Technical White Paper

Summiting Mount Regulation for Public Sector DFR Programs

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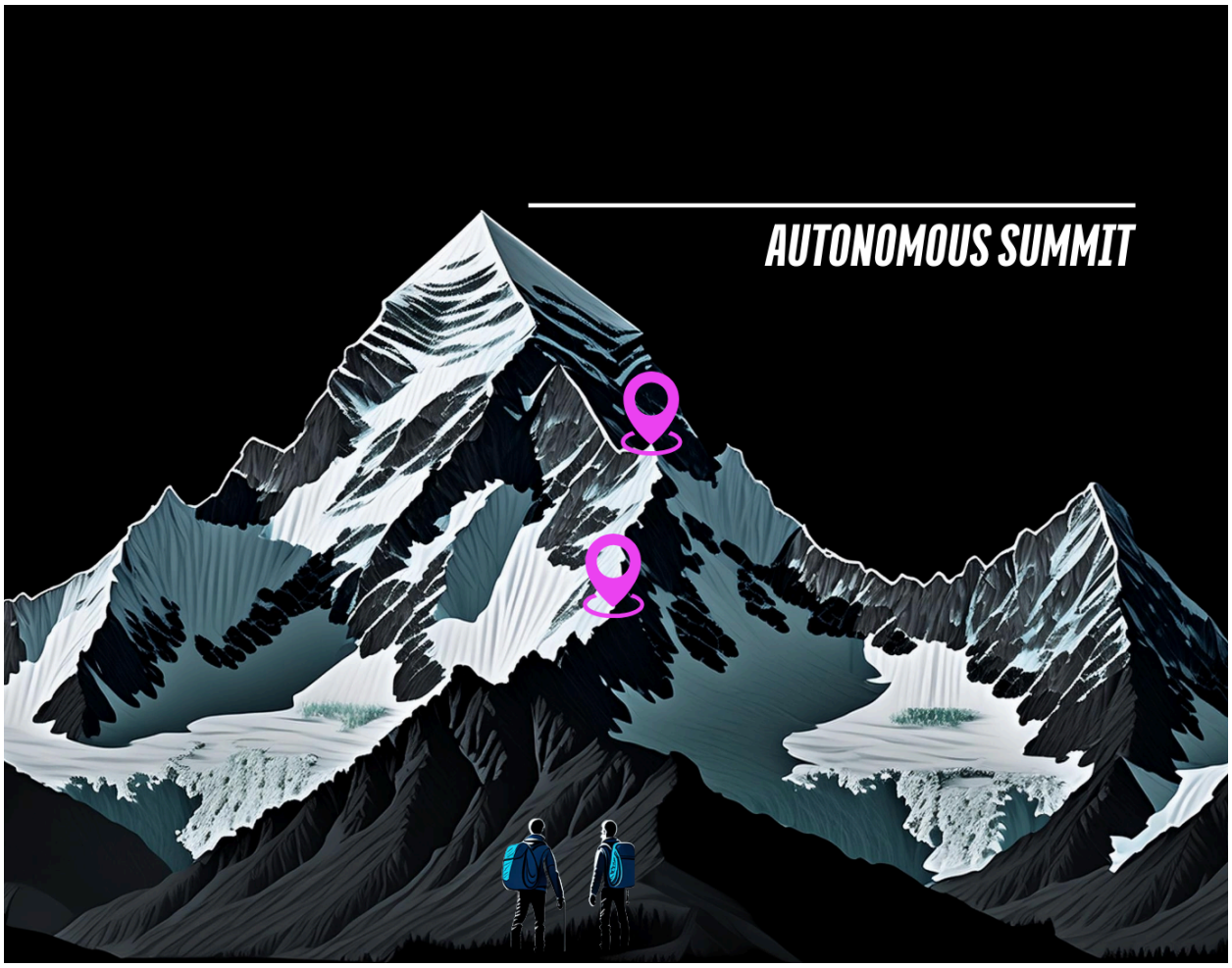


Introduction

In an era where technological advances continuously reshape the landscape of public safety, the deployment of Drones as First Responders (DFR) has emerged as a groundbreaking development. DFR is possible today with the use of visual observers, but removing the requirement for visual observers is key to scaling the concept in communities across the US.

The Skydio Regulatory Team's mission is to steadily and incrementally unlock more advanced DFR operations that are **safe, simple, and scalable** while enhancing public safety and maintaining public trust. This paper delves into our approach to clear regulatory hurdles for DFR programs, including our perspectives on simple and scalable airspace awareness for beyond visual line of sight (BVLOS) operations.

Skydio Regulatory Services Team: Who We Are

Skydio's Regulatory Team consists of aviation experts with a proven track record and extensive backgrounds in aviation operations, technology development, and regulatory affairs. Here are some key aspects of the team:

Diverse Expertise: The team consists of pilots and operations-minded individuals who hold a range of FAA certificates from Certified Flight Instructor to Remote Pilot. With over 25 years of combined experience working at places like the DOJ, NASA, and FAA Test Sites, we have a deep understanding of the drone industry.

We consider ourselves experts in airspace awareness and have extensive experience with various detection and avoidance systems. This expertise allows us to develop comprehensive safety cases and guide our customers through the complexities of regulatory compliance with confidence..”

-Jakee Stoltz, Skydio Director Aviation Regulatory Affairs

Industry Leadership: The Skydio Regulatory Team has consistently been recognized as leaders in advancing drone regulations. Recently, Jenn Player, Head of Aviation Regulatory Affairs at Skydio, held a key leadership role on the Federal Aviation Administration’s (FAA) UAS BVLOS Aviation Rulemaking Committee (ARC) and served on the UAS Detection and Mitigation ARC that provided recommendations to the FAA on both topics.

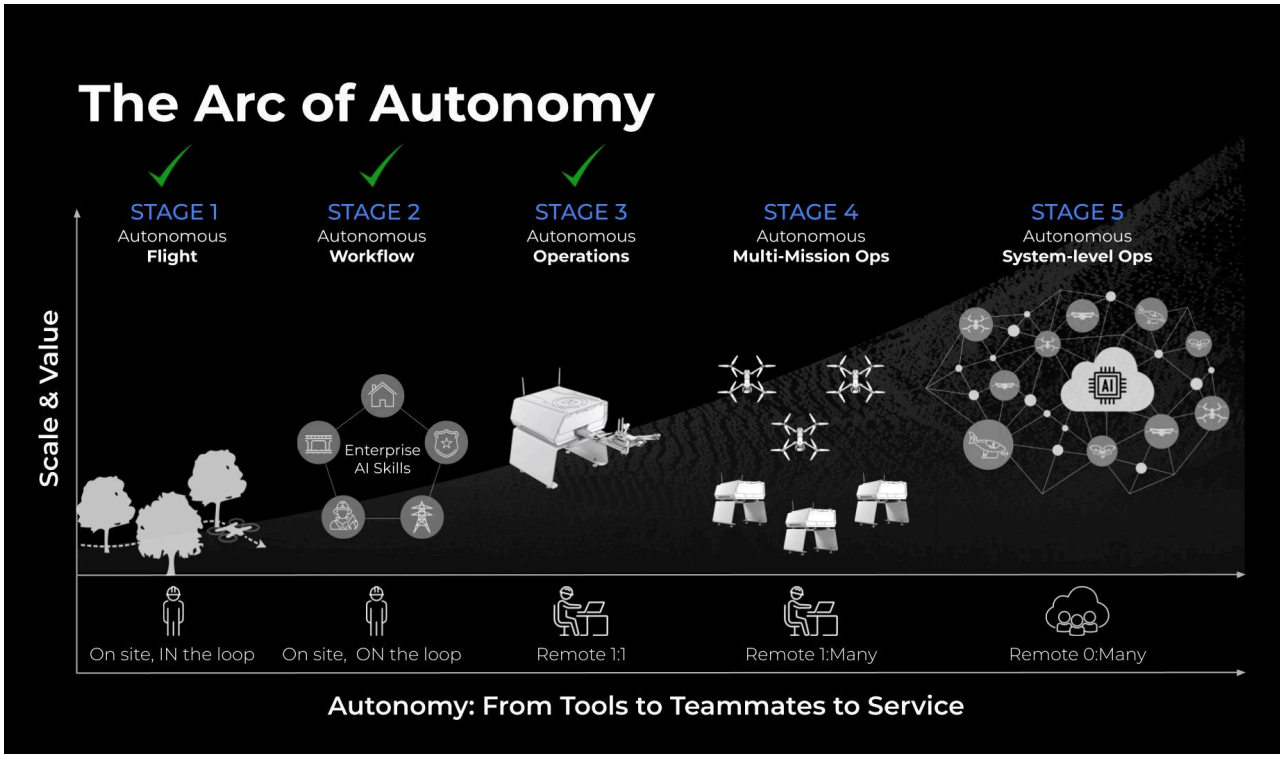
Powerful Partners: The team serves as a powerful partner to Skydio customers, such as Oklahoma City Police Department (OKCPD), by helping them navigate the regulatory requirements necessary to conduct advanced drone operations such as BVLOS without visual observers. This includes learning about an agency's operations and objectives and assisting them with obtaining the necessary FAA waivers.

Did you know?

The Skydio Regulatory Team has more than 25 years of combined experience working with the DOJ, NASA, and FAA Test Sites, and bring a deep understanding of the drone industry to their engagement with customers.

The Skydio Approach to Regulatory Hurdles

In 2021, Skydio laid out an evolutionary path for the industry called the Arc of Autonomy, a framework to move the industry forward from inefficient manual operations to remotely operated drones-as-a-service capable of delivering valuable services 24/7, just like any other piece of basic infrastructure today.



Skydio vision for the future of Drone as First Responder (DFR)

The Skydio Regulatory Team has a proven track record of incrementally moving the industry forward by overcoming regulatory hurdles. Here is the progress Skydio has made with our customers to-date:

1. **2020 - Stage 1 and 2 at scale:** In 2020, the concept of Tactical BVLOS was approved by the FAA. Tactical BVLOS allows public safety pilots to operate drones just beyond line of sight and behind obstacles, without visual observers or costly detect-and-avoid (DAA) technology. Tactical BVLOS approvals have been issued to 568 agencies as of May 2024.

2. **2021 - Stage 3 achieved:** In 2021, BNSF Railway received approval to conduct remote operations of Skydio drones in docks. For the first time, a remotely located pilot could launch a drone from Skydio Dock and conduct BVLOS operations. The

precedent-setting approval combined shielded operations and non-cooperative DAA technology.

3. **2023 to Today - Stage 3 at Scale:** In 2023, the pace of regulatory advancements picked up with a series of approvals enabling fully remote operations **without visual observers**:

    a. In early 2023, Dominion Energy and New York Power Authority received approval to conduct remote operation of Skydio drones in docks. These approvals combined shielded operations, 50’ from the ground or structures, and ADS-B In technology. Importantly, these approvals do not require expensive and cumbersome DAA technology.
    b. In the middle of 2023, Southern Company received approval to conduct remote operations of Skydio drones in docks, this time up to 200’ AGL over critical infrastructure, with the use of ADS-B In, and again without expensive and cumbersome DAA.
    c. In early 2024, Skydio and Pasco County Sheriff Office received approvals to conduct remote operations of Skydio drones in docks, this time up to 200’ AGL within Mode C Veils. This approval leverages ADS-B Out airspace and ADS-B In, and again without expensive and cumbersome DAA.

More than 25 Skydio customers have received similar approvals to-date, and innumerable other companies have taken advantage of this path Skydio helped create.

Unlocking Drone as First Responder

Skydio has been helping public safety agencies achieve advanced operations such as Tactical BVLOS and DFR since 2020. Here is a look

at where Drone as a First Responder is today and more importantly, the Skydio Regulatory Team's approach to removing the requirement for visual observers without adding cumbersome and costly technology like radar systems.

> “Like climbing a mountain, the work we're doing is a journey. It's not something that's been accomplished overnight. We've been working at this for many years, and it takes persistence, teamwork, and patience to navigate our way through some uncharted territory on our way to the summit.”

Jakee Stoltz, Skydio Director Aviation Regulatory Affairs

How DFR is Done Today

Drone as First Responder today is enabled by an FAA approval called a First Responder Beyond Visual Line of Sight Certificate of Authorization (FR-BVLOS COA). This approval allows a remotely located pilot to operate a drone through Skydio Remote Flight Deck software while a visual observer monitors airspace around the drone and communicates hazards to the pilot.

How DFR is accomplished with visual observers on rooftops (credit Federal Aviation Administration) (source: FAA)

visual observers are typically positioned up on a rooftop for clear sightlines to the drone and surrounding airspace, but can be positioned in other locations that afford them a view of the sky. Operations are typically approved up to 400 feet above ground level (AGL) in uncontrolled airspace and up to the UAS Facility Map altitude in controlled airspace. Operations are also allowed over human beings when necessary to safeguard human life.

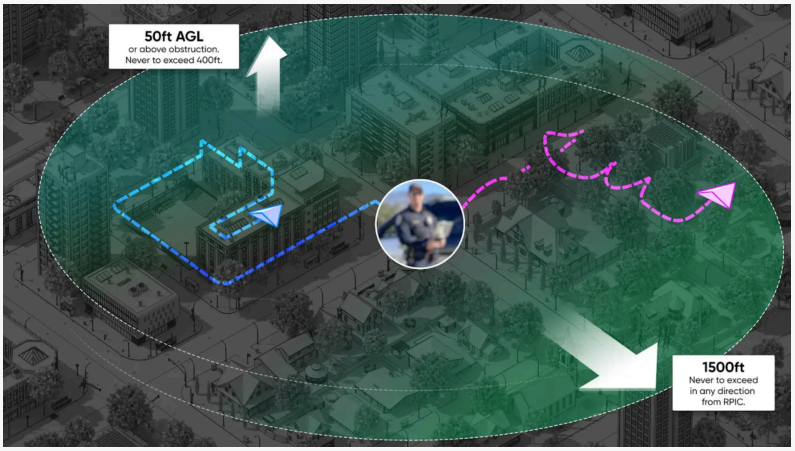
The Skydio Regulatory Team assists agencies in obtaining this approval in a timely, efficient manner so that they can focus on public safety and not on becoming regulatory experts. One example of this was in 2023 for the Oklahoma City State Fair. OKCPD collaborated with Skydio to expand their drone operations and deploy Dock-based Drone as First Responder to increase the safety of attendees at the Oklahoma State Fair.

The Skydio Regulatory Team helped OKCPD navigate the process to get this approval in less than two months, well ahead of the State Fair. This gave OKCPD time to focus on deploying, testing, and mission planning for the event. The deployment leveraged OKCPD officers

positioned throughout the fair as visual observers who communicated airspace hazards to the pilots located in a safe indoor location.

Did you know?

In 2020, the FAA approved the concept of Tactical BVLOS, allowing public safety pilots to operate drones just beyond line of sight and behind obstacles without the need for costly detect and avoid technology. Tactical BVLOS approvals have been issued to 568 agencies as of May 2024.



This approval also supports OKCPD implementation of Patrol-Led DFR using Skydio X10's 5G connectivity and Remote Flight Deck software. In this type of deployment, officers activate Skydio X10 from patrol vehicles and hand off control to remotely located pilots.

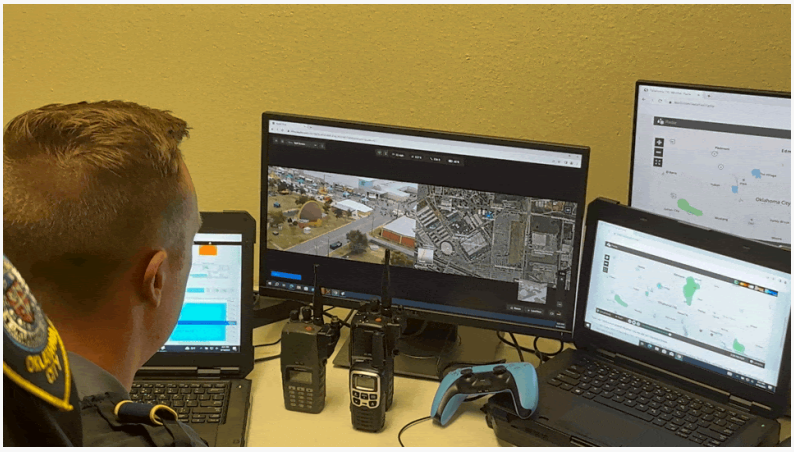
Unlocking Fully Remote DFR at Scale

Skydio customers have been conducting remote operations under Part 107 without the need for a visual observer since 2023, leveraging a combination of shielded operations, Skydio Autonomy, and ADS-B In.

The team is pursuing a similar regulatory approach to unlock DFR remote operations without visual observers and the following sections describe this approach further.

Did you know?

Skydio received approval for one operator to remotely operate up to 10 drones simultaneously, supporting high volume flight testing to ensure Skydio products are rigorously tested during development.



Shielded DFR Operations

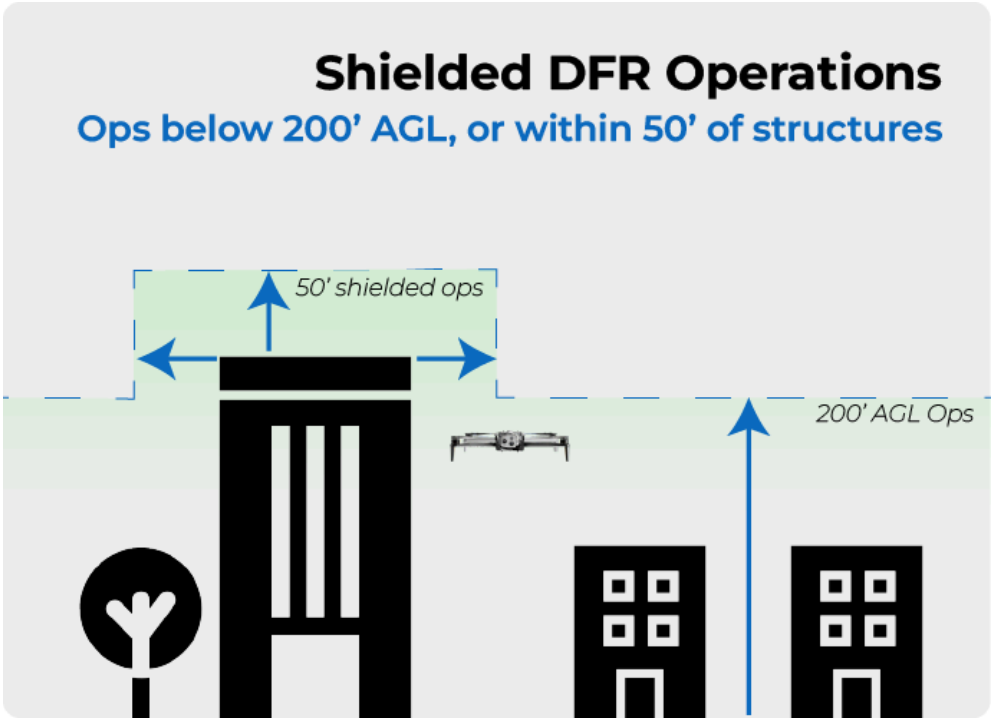
The concept of operating a drone in proximity to structures and other ground obstacles that are avoided by crewed aircraft is referred to as Shielded Operations. Structures and ground obstacles are hazardous to crewed aircraft and are often avoided by 500’ or more, creating a volume of airspace directly around structures and objects where drones can operate without risk of impacting crewed aircraft operations. Skydio has led the way in pioneering shielded remote operations by assisting customers like Dominion Energy, NYPA, and

Southern Company in receiving ground-breaking remote operations approvals.

> “Our experience with the commercial and utilities sectors has informed our approach to DFR. We have seen how shielded operations and autonomy reduce risks and improve efficiency in these sectors. We are now applying these learnings to enhance public safety operations, aiming to provide scalable and effective solutions for first responders.”

Jakee Stoltz, Skydio Sr. Regulatory Program Manager

Skydio worked with numerous agencies to understand how shielded operations could be applied to DFR operations and find a balance between aviation safety and operational capability. The Skydio Regulatory Team developed a new type of shielded operations for DFR up to 200’ AGL, or within 50’ of structures for environments where the structures are taller than 200 feet.



Operating at 200’ AGL or within 50’ of structures, a concept we called Shielded DFR Operations, in an urban environment provides a buffer between the drone and nearly all other aviation activities that are typically no lower than 500’ AGL for their own safety, resulting in a safer operation by decreasing the likelihood of encountering low flying aircraft.

Skydio Autonomy

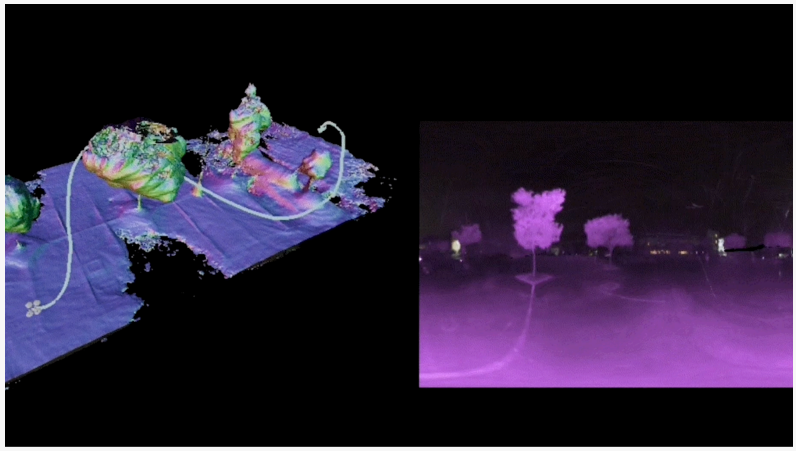
Conducting shielded operations decreases the likelihood of encountering low flying aircraft, but increases the risk of colliding with an object or obstacle.

That is, unless you’re flying a drone equipped with Skydio Autonomy. Skydio Autonomy allows operators to confidently conduct shielded operations, even at night with Skydio NightSense, by reducing the risk of colliding with objects and obstacles. Reduced risk of colliding with objects and obstacles also leads to increased safety to bystanders on

the ground by preventing incidents where the drone strikes and objects and tumbles to the ground.

Did you know?

Skydio NightSense technology enables drones to navigate and operate safely in low-light and nighttime conditions. By using advanced sensors and AI-driven obstacle avoidance, NightSense enables Skydio drones to conduct complex missions even in complete darkness, ensuring operational effectiveness and safety around the clock.



There are numerous other safety features in Skydio Autonomy that support safe operations, including:

- Geofencing and Safe Landing Zones to ensure the drone remains in the desired operations area and can land in a safe location in the event of unforeseen issues

Learn how to use the latest Skydio features for DFR in the latest Skydio Release notes

- Moving Map View with AR Street Overlays to help the pilot maintain situational awareness of their location and the surroundings

AR Street overlays reduce cognitive load by allowing the pilot to understand the operating environment.

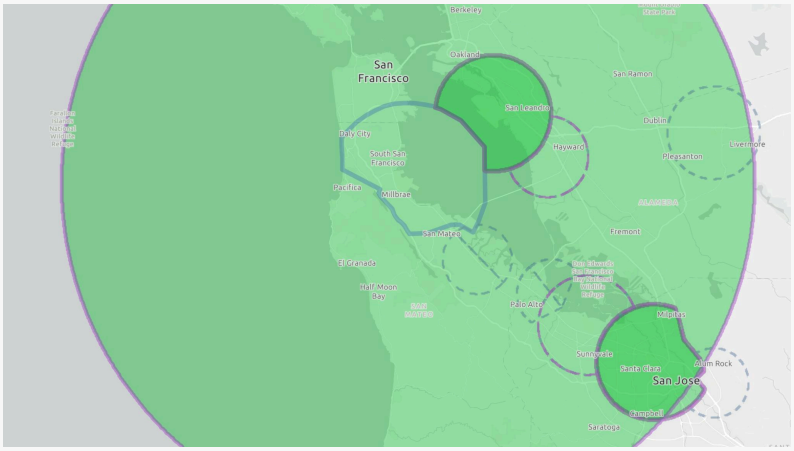
ADS-B Technology

Automatic Dependent Surveillance - Broadcast (ADS-B) is a surveillance technology used in aviation that enables aircraft to determine their position via satellite navigation and periodically broadcast it, along with other relevant information such as altitude, speed, and identity, to air traffic controllers and other nearby aircraft. There are two aspects to using ADS-B Technology for DFR: ADS-B Out and ADS-B In.

