



Safety Foundations for Scalable BVLOS

The Case for SMS and Cooperative Detection as the Strongest Scalable Baseline Architecture

Introduction

The Federal Aviation Administration’s (FAA’s) Beyond Visual Line of Sight (BVLOS) rulemaking presents a critical opportunity to enable scalable unmanned aircraft system (UAS or drone) operations while reinforcing the safety foundations of the National Airspace System (NAS). If implemented effectively, the rule can unlock substantial public benefits—including improved emergency response, infrastructure inspection, and operational efficiency—while maintaining aviation’s longstanding commitment to risk management and system integrity.

A strong safety foundation is critical to the successful integration of BVLOS operations into the NAS, including for the acceptance of drone technology by the public and aviation stakeholder communities. For decades, widely-recognized Safety Management System (SMS) and cooperative technology frameworks have underpinned the safest, most complex, and most heavily utilized segments of the NAS. These systems enable shared situational awareness, interoperability among diverse airspace users, and scalable regulatory oversight. They are trusted because they provide predictable, enforceable, and system-wide safety performance.

The integration of new entrants into the NAS has historically been achieved not by isolating those entrants, but by integrating them into existing aviation systems. Safety has advanced through convergence—by establishing common standards, shared situational awareness, and interoperable procedures that allow diverse users to operate predictably in shared airspace. The transition from procedural separation to radar, the adoption of Mode C and Mode S transponders, the deployment of Traffic Collision Avoidance System (TCAS) and ACAS, and the global move toward Automatic Dependent Surveillance-Broadcast (ADS-B) all reflect this pattern of increasing airspace transparency for *all* users.

BVLOS drone operations should follow the same trajectory. The question facing policymakers drafting the BVLOS rule is not whether additional mitigations may be appropriate for certain operations, but what requirements should constitute the **baseline safety architecture** upon which scalable BVLOS operations are built—one defined by performance-based safety outcomes rather than prescriptive technological mandates, and that enables acceptable levels of risk to be demonstrated through multiple, layered mitigations. **That baseline should be one that the FAA can oversee consistently, with which operators can broadly comply, and that integrates seamlessly into the existing NAS safety ecosystem.**

A framework built on SMS principles and cooperative detection satisfies those criteria. Together, these pillars enable UAS to exercise safety assurance and risk management through participation in shared awareness frameworks alongside manned aviation, support predictable interactions among airspace users, and provide the transparency necessary for effective regulatory oversight. Conversely, treating non-cooperative detection as a baseline requirement risks fragmenting the safety ecosystem and complicating FAA oversight. While non-cooperative sensing technologies may serve as useful, context-specific mitigations for certain operations, they are not a scalable substitute for cooperative participation across the NAS, especially for operations, such as many public safety missions, that leverage small size as a proven safety mitigation. The Commercial Drone Alliance (CDA) strongly supports scalable SMS requirements for drone operations and cooperative airspace management as foundations for nationwide BVLOS operations.¹

Safety Management Systems (SMS) Applied to UAS Technologies

The SMS Framework in UAS Operations Today

The FAA's SMS framework is built on four components: Safety Policy, Safety Risk Management, Safety Assurance, and Safety Promotion. These components comprise the

¹ The CDA is the leading U.S. non-profit organization focused on U.S. leadership in drone technology and the integration of commercial drones into the NAS. The CDA consists of key leaders in the commercial drone industry and actively participates in regulatory and policy efforts to facilitate the safe and secure development and expansion of domestic commercial drone operations. The CDA collaborates with all levels of government on policies for industry growth and educates on the safe and responsible use of commercial drones to achieve economic benefits and humanitarian gains. We bring together commercial drone end-users, manufacturers, service providers, drone security companies, and vertical markets including oil and gas, precision agriculture, construction, security, communications technology, infrastructure, newsgathering, filmmaking, package delivery and logistics, and more. Learn more at <https://www.commercialdronealliance.org>.

foundational safety standard for aviation in the United States, creating a structure that informs Safety Risk Management decisions and ensures accountability before a system failure occurs. At this time, all Part 121, Part 135, Part 91.147, and Part 21 certificate holders are required to implement SMS framework requirements into their operations. The proposed BVLOS rule would require future Part 108 operators to implement the relevant elements of the FAA's SMS regulations (Part 5) into their operations. Safety has been a longstanding priority for the drone industry, and will continue to be, especially as the number of drone operations increase following the finalization of the BVLOS rule.

In practice, operators seeking authorization for BVLOS operations already perform rigorous safety analysis consistent with SMS principles through existing FAA approval processes. When applying for operational approvals, including BVLOS authorizations, applicants are required to meet standards outlined in FAA Order 8040.6A, which requires applicants to submit a comprehensive Operational Risk Assessment (ORA) and supporting materials that identify hazards and propose mitigations.² These submissions require operators to systematically identify hazards, demonstrate how those hazards are controlled through procedural, technical, and operational measures, and describe how safety risks will be monitored and managed over time. This process applies core SMS principles to UAS operations, demonstrating that rigorous, documented safety processes are already standard practice for operators seeking BVLOS authorization.

Additionally, the transition to a more cooperative airspace as a regulatory baseline, as detailed in the next section, will further improve SMS implementation by standardizing the baseline for more efficient regulatory oversight. This will deter the creation of safety silos—with safety data held within independent, proprietary systems—which make it harder for the regulator to assess aggregate risk across the NAS.

Industry Commitment to SMS Implementation

While not formally required for all drone operators at this time, the FAA Drone Safety Team (DST) released recommendations for using SMS tailored to drone operations, particularly those operating under Parts 91, 107, or 135.³ The DST provides SMS guidance for UAS based on three levels of operational complexity, aiming for obtainable and effective safety practices for all types of drone operations. A key aspect of this guidance is that, similar to other aviation sectors, SMS should be scalable depending on the risk profile and complexity of the drone operations. This furthers the idea that safety requirements should appropriately

² See Fed. Aviation Admin., Order 8040.6A, *UAS Risk Management Policy* (Sept. 1, 2023).

³ See Drone Safety Team, *Recommendations for using Safety Management Systems (SMS) in UAS Operations* 4, <https://dronesafetyteam.org/drone-safety-team-dst-sms-recommendations/> (last visited Apr. 13, 2026).

reflect the operations that they are regulating, rather than implement a one-size-fits all safety requirement. This guidance, developed in collaboration with the FAA and commercial drone industry, embodies the shared safety priority for commercial drone operations. The drone industry is already implementing this guidance today to assure drone safety and to build public trust across the country.

The Safety Solution for Large-Scale BVLOS Operations

Cooperative Detection: A Proven Safety Model

Cooperative detection is not an experimental concept, but a longstanding pillar of aviation safety. It reflects the same standardized, interoperable surveillance principles that have guided the safe evolution of the NAS for decades. Cooperative surveillance has successfully enabled reduced separation standards in terminal, en route, and remote airspace. Oceanic operations—conducted entirely beyond radar coverage—rely exclusively on cooperative position reporting. At many airports, particularly at low altitudes and surface level, cooperative detection methods such as ADS-B provide surveillance where radar does not.

These systems are trusted because they are standardized, interoperable, and universally understood. They allow diverse aircraft, operators, and service providers to make consistent decisions based on shared information. In short, they flatten the information plane and create a system that facilitates rapid communication and decision-making for all users.

Empirical evidence underscores the safety value of conspicuity itself: a study examining the impact of ADS-B In equipage on general aviation and Part 135 air taxi operations found that aircraft equipped with ADS-B In experienced a 53% reduction in overall accident likelihood and an approximately 89% reduction in fatal accident likelihood compared to non-equipped aircraft.⁴ These findings demonstrate that increasing electronic conspicuity and shared situational awareness yields substantial safety benefits.

Extending this paradigm to BVLOS operations reflects a continuation of established aviation practice, integrating UAS into the NAS through familiar, safety-proven mechanisms. Cooperative detection allows drones to integrate into the same situational awareness framework that governs manned aviation, supporting consistent decision-making by operators, automated systems, and air traffic services alike. By establishing standardized, clearly communicated, and cost-conscious barriers to entry, cooperative detection enables

⁴ Daniel Howell and Jennifer King, *Measured Impact of ADS-B In Applications on General Aviation and Air Taxi Accident Rates* 7 (2019), https://download.aopa.org/advocacy/2019/dhowell_jking_DASC2019_V2.pdf.

broad participation in the NAS while allowing safety standards and procedures to be implemented and enforced in a manner that enhances safety for all airspace users.

Acceptable Level of Risk

FAA safety policy focuses on continuously reducing risk through system design, operational discipline, and effective oversight. The FAA manages aviation safety by identifying hazards, implementing mitigations, and monitoring outcomes across the NAS.⁵ This framework emphasizes the identification of hazards and the implementation of mitigations that demonstrably reduce risk across the system as a whole—the core of SRM. Cooperative detection aligns directly with this approach by increasing conspicuity, improving predictability, and producing measurable, system-wide safety performance. Participation can be tracked, compliance can be enforced, and safety outcomes can be evaluated over time across fleets and regions. This system-level approach mirrors how the FAA already manages risk through programs such as the Aviation Safety Information Analysis and Sharing (ASIAS) system, which aggregates and analyzes de-identified safety data across operators, fleets, and regions to identify emerging hazards and assess the effectiveness of mitigations.⁶

Comparing Cooperative and Non-Cooperative Detection

The difference between cooperative and non-cooperative detection⁷ is structural, representing two distinct perspectives on safety within the NAS. Cooperative detection operates at the **system** level. It provides shared visibility among airspace users, supports interoperability across manufacturers and operators, and integrates with existing surveillance, procedural, and traffic management frameworks. Cooperative detection in aviation is analogous to turn signals, brake lights, and traffic signals in road transportation—standardized, shared cues that allow all users to operate from a common and predictable understanding of traffic, and with clear, constant communication about how other users are operating. Barriers to entry are standardized, clearly communicated, and cost-conscious,

⁵ See Fed. Aviation Admin., *Safety Management System* (Sep. 11, 2024), https://www.faa.gov/about/initiatives/sms/explained/components#safety_risk_management (“The essential idea of any SMS — be it a product/service provider’s SMS or the SMS of the regulator responsible for safety oversight — is to provide for a *systematic approach* to achieving *acceptable levels of safety risk*.” (emphasis added)).

⁶ See Fed. Aviation Admin., *Aviation Safety Information Analysis and Sharing (ASIAS)*, <https://www.asias.faa.gov/apex/f?p=100:1>.

⁷ In the context of this paper, cooperative detection refers to the ability to detect electronically conspicuous manned aircraft, while the points made about the applicability of detection for non-cooperative aircraft refer only to manned aircraft that are not electronically conspicuous. These statements do not refer to the detection of unauthorized UAS, which is outside the scope of this paper and the BVLOS rule as proposed.

allowing for all users to safely operate in the airspace and for standards and procedures to be implemented and enforced in a way that enhances safety for all airspace users.

Non-cooperative detection, by contrast, is inherently limited by the capabilities of the sensor. Sensors observe only what is within their field of regard, their performance varies with environmental conditions, and their outputs are not shared across the broader system. While these technologies may enhance safety for certain individual operators, they do not create an appropriate regulatory baseline. Non-cooperative DAA (detect and avoid) is more akin to driving without signals and relying solely on cameras and onboard sensors to infer another vehicle's intent. While sensor-based inference can reduce risk in individual cases, modern transportation systems scale safety by requiring cooperative signaling as the baseline, not by assuming accurate perception by every participant.

Additionally, safety frameworks that depend on bespoke, operator-specific sensing solutions are inherently difficult to evaluate at scale. They require individualized demonstrations, complicate oversight, and make it challenging for the FAA to assess whether aggregate risk is increasing or decreasing over time. While such approaches may be appropriate for specific operations or locations, they do not provide a durable or integrated foundation for nationwide BVLOS integration under an SMS-based regulatory model.

The available collision record shows that non-cooperative detection is neither necessary nor preferred as a baseline safety requirement for authorized operations. The FAA's compilation of confirmed and probable drone-to-manned aircraft collisions indicates that these events frequently involve unidentified or unrecovered drones.⁸ This suggests that observed collision risk is closely associated with gaps in compliance, accountability, and visibility, rather than limitations in cooperative safety architectures themselves.

In parallel, industry consensus standards exist—and continue to mature—to support both strategic and tactical cooperative mitigations, including standards for airborne risk analysis that help operators identify and avoid areas of high manned-aircraft density (e.g., ASTM WK93896), as well as standards to validate the performance of cooperative detect-and-avoid systems (e.g., ASTM F3442, ASTM WK95242, and RTCA DO-386). Together, these frameworks support a system-level approach in which increasing cooperative participation and enforceability enables scalable oversight and continuous safety

⁸ See Fed. Aviation Admin., *Drone versus Manned Aircraft Collisions* (Jun. 2024), <https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.faa.gov%2Ffiles%2Fgslac%2Flibrary%2Fdocuments%2F2024%2FJun%2F398607%2FDrone%2520Collision%2520List%2520June%25202024.pptx&wdOrigin=BROWSELINK>.

improvement, while allowing non-cooperative sensing to be layered where appropriate based on operational context.

Treating non-cooperative DAA as a universal requirement would invert longstanding aviation safety logic by prioritizing bespoke sensing solutions over interoperability and common standards. Such an approach would fragment the safety ecosystem, complicate FAA oversight, and ultimately undermine the predictability that scalable aviation operations require.

The Public Safety Use Case

BVLOS operations offer significant public benefits that the FAA has repeatedly recognized in civil and public contexts, including Drone First Responder (DFR) law enforcement programs and proactive inspection of critical infrastructure, among others.⁹ These missions generally rely on small, lightweight aircraft where size, weight, power, and cost constraints are central to operational viability. Public safety agencies have conducted extensive BVLOS operations under FAA-issued DFR waivers using procedural, operational, and cooperative mitigations as a baseline safety framework. Imposing a non-cooperative DAA requirement risks severely undermining the paradigm of these high-impact operations by imposing size, weight, and power constraints that many public safety platforms cannot absorb, potentially reversing the significant progress made in the deployment of this critical technology without delivering commensurate system-level safety gains. Further, a cooperative ecosystem raises the safety baseline for all users while preserving flexibility for these types of operators. This model ensures that public safety aircraft are predictable participants in a shared situational awareness framework—a core requirement for effective Safety Risk Management—rather than isolated actors relying on bespoke sensor systems.

In contrast, cooperative detection raises the safety baseline for all users while preserving flexibility for operators to layer additional mitigations as warranted by operational risk and context. Aviation safety has historically advanced by raising the cooperative baseline for all participants rather than by requiring each aircraft to independently sense and resolve every hazard. Non-cooperative detection may reduce residual risk in specific operations, but it does not replace the system-level benefits of shared, cooperative participation. This allows the NAS to remain accessible to safe, compliant users performing missions critical to public safety, national security, and infrastructure resilience.

⁹ See Fed. Aviation Admin., *Part 91 Public Aircraft/Public Safety Operations Certificate of Waiver and Authorization (CoW/A) Frequently Asked Questions v8* (Jul. 3, 2025), https://www.faa.gov/uas/public_safety_gov/public_safety_toolkit/Public_Aircraft-Public_Safety_Operation_CoW-COA_FAQ.pdf.

Conclusion

The success of the BVLOS rule will depend not on how many technologies it mandates, but on how well it integrates UAS into the existing aviation safety ecosystem. The SMS framework lays the groundwork for safety procedures across the aviation industry, encouraging safety policies, risk management, assurance, and promotion in a manner that complements the complexity of varying use-cases and operations. Additionally, cooperative detection offers a proven, interoperable, and enforceable foundation that aligns with decades of aviation safety practice. It moves the industry away from the fragmented landscape of independent DAA solutions toward a more transparent safety architecture that supports scalable oversight and continuous improvement. By anchoring BVLOS policy in safety frameworks and cooperative participation—while allowing flexibility for additional mitigations where appropriate—the FAA can enable scalable operations, deliver public benefit, and uphold its mandate to ensure the safety of the NAS for all users. The CDA remains committed to collaborating with all federal stakeholders to ensure that the NAS continues to uphold its status as the benchmark for aviation safety.