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Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap

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Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap, 3rd Edition 2020

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Introduction

Unmanned aircraft systems (UAS) are fundamentally changing not only aviation, but also the way we live and do business. Drones are reinventing industries and creating new ones every day. The promise of full integration of drones means a future where better health care, safer working conditions, faster commercial delivery, and so much more will be available to millions of Americans. But the safe integration of unmanned aircraft into the National Airspace System (NAS) is a significant challenge. The Federal Aviation Administration (FAA) has made great strides in developing the technical and regulatory standards, policy guidance, and operational procedures on which successful UAS integration depends.

Since the last edition of this Roadmap, we have achieved several goals, including:

- Establishing full FAA authority over all UAS operating in the NAS through the 2018 FAA Reauthorization Act, in which 50 UAS-related provisions were outlined
- Expanding automation for how drone users get near real-time permission to fly in controlled airspace through the Low Altitude Authorization and Notification Capability (LAANC)
- Granting more than 65,000 waivers and exemptions to allow more drone fliers to complete advanced operations
- Leveraging existing regulations to enable new and novel operations through the UAS Integration Pilot Program (IPP), launched by Secretary of Transportation Elaine L. Chao two years ago
- Outlining what universal requirements for remote identification (remote ID) will look like and drafting a notice of proposed rulemaking (NPRM)
- Continuing to lay the groundwork for a comprehensive UAS Traffic Management (UTM) system by working closely with the National Aeronautics and Space Administration (NASA) and other partners

On these and several other accomplishments, this third edition of the "Integration of Civil Unmanned Aircraft Systems in the National Airspace System Roadmap" (Roadmap) provides an update on the progress the FAA has made thus far in achieving UAS integration. It also gives a 5-year outlook on the path and the challenges that lie ahead, including detect and avoid (DAA) technologies and the demand for advanced air mobility advanced air mobility (AAM). As you will read in this Roadmap, through partnerships with industry and other stakeholders, the FAA is harnessing the energy, know-how, and innovation needed to reach the goal of full UAS integration as soon as possible. To do that, it will continue to be a combined effort between the FAA and our stakeholders, sharing trends, efficiencies, and solutions to ensure aviation safety remains at the forefront.

As you read through this year's Roadmap, which has been streamlined versus previous versions since many our UAS-related activities and accomplishments are captured in numerous online resources, we hope you will agree that we are seeing a success story in the making, not only in terms of progress, but also in terms of expanding operations and capabilities. As safety is everyone's responsibility, the FAA encourages you to help share the safety message and join the discussion as we work to expand UAS integration in our nation's skies. We're confident that our joint success will continue, and we are eager to see what we will accomplish together in the next few years.

Executive Summary

The third edition of the Roadmap comes at a time when we are witnessing rapid developments in the UAS landscape. The Integration Pilot Program (IPP), for example, is nearing completion, with results coming in from all corners of the United States. The nine IPP Lead Participants have been evaluating a host of operational concepts, including night operations, flights over people and beyond the pilot's line of sight, package delivery, detect-and-avoid technologies, and the reliability and security of data links between pilot and aircraft. We have already seen direct societal benefits such as faster medical test deliveries via drone to labs in North Carolina, pipeline monitoring in Alaska, package delivery in Virginia, and new and novel ways for public safety to engage with the public in California. In other non-IPP partnerships we see drones used to assist with disruptions to rail traffic. Drones are also being used to gather information before law enforcement enters a crime scene, in some cases helping to avoid danger, and in others saving resources by discovering that an urgent response is not required. And yes, drones are delivering burgers too. Always mindful of the risks involved, there can nevertheless be no doubt now: drones have the capacity to change how we live for the better.

This Roadmap lays out the current and projected status of many of the most complex issues the FAA and the drone community face as we work together to integrate UAS into the NAS. It touches on recent UAS accomplishments, the 2018 Reauthorization Act, the UAS Integration Pilot Program (IPP), other partnerships, the regulatory outlook, airspace access and management, and education and outreach efforts. As we look to the future, we must consider the challenges of remote ID implementation, counter-UAS (c-UAS) issues, UTM and AAM. The Roadmap also focuses on the challenges of the pace of UAS innovation and the human element—societal acceptance. Certainly there is a long road ahead of us. But the Roadmap tells another story, too. Here we see a path forward, through regulation and innovation, all in the service of seamless drone operation. It is the story of an Agency and Department determined to work with stakeholders to overcome obstacles, in the pursuit of the promise of an airspace system that includes manned and unmanned aircraft operating safely in the sky.