Did you know?

Recent reports indicate that as many as 98% of aircraft in Mode C Veils (30 mile rings around America's busiest

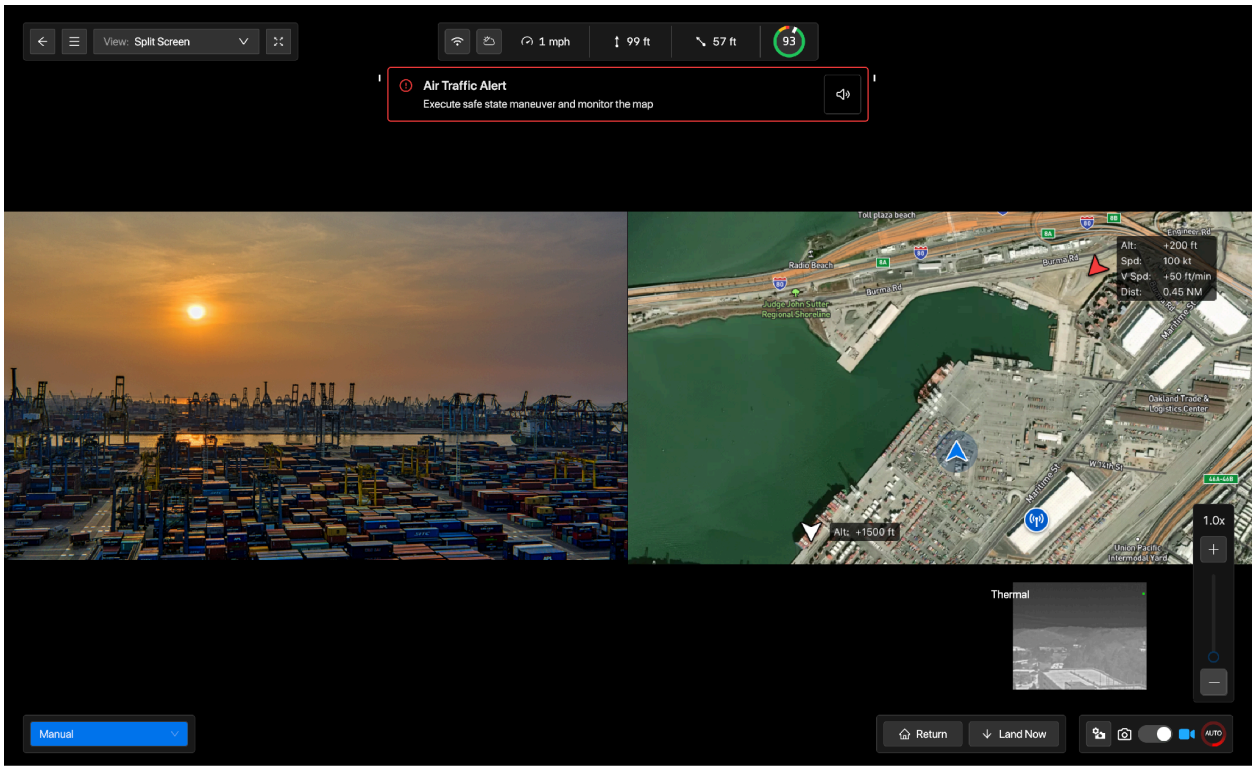
airports) are equipped with onboard ADS-B transponders, significantly enhancing airspace awareness and safety for both manned and unmanned aircraft operations.



ADS-B Out: In 2020, the FAA made broadcasting ADS-B Out mandatory in certain low-altitude airspaces including Mode C Veils, Class B airspace, and Class C airspace. In ADS-B Out airspace, aircraft are required to broadcast ADS-B data unless they receive FAA approval to operate without it. This means that in these airspaces, nearly all aircraft can be seen by drone operations receiving the ADS-B data.

ADS-B In: Skydio integrated ADS-B In in the Skydio Dock and Remote Ops platform in 2023 which enabled commercial customers under Part 107 waivers to begin conducting remote operations without a visual

observer.



Example of Air Traffic Alert in Skydio Flight Deck Drone as First Responder (DFR) software.

The Skydio ADS-B integration is simple to use and helps operators remain well clear of low flying aircraft. Operators are able to see the position and relative altitude of ADS-B equipped aircraft on Remote Flight Deck's map view.

In the unlikely event that a low flying aircraft, such as a medivac helicopter, approaches the drone's position, the operator receives an alert which directs their attention to the Map View. The low flying aircraft is color coded and precise information including relative altitude, relative distance, and speed is displayed next to the aircraft. This assists the operator in making a quick decision whether or not an avoidance maneuver is needed to give way to the aircraft.

Experts in Airspace Awareness

Airspace awareness is important for safety and security reasons. Agencies should consider two types of airspace awareness when evaluating technology:

1. Airspace awareness around sensitive areas like airports, jails, and special events. Commonly referred to as Counter UAS (C-UAS).
2. Airspace awareness for BVLOS operations.

The technology needed to support both use cases can vary and the Skydio Regulatory Team's extensive experience with non-cooperative detect-and-avoid (DAA) technology, from radars to electro-optical to acoustic systems, has given us a deep understanding of how each system can be used to support both types of airspace awareness.

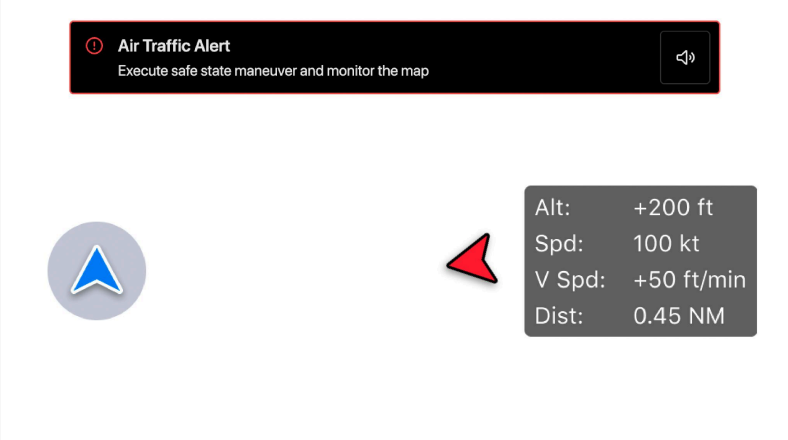
> “Radars can be almost too good at seeing things, including birds and vehicles, which adds complexity and cognitive load for the operator. This makes it challenging to differentiate between actual threats and benign objects, adding unnecessary workload for pilots.”

Jakee Stoltz, Skydio Director Aviation Regulatory Affairs

For example, radars are commonly used as part of a layered Counter UAS system and are quite good at detecting unknown objects for further identification by a camera or radio frequency (RF) system. But when used by themselves for BVLOS operations, can have drawbacks where a pilot must interpret this radar data to determine what is and what isn't a threat.

Did you know?

Skydio's ADS-B integration is simple to use and helps operators remain well clear of low-flying aircraft. Operators receive alerts showing the relative altitude, location, and distance between the drone and approaching aircraft, facilitating quick and informed decision-making.



The Team's experience with airspace awareness technology has informed our current approach to use Shielded DFR Operations and ADS-B In without leveraging non-cooperative technology at this time. We believe this approach is more cost effective and simple which supports scalability.

Cost Effectiveness

ADS-B technology is cost effective. The cost of an ADS-B receiver is far less (2-3 orders of magnitude) than other sensors and has a far greater range, resulting in fewer sensors needed to provide complete airspace awareness of an agency's jurisdiction.

Example of airspace awareness system tested by Jakee Stoltz during his tenure as a Northern Plains UAS Test Site

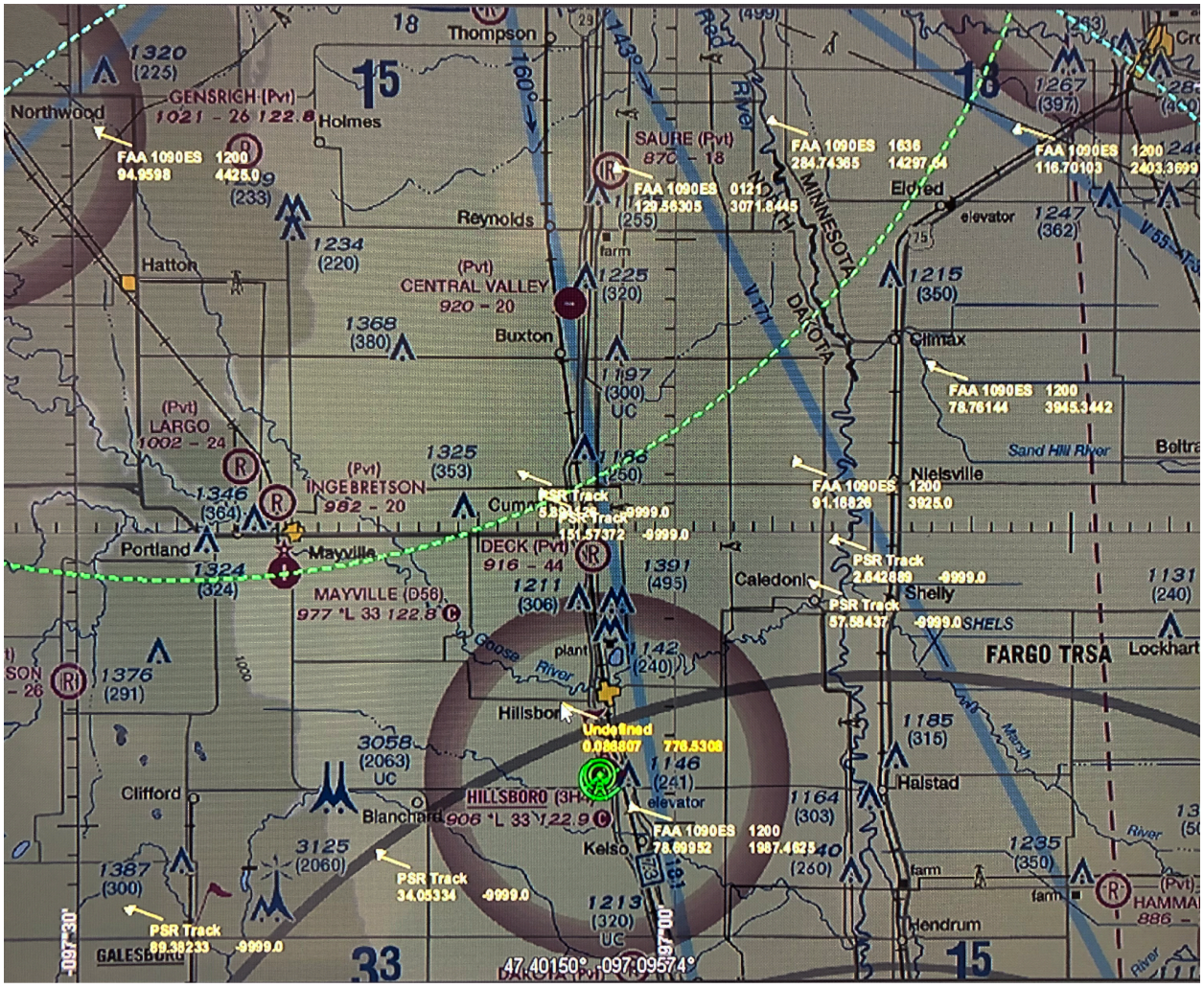
Other types of sensors can come with high costs, unique installation requirements, and yearly expenses for software and maintenance.

Simplicity

ADS-B technology is based on GPS which results in precise information about where aircraft are, their altitude, and their speeds.

Skydio Remote Flight Deck then displays this information to pilots in an easy to understand manner that supports quick decision making in the event the drone needs to be maneuvered to give right of way.

Other sensors have to estimate where aircraft and often have detection rates below 100% or the possibility of false positives. Radars, for example, detect other objects such as party balloons, vehicles, birds, and trees swaying in the wind. This is referred to as “ground clutter” and it becomes difficult for a pilot to determine if a detected object is a low flying helicopter or a semi-truck. Software algorithms can filter out some of this ground clutter, but it is difficult to completely remove it so that a DFR pilot only sees low flying aircraft.



Airspace awareness displays with radar data can be difficult for pilots to interpret, requiring additional training and experience. In this example, ADS-B data is shown with Primary Surveillance Radar (PSR). PSR targets have unknown altitudes with 2D radars.

Approvability

Skydio began a trend in 2023 of helping commercial customers receive remote operations approvals using the combined approach of shielded operations and ADS-B technology. This trend has continued to this day with over 25 customers conducting remote operations today and countless other operators in the drone industry receiving similar approvals. The Skydio Regulatory Team believes this success will continue in 2024 and beyond as public safety agencies like Pasco

County Sheriff's Office begin to receive approvals to conduct operations up to 200' AGL in a Mode C Veil.

Did you know?

NYPD uses remotely operated Skydio drones to respond to calls for service? These drones, equipped with advanced autonomy and airspace awareness technology, provide real-time situational awareness, allowing officers to assess and respond to incidents more effectively and safely.

> Our goal at Skydio is to bring our expertise to our customers and help them achieve success as well."

Jakee Stoltz, Skydio Director Aviation Regulatory Affairs

Conclusion

As the deployment of Drones as First Responders (DFR) evolves, Skydio stands at the forefront of this technological revolution, striving to unlock the full potential of fully remote DFR operations at scale. By addressing regulatory challenges head-on and leveraging innovative solutions such as DFR shielded operations, Skydio Autonomy, and ADS-B In, Skydio continues to make strides in advancing the ability of public safety agencies to conduct safe, efficient, and effective drone operations without the need for visual observers.

Skydio's Regulatory Team, with its deep expertise and proactive engagement, has played a pivotal role in this progress. Their efforts have enabled public safety agencies to overcome regulatory hurdles, obtain necessary waivers, and implement advanced drone programs that enhance community safety and operational efficiency. The success stories of Skydio's collaborations with various agencies demonstrate the tangible benefits of these efforts, showcasing how drones can transform public safety operations.

WATCH: Summiting Mount Regulation for Drone as First Responder (DFR) Programs

Looking forward, Skydio remains committed to continuous innovation and regulatory excellence. As the landscape of public safety continues to evolve, Skydio will lead the way in integrating drones into critical operations, fostering safer and more responsive communities.

See how Skydio Regulatory Services can help your program meet its goals: https://www.skydio.com/skydio-regulatory-services