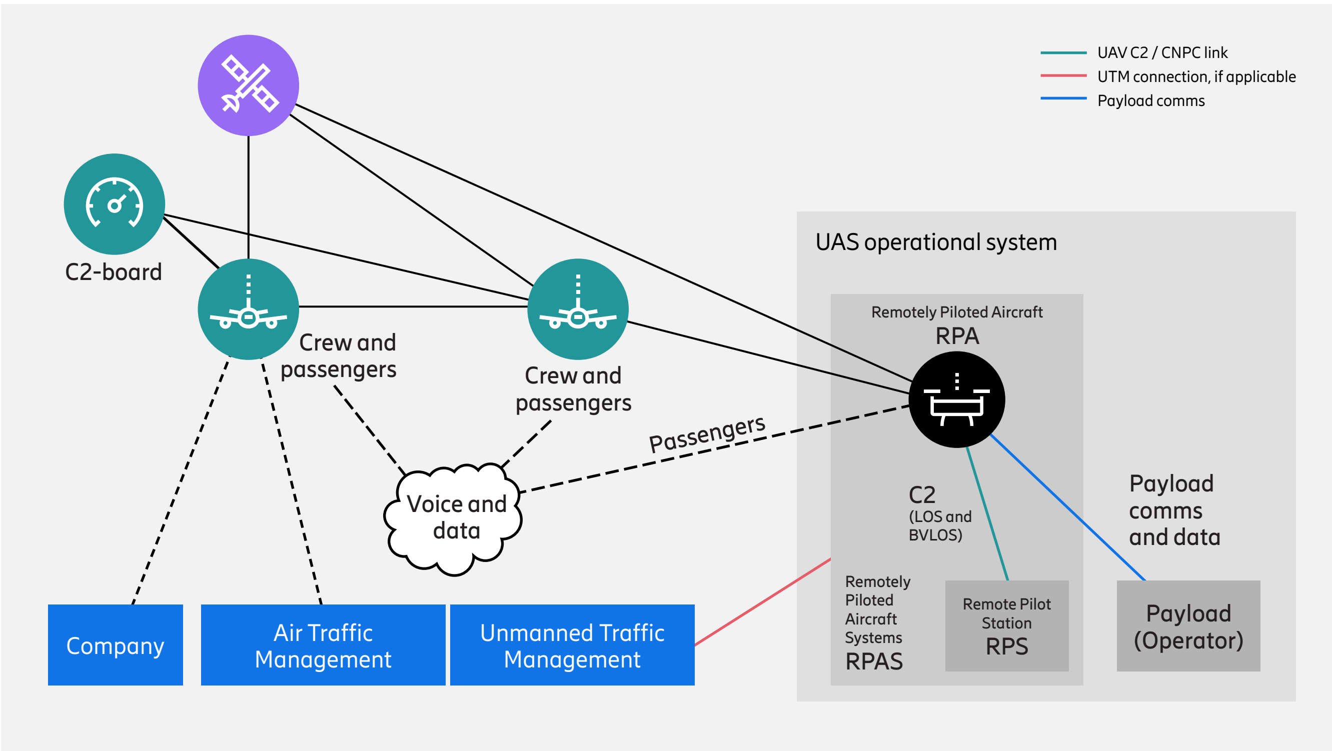
Connectivity to support drone operations [8]

Drones, as newcomers to the aviation ecosystem, have distinct connectivity requirements that 5G Standalone is well-positioned to meet. The primary connectivity legs include:

- **Command and Control (C2):** Supports visual line of sight (VLOS) and beyond visual line of sight (BVLOS) operations.
- **Payload Communication:** Transmits sensor data for real-time analytics.
- **UTM Connectivity:** Ensures compliance with airspace regulations via network APIs.

5G Standalone's ability to provide continuous coverage, high retainability, and additional services like positioning and Remote ID broadcast makes it an ideal solution for these connectivity needs (see Figure 2).

Figure 2: Emerging connectivity needs in aviation



Enabling infrastructure for nationwide coverage

Over 430.000 U.S. cellular towers, enhanced with uptilt antennas and beamforming, provide cost-effective coverage up to 10.000 feet, supporting the FAA's goal of precise surveillance at 200 airports. By enhancing these mobile network towers with uptilt antennas and beamforming technology, telecom operators can extend reliable 5G connectivity up to 10.000 feet. Dedicated sky networks, such as Teracom's in Sweden [5] which cover up to 16.000 feet, serve as a successful commercial reference for nationwide deployment. This infrastructure supports the scalability needed to manage the increasing volume of low-altitude and mid-altitude operations serving needs for national Public Safety and Defense Aerial connectivity as well as drone corridors.

Vision realization

5G Standalone creates a connected ecosystem for drones, air taxis, helicopters, and commercial aircraft, supporting the FAA's goal of integrating UAS into the NAS by 2029. Its high-speed, low-latency features enable real-time management, aligning with the FAA's modernization timeline.

The vision for Air Traffic Control (ATC) is to establish a safer, smarter, and more sustainable digital airspace, enabled by 5G Standalone technology across all altitudes, from low-altitude drone operations to medium-altitude aircraft and platforms. By integrating 5G Standalone with Unmanned Traffic Management (UTM) systems and leveraging existing telecommunications infrastructure, a fully connected ecosystem can be created to support a wide range of applications, including air taxis, drone deliveries, traditional aircraft, and emerging low and medium-altitude platforms.

5G Standalone offers high-speed, low-latency communication with features like Massive MIMO, beamforming, network slicing, and network programmability, enabling real-time data exchange critical for air traffic management at all altitudes. This vision aligns with the Federal Aviation Administration's (FAA) BEYOND and Integration Partnership for Autonomy (IPA) programs, which focus on safely integrating unmanned aircraft systems (UAS) into the National Airspace System (NAS).

By developing robust safety, regulatory [10], and technological frameworks, this 5G Standalone-enabled ATC ecosystem can drive innovation in transportation, logistics, and urban planning, creating a cohesive and future-ready airspace.

Key benefits of 5G for the ATC system

The FAA benefits from 5G capabilities in air traffic control through:

- Real-time data exchange for UTM, improving coordination in Class G and B/C airspace.
- Accurate tracking for Remote ID and DAA, enabling routine BVLOS operations.
- NIST-compliant cybersecurity to safeguard UAS operations.
- Support for Primary, Alternate, Contingency, and Emergency (PACE) communication, aligning with FAA safety standards.
- Provide precision location-based landing information to mitigate risks against GPS spoofing

5G Standalone technology overview

Cellular technology enables wireless communication by dividing geographic regions into "cells," each served by a base station. Mobile devices communicate with nearby base stations over assigned radio frequencies, handing off connections seamlessly as users move. Since the first-generation (1G) analog voice systems of the 1980s, cellular networks have evolved through digital voice (2G), mobile data (3G), broadband data (4G/LTE), and now to the fifth generation, 5G Standalone. Each generation has delivered marked improvements in capacity, speed, latency, and overall user experience.

5G Standalone represents the latest milestone in this evolution. It retains the fundamental cell-based architecture but introduces advanced radio techniques, flexible network designs, and cloud-native core functions. By leveraging a broader spectrum, including existing bands (sub-6 GHz) and millimeter-wave frequencies (above 24 GHz), and combining them with sophisticated antenna arrays (massive MIMO) and beamforming, 5G Standalone dramatically boosts capacity and coverage. Software-defined networking and network slicing allow mobile operators such as AT&T, T-Mobile, and Verizon to tailor performance, reliability, and security for diverse use cases.

Based on the 3GPP standard, 5G Standalone is a globally adopted mobile broadband technology offering high speed, low latency, and reliable connectivity. The 5G ecosystem supports a wide range of devices, from smartphones and IoT sensors to UAS and eVTOL aircraft, enabling seamless integration and real-time data sharing for mission-critical and commercial applications in the digital airspace. MNOs [9] deliver 5G connectivity as a scalable, subscription-based service, leveraging existing infrastructure to reduce costs and accelerate deployment, aligning with the FAA's emphasis on efficient resource utilization.

Key advantages of 5G

Global adoption

- Standardized by 3GPP and embraced by regulators worldwide, 5G Standalone deployments span North America, Europe, Asia, and beyond.
- Harmonized spectrum allocations facilitate roaming and equipment economies of scale.
- Leading network equipment vendors and device manufacturers support a global 5G Standalone ecosystem.

High-speed connectivity

- Peak data rates up to 20 Gbps in ideal conditions, with sustained user throughputs of hundreds of Mbps in urban cells.
- Multi-gigabit links enable data-intensive applications such as high-definition video streaming, augmented/virtual reality, and rapid large-file transfers.

Low latency

- 5G Standalone technology is capable of consistently low round-trip latencies of below 20 ms. It should be noted that commercial Mobile Network Operators (MNOs) generally do not offer guarantees.
- Real-time responsiveness supports time-critical applications: remote piloting aids, collision-avoidance systems, and precision air traffic control services.

Virtual private networking

- Network slicing can isolate mission-critical FAA services from general-purpose traffic, ensuring consistent performance and security.

Wide range of devices

- 5G Standalone supports everything from smartphones, IoT sensors, UAS, and eVTOL aircraft
- Device form factors range from high-performance modems to ultra-compact modules optimized for low power consumption.
- FAA applications can leverage this diversity for in-flight connectivity, ground-based sensors, runway monitoring, weather stations, and more.

5G Standalone, standardized by 3GPP, offers high-speed, low-latency connectivity for smartphones, IoT sensors, UAS, and eVTOLs. It uses sub-6 GHz and millimeter-wave bands, massive MIMO, and beamforming to boost capacity. Compared to 4G, 5G delivers:

Table 1: 5G Standalone capabilities compared with 4G

		4G	5G
1	Service quality	No Slicing	Advanced Slicing
2	Theoretical latency	20-30 ms	1-10 ms*
3	Throughput	1 Gbps	20 Gbps
4	Devices	100K/km²	1M/km²
5	Power efficiency	Moderate	>133%
6	Cybersecurity	Commercial	NIST-compliant encryption

*Note: Commercial MNOs typically achieve 10-20 ms latency, with guarantees via SLAs.

5G Standalone capabilities for Air Traffic Control

5G Standalone technology offers a suite of capabilities [6] tailored to the FAA's requirements for air traffic control, including communication, positioning and detection, control of connected UAS, performance, security, ubiquitous coverage from the ground and sky, Primary, Alternate, Contingency, and Emergency (PACE) communication for commercial planes, and the ability to collaborate and share data via APIs. This is further outlined in the following Table 2:

Table 2: 5G Standalone capabilities and FAA benefits

Capability	Description	FAA benefit
Communication	High-throughput, low-latency channels for ground-to-air and air-to-air interactions.	Supports UTM and DataComm, enhancing coordination in all airspace classes.
Positioning and detection	Precise location services and SIM density data for tracking UAS and rogue drones.	Aligns with Remote ID and DAA, enabling BVLOS operations.
Control of connected UAS	Reliable BVLOS connectivity with dynamic QoS via network APIs.	Supports routine BVLOS operations, aligning with FAA rulemaking.
Performance (SLAs)	Low-latency, high-throughput connectivity with tailored SLAs.	Ensures reliability for UTM and ATM, meeting FAA safety standards.
Security	NIST-compliant encryption and network slicing for secure UAS operations.	Complies with FAA cybersecurity mandates, protecting the NAS.
Ubiquitous coverage from the ground	Enhanced cellular towers provide coverage up to 10,000 feet.	Supports surveillance at 200 airports and new ARTCCs.
Ubiquitous coverage from the sky	5G Terrestrial and Non-Terrestrial Networks (NTN) provide reliable, resilient, and ubiquitous connectivity that complements traditional ground-based networks [7]	Aligns with the FAA's goal of nationwide UAS integration; as NTN evolves, direct-to-device solutions will extend coverage to any flying object.
PACE for commercial planes	Supports primary, alternate, contingency, and emergency communication.	Ensures redundancy for commercial aviation in the NAS.
Collaboration and data sharing via network APIs	APIs enable dynamic QoS, location tracking, and airspace management.	Supports UTM and DataComm, enhancing coordination in all airspace classes.

Providing 5G Standalone coverage for aerial user equipment (UEs)

Current 5G Standalone networks are not optimized for aerial UEs, leading to challenges like frequent handovers during horizontal flight due to exposure to multiple Physical Cell IDs (PCIs) and increased UL interference to neighboring cells.

Aerial radio channels differ significantly from terrestrial ones due to their higher likelihood of Line-of-Sight (LOS) propagation, resulting from fewer obstacles in the sky. As altitude increases, signal propagation approaches free-space conditions. However, existing 5G Standalone networks are optimized for terrestrial broadband, with base station antennas downtilted to enhance ground coverage and minimize inter-cell interference. Consequently, aerial user equipment (UEs), such as UAVs, are often served by the sidelobes of these antennas, which have lower gains than the main lobes. The stronger LOS propagation can sometimes compensate for this, potentially delivering stronger received signal strengths.

Simulations and trials indicate that aerial UEs generate increased uplink (UL) interference and experience higher downlink (DL) interference compared to terrestrial UEs. The Synchronization Signal/PBCH Block (SSB) shapes cell coverage through its common channel beam, determining the serving cell for a UE. On the ground, 2D network planning mitigates intra-frequency interference by down-tilting SSB radiation patterns, adjusting transmit power (TX power), and using narrow vertical beam shapes tailored to the deployment area.

At medium altitudes, aerial UEs face elevated intra-frequency interference due to LOS visibility of multiple cells via main or sidelobes (see Figure 3). Simultaneously, high-flying UEs create UL interference across multiple base stations.

Proposed solutions for aerial 5G Standalone optimization

To address these challenges, Aerial Cell Configuration, Interference Mitigation, and/or Mobility Management can be deployed and optimized using generative AI to maximize network performance and capacity:

- **Aerial Cell Configuration:** Configure aerial cells by designating some existing ground cells as aerial cells with adapted SSB radiation patterns to form a wide, cohesive aerial cell layer. This minimizes overshooting into neighboring cells. Each sector can support two New Radio (NR) cells, one for ground and one for aerial UEs, ensuring tailored coverage.

- **Interference Mitigation:** To address interference for aerial UEs, 5G uses distinct SSB frequencies to avoid collisions, ensuring reliable UAS tracking for FAA's surveillance goals. Control intra-frequency SSB interference by using distinct SSB frequency positions for aerial carriers.

- **Mobility Management:** Implement mobility control in IDLE and CONNECTED modes to prioritize aerial UEs staying within aerial cells during horizontal flight and vertical take-off/landing. Inter-frequency mobility configurations enable user- and service-specific mobility, using the same time/frequency spectrum resources for ground and aerial carriers while preventing intra-frequency SSB collisions.

By leveraging these solutions, network APIs, and generative AI, the FAA can achieve a robust, automated, and optimized 5G Standalone network tailored for low-altitude aerial operations, ensuring reliable performance and scalability.

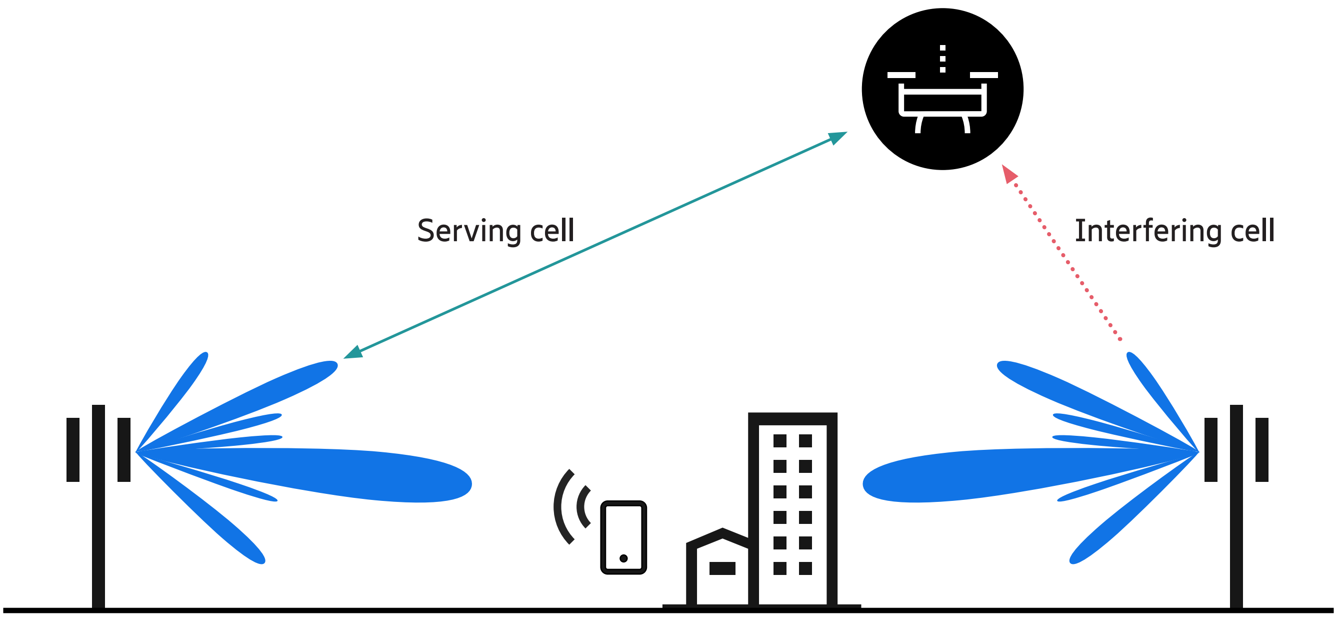


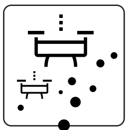
Figure 3: Interference at different heights

5G Standalone for Air Traffic Control implementation options

Ericsson proposes three implementation options for deploying 5G in air traffic control (ATC) for the FAA: 1) FAA Private Network, 2) 5G MNO Network Slice, and/or 3) a hybrid approach. Each option has distinct advantages and challenges as described in Table 3 below.

Table 3: 5G Implementation options

Option	Description	Pros	Cons
1 FAA Private Network	Dedicated 5G Standalone network on B79 spectrum (4.5–5 GHz)	High security, customization, and interference management	High initial cost
2 MNO Network Slice	Dedicated slice from MNO networks	Cost-effective, scalable	Less control
3 Hybrid approach	Combining private and public networks	Flexible, scalable, ubiquitous coverage	Private/public coordination required



Option 1:
FAA Private Network

A private 5G network on dedicated spectrum (e.g., B79 in the 4.5–5 GHz range) offers the FAA complete control, high security, and tailored performance for mission-critical low-altitude ATC applications. This option ensures independence from public networks and is optimized for digital low-altitude airspace coverage.

Key benefits

Enhanced security

- Data remains on-site, minimizing exposure to external threats.
- Custom security policies enable strict access controls, authentication, and traffic monitoring.
- Offers complete control and NIST-compliant security, ideal for critical ATC applications.

Dedicated performance

- Guaranteed bandwidth prevents congestion from public users.
- Low latency supports real-time applications like robotics, automation, and AR/VR.
- High reliability through customizable redundancy and failover mechanisms.

Customization and control

- Full network management allows tailored device onboarding and quality-of-service (QoS) settings.
- Optimized for low-altitude coverage, free from terrestrial network interference.
- Seamless integration with existing IT/OT systems and private cloud infrastructure.

Option 2:
5G Standalone MNO Network Slice

Leveraging the existing 5G Standalone infrastructure of U.S. Mobile Network Operators (MNOs), which spans 430,000 sites, this option allocates a dedicated network slice for FAA, UAVs, and other low-altitude operations. This approach customizes connectivity to meet ATC requirements while reusing robust nationwide networks, and requires MNOs to enhance coverage with uptilt antennas by 2028.

Key benefits

Cost-effectiveness

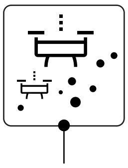
- Utilizes existing MNO infrastructure, reducing deployment costs.
- Provides scalable, continuous coverage for beyond-line-of-sight (BLOS) drone operations.

Customized connectivity

- Network slicing enables service differentiation, mobility/traffic steering, and tailored QoS.
- Supports diverse use cases, from commercial drones to air traffic management.

Integration with existing services

- Seamlessly integrates with MNO services for reliable, nationwide coverage.



Option 3:
Hybrid: FAA Private and MNO Public Network Slice

As the low-altitude economy grows with increasing numbers of drones, air taxis, helicopters, and commercial aircraft, a hybrid approach combining private and public 5G Standalone networks offers a flexible, scalable solution for ubiquitous ATC coverage across the U.S.

Key benefits

Ubiquitous coverage

- Public MNO networks provide nationwide BLOS connectivity.
- Private FAA networks ensure high security and capacity in critical locations.

Flexibility and scalability

- Balances cost, control, and coverage by leveraging both network types.
- Adapts to varying security and performance needs across regions

Phased implementation

- Allows gradual deployment, enabling optimization over time based on operational feedback.
- Balances cost and control, supporting phased deployment by 2029. Aligns with the FAA's acquisition strategy (49 U.S.C. § 106(I), § 40110) through open 3GPP standards, avoiding vendor lock-in.

Challenges

- Requires coordination between private and public network operations.
- Demands integration to ensure seamless performance across a hybrid infrastructure.

This hybrid model is ideal for scaling ATC capabilities to meet the demands of an evolving low-altitude airspace, ensuring both security and widespread coverage.

Technology evolution

The evolution of 5G, 6G, and future technologies will further enhance low-altitude air traffic control. These include network programmability, Integrated Sensing and Communication (ISAC), and 6G.

Programmable network functions

5G Standalone networks provide programmable network functions critical for integrating advanced AI capabilities into air traffic control systems. These networks enable the FAA to leverage machine learning, generative AI, and other AI-driven technologies to optimize complex use cases, moving toward fully autonomous, intent-based networks with minimal human intervention. By utilizing standardized APIs through aggregators, developers can access 5G features such as differentiated connectivity, location services, security, and network insights, enabling seamless integration with FAA applications to support mission-specific requirements.

In 5G Standalone networks, AI agents can be deployed within the network infrastructure to replace rule-based algorithms, introduce new AI-driven components, or enhance existing ones. These agents harness real-time network data to predict outcomes, detect anomalies, dynamically allocate resources, and optimize quality of service. This transformation improves network performance, reduces costs, conserves resources, enhances energy efficiency, and strengthens security. Programmable networks also enable innovative orchestration and automation of service delivery, including the use of rApps to program the Radio Access Network (RAN), paving the way for AI-powered, service-centric networks capable of autonomous operations.

In 5G Standalone networks, the FAA can connect to public networks via Network APIs, which provide access to advanced capabilities like differentiated connectivity tailored to air traffic control applications. These APIs allow developers to enhance existing applications or create new ones by leveraging features such as location, security, and network insights. As network technologies evolve toward 6G, cognitive networks, and network compute fabrics, the capabilities exposed through APIs will expand, further driving innovation across ecosystems and supporting the FAA's journey toward scalable, autonomous, and differentiated network services.

Integrated Sensing and Communication (ISAC)

Supports detection and management of unconnected drones, reinforcing airspace security and supporting the FAA's safety objectives. Pilots of this capability are currently underway on 5G Standalone networks.

ISAC offers significant potential for drone detection, a high-priority use case for 6G networks due to its relevance in defense, public safety, and airspace management. By leveraging existing cellular infrastructure, ISAC enables the detection of uncrewed aerial vehicles (UAVs) without requiring them to be connected to the network, unlike traditional location-based services. Using radar-like techniques, ISAC compares transmitted reference signals with their reflections to infer drone properties such as location, velocity, and direction. This capability is particularly valuable in outdoor environments, where ISAC can operate in monostatic, bi-static, or multi-static modes, utilizing base stations or other network nodes to process reflected signals and achieve wide-area coverage.

The economic and operational benefits of ISAC for drone detection are substantial, as it capitalizes on the widespread deployment of cellular base stations to provide cost-effective, scalable solutions compared to dedicated radar systems. Key performance metrics, such as detection probability (targeted at 99% in some scenarios) and low false alarm rates (e.g., 3%), ensure reliable identification of drones, even in cluttered environments. Higher carrier frequencies, such as those in the millimeter-wave or sub-THz bands, enhance Doppler shift precision for accurate velocity estimation, while wide pulse bandwidths improve range resolution, enabling differentiation of drones from other objects. Sensor fusion, integrating ISAC data with inputs from cameras or environmental sensors, further enhances detection accuracy, particularly in challenging conditions like poor visibility or adverse weather.

Despite its promise, ISAC-based drone detection faces technical challenges, including mutual interference between sensing and communication functions and the need for adaptive waveform designs to balance both objectives. Dynamic environments, such as urban areas with multipath propagation, complicate real-time sensing, necessitating advanced algorithms like AI-driven signal processing for robust performance. Standardization efforts, such as those in 3GPP Release 19 and beyond, are critical to ensuring interoperability and ecosystem readiness. By addressing these challenges through continued research and collaboration, ISAC can deliver a transformative solution for drone detection, supporting safe and economic UAV transport and enhancing critical infrastructure protection by 2030.

6G

6G will enable a highly connected, intelligent, and safe digital airspace infrastructure that can scale to support the proliferation of drones, autonomous aircraft, and new urban air mobility services, all while ensuring rigorous safety, security, and operational efficiency.

Table 4 provides a summary of the key innovations and how they could benefit the digital airspace.

Table 4: 6G and Air Traffic Control

6G component	Key Benefit for Air Traffic Control
Cell-free networks	Seamless coverage for fast-moving UEs.
AI/ML-powered networks	Autonomous decision-making for UTM.
URLLC	Reliable, low-latency C2 links.
Terrestrial-satellite convergence	Ubiquitous coverage for remote airspace.

Recommendations

To modernize Air Traffic Control (ATC) across low, medium, and high altitudes, Ericsson proposes a strategic roadmap leveraging 5G Standalone technology to address the evolving needs of digital airspace. These recommendations align with the FAA and Integration Partnership for Autonomy (IPA) initiatives to safely integrate Unmanned Aircraft Systems (UAS), Urban Air Mobility (UAM), and commercial aviation into the National Airspace System (NAS).

By focusing on scalable infrastructure, advanced connectivity, and robust security, these steps aim to create a safer, smarter, more sustainable digital airspace and to modernize ATC by 2029:

- **Pilot 5G Standalone use cases by Q3 2026:** Collaborate with U.S. drone and eVTOL manufacturers to pilot 5G technologies in real-world applications such as drone delivery, air taxi operations, and commercial airline connectivity, aligning with the FAA's September 2025 contract award. These pilots will validate 5G's high-throughput, low-latency communication for Command and Control (C2), payload data transmission, and Unmanned Traffic Management (UTM) integration. By 2027, scale successful use cases to demonstrate real-time airspace management, aligning with the FAA's goals for safe UAS integration and enhanced situational awareness in controlled and uncontrolled airspace.

- **Upgrade cellular infrastructure by 2027:** Partner with Mobile Network Operators (MNOs) and the FAA to co-invest in upgrading over 430,000 U.S. cellular towers with uptilt antennas and beamforming technology by 2027. This will extend reliable 5G Standalone coverage to low and medium altitudes (up to 10,000 feet). Engage with the FAA and FCC to explore dedicated spectrum allocations (e.g., B79 in the 4.5–5 GHz range) for ATC-specific networks, ensuring interference-free connectivity and compliance with Remote ID and Detect-and-Avoid (DAA) requirements. Deploy APIs for QoS, positioning, and UTM integration, supporting the FAA's UAS Data Exchange and LAANC.

- **Implement network APIs by 2028:** Deploy network APIs to enable dynamic Quality of Service (QoS) management, precise positioning, and SIM-based identity tracking for UAS and UAM. Leverage APIs such as Aerial Connectivity for C2, Positioning Augmentation, and 3D Coverage Data to enhance real-time flight path management, airspace surveillance, and compliance with the FAA's UAS Data Exchange and Low Altitude Authorization and Notification Capability (LAANC). By 2028, deploy APIs for QoS, positioning, and UTM integration, supporting the FAA's UAS Data Exchange and LAANC.

- **Strengthen cybersecurity by 2028**: Invest in dedicated cybersecurity solutions tailored for 5G Standalone-enabled UAS and ATC operations, including encryption, network slicing, and secure SIM-based identity management. By 2028, develop NIST-compliant protocols for UAS operations, ensuring NAS security.

- **Advance AI automation by 2028:** Deploy rApps for real-time UTM optimization, aligning with BEYOND and IPA programs. This will enhance scalability, reduce operational costs, and improve safety, paving the way for future 6G and cognitive network advancements.

- **Showcase NTN interoperability by 2029:** Pilot terrestrial-NTN handovers for ubiquitous coverage. Demonstrate seamless handovers for drones, air taxis, and commercial aircraft, ensuring continuous coverage in remote and oceanic airspace. This aligns with the FAA's goal of nationwide UAS integration and supports Primary, Alternate, Contingency, and Emergency (PACE) communication scenarios for commercial aviation.

- **Develop scalable UTM systems by 2030:** Support 10,000 UAS per square mile, integrating with UAS facility maps for BVLOS operations. Leverage 5G Standalone's low latency and high reliability to enable real-time telemetry, conflict resolution, and airspace coordination in uncontrolled Class G and controlled Class B/C airspace. Integrate with the FAA's UAS Facility Maps to enhance situational awareness and support Beyond Visual Line of Sight (BVLOS) operations.

- **Align with regulations:** Collaborate with the FAA, FCC, and MNOs to meet June 11, 2025 executive orders, leveraging task forces.

By implementing these recommendations, stakeholders can transform Air Traffic Control to support the growing demands of drones, air taxis, and commercial aviation, fostering innovation, safety, and economic growth in the National Airspace System (NAS) [11].

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With 28 years of Telecom/ICT leadership, Elisiario Cunha drives innovation as Ericsson's Vice President and CTO for the US Government in Market Area Americas. His 14 years in telecom operations at TIM and Oi Brazil, combined with over 14 years at Ericsson, enable him to deliver transformative technology solutions for clients such as Vodafone, US Cellular, Cable Operators, and Utilities. A proven leader, Elisiario builds high-performance teams across North America, Europe, and Brazil, aligning cutting-edge technology with business goals to empower clients in a dynamic digital landscape.

Fred Ter Haar

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As Private 5G is increasingly being adopted for mission critical purposes, Fred Ter Haar is developing Ericsson's business with the U.S. Government in the areas of transportation, homeland security, and defense. Fred Ter Haar is a wireless industry veteran with expertise in Open RAN, Core Networks and Service Management and Orchestration. Prior to joining Ericsson, Ter Haar worked at Rakuten Symphony, Altiostar, and KPN. Ter Haar holds a Master's degree in Computer Science from the Vrije Universiteit in Amsterdam, the Netherlands.

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Kapil spearheads the convergence of Telecom and Aviation. As the CEO and co-founder of Ericsson Drone Mobility, Kapil pioneered the digitalization of airspace by integrating 5G to power safe, beyond-visual-line-of-sight drones. With over two decades of Business leadership globally, he excels in emerging technologies, digital-airspace strategy and sustainable innovation scaling. Kapil chairs GSMA Drone Interest Group and is an advisor at British Standard Institute Advance Air Mobility and World Economic Forum AVIATE. He is an active ICAO AAM task force contributor and shares thought leadership in various global conferences.

About Ericsson

Ericsson enables communications service providers and enterprises to capture the full value of connectivity. The company's portfolio spans the following business areas: Networks, Cloud Software and Services, Enterprise Wireless Solutions, Global Communications Platform, and Technologies and New Businesses. It is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's innovation investments have delivered the benefits of mobility and mobile broadband to billions of people globally. Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

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