Charting the Path Forward

Led by Secretary Chao, the Department of Transportation developed an ambitious vision for safely integrating UAS. The FAA, in close coordination with organizations across the US government, intends to fully integrate unmanned aircraft into the NAS, with drones operating safely and seamlessly with manned aircraft. Manned and unmanned aircraft may occupy the same airspace and in some cases, use the same air traffic management systems and procedures. We seek to integrate, not segregate.

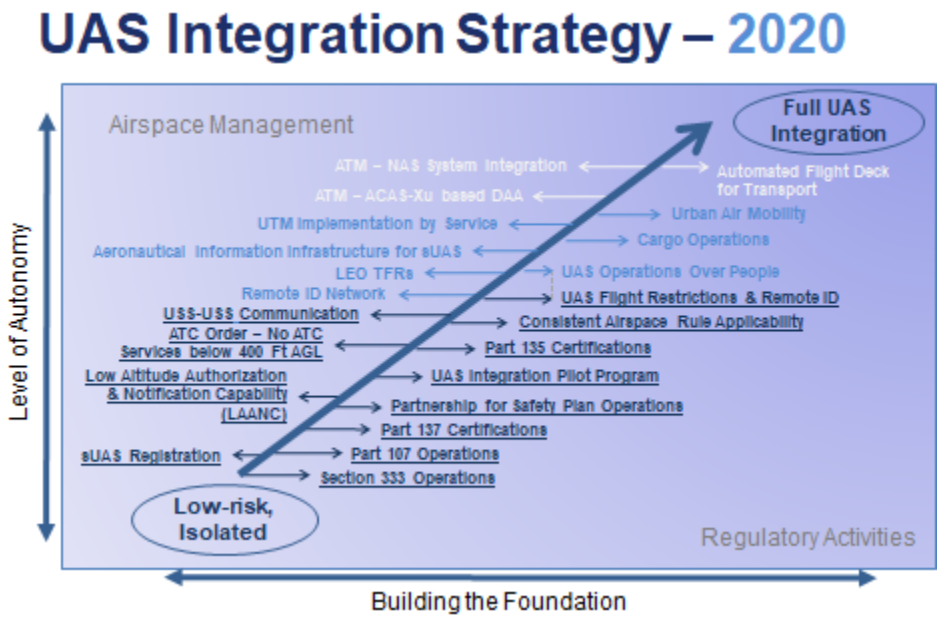
The FAA has reinforced its focus on the safety of all aircraft operations as we work on a number of initiatives to support UAS integration. We have continued to engage in outreach to UAS operators and the public at large to educate current and prospective drone users about their safety responsibilities.

We are also developing new rules for UAS integration into the NAS, including a proposed new rule on the issue of remote identification of UAS operators, a crucial stepping stone for UAS traffic management.

As we approach UAS integration with expanded operations, the FAA is working with stakeholders to make sure that all security concerns are addressed. The Agency is cognizant of adverse scenarios where operators have malicious intentions and want to cause disruption and harm. There has to be a clear balance between security and expanding operations.

Right now, the FAA is leveraging an "operations first" approach to authorize UAS operations using existing regulations. Through the use of our current regulations and associated exemptions, we are paving a path forward for the development of future policy and regulations. Simultaneously, the FAA is conducting UAS research in a "building block" approach for operational capabilities. As this research informs rulemaking and policy activities, the FAA will enable increasingly more complex UAS operations over time, including (future) autonomous beyond visual line-of-sight (BVLOS) operations and flights over people not directly participating in the operation.

Figure 1. UAS Integration Strategy – 2020



The FAA has spent six decades working with airlines, manufacturers, and countless others to create the safest airspace in the world. We are ready to use everything we have learned from manned aviation to make sure the drone industry can reach its full potential as quickly and safely as possible. Figure 1 shows the path from introduction of UAS into the NAS, previous accomplishments (including Small UAS (sUAS) Registration, Part 107, IPP, and more), current work (Part 135 certifications, Operations Over People, Remote ID, and more), and future needs and challenges (cargo operations, AAM, automated flight deck) that will lead to UAS being fully integrated into the NAS.

Recent UAS Integration Activities & Accomplishments

To see where we are headed with UAS integration, we need to first know where we are today. Guiding the FAA's activities in recent years and at present are several key priorities. Specifically, the FAA has been working to:

- leverage the safety culture of industry partners to increase safety awareness among all parties, especially recreational fliers;
- increase education for operators, automating authorizations through LAANC – another key component of our UTM architecture—and streamlining our internal waiver evaluation process to meet the demand for more waivers and controlled airspace authorizations than ever before;
- identify gaps in research and development (R&D) to inform integration and recommend prioritized changes or additions to policies and capabilities to achieving integration;
- make major progress on real-world testing and develop or deliver additional new rules to codify what we're learning; and
- work with industry to facilitate the development of risk-based consensus standards, while ensuring that future rulemaking efforts for more complex operations fully address safety and security requirements that haven't traditionally been considered aviation concerns.

In addition to our domestic activities, we are also contributing the FAA's international goal of being a global leader. To that end, in the past year, we have met bilaterally and multilaterally to share lessons learned and best practices with the goal of harmonizing with key international partners as each State develops its own regulations to integrate UAS into the airspace of their respective countries.

In 2019, the FAA began publishing quarterly progress reports which recap many of the key integration-related deliverables and accomplishments of the FAA. These reports may be found here: https://www.faa.gov/about/plans_reports/#accomplishment.

Below is information on the FAA Reauthorization Act of 2018 as well as the current status of the UAS Integration Pilot Program, existing partnerships, the UAS regulatory outlook, airspace access and management, outreach, enforcement, and key research. This information provides a snapshot of present-day FAA UAS activities. When available, links are provided for more information.

2018 Reauthorization Requirements

The UAS-related requirements in the FAA Reauthorization Act of 2018 support the integration of UAS, maintaining the overall safety and security of the NAS, and reinforce the FAA's Implementation Plan approach. As the provisions in the Act demonstrate, the FAA's focus is on using existing regulations to create pathways for advanced operations today. This reauthorization is valid until 2023 and allows us the flexibility to continue to be the world leader in aviation safety and innovation.
The numerous UAS-related provisions included in the Reauthorization Act re-affirm the FAA's commitment to the success of the IPP, the FAA's focus on enabling operations for both civil and public operators, and on developing more security measures to enable safe integration. The UAS provisions also reinforce what is in the FAA UAS Implementation Plan.

As the provisions in the Act demonstrate, the FAA's focus is on using existing regulations to create pathways for advanced operations right now while we simultaneously develop performance-based rules that will enable routine complex operations in the future. The FAA looks forward to further collaboration with Congress and the Administration as we continue to implement the requirements of the 2018 Reauthorization Act and advance safe and secure UAS integration into the nation's airspace.

The Act can be viewed at https://www.congress.gov/115/bills/hr302/BILLS-115hr302enr.pdf.

The UAS Integration Pilot Program

One of the most exciting new developments in FAA's efforts is the IPP. In October 2017, the United States Executive Office of the President issued a Presidential Memorandum for the Secretary of Transportation to establish the IPP, and required the FAA to prioritize support for the effort through FY 2020. The IPP is a partnership with state, tribal, and local governments to jointly test and mature the concepts, processes, and data required to further integrate UAS into the NAS, as well as to build public acceptance that will support expanded operations nationwide. The IPP Lead Participants began operations, as well as community outreach initiatives, in 2018. The FAA draws upon the results of the IPP partnerships to inform rules, processes, and procedures to enable expanded UAS operations.

More information about the IPP may be found at:
https://www.faa.gov/uas/programs_partnerships/integration_pilot_program/.

Existing Partnerships

Partnership for Safety Program

The UAS Partnership for Safety Program (PSP) was launched in December 2016 to address and advance complex UAS operational capabilities. The PSP establishes working relationships between the FAA and industry, and facilitates the full integration of UAS into the NAS.

Pathfinder Program

In May 2015, the FAA announced the UAS Focus Area Pathfinder Program, an industry partnership program to develop and validate operational concepts for certification, operations, and safety beyond established or proposed policies and procedures. The three industry partners – CNN, PrecisionHawk, and BNSF Railways – focused their work on the operational expansion of: visual line-of-sight operations over people; extended and BVLOS operations in rural areas; and BVLOS operations over right-of-ways.

By the end of 2017, the program's three focus areas had all met their planned objectives, namely to:

- define the parameters to allow for safe operation of drones in the NAS;
- obtain operational approval for the Pathfinder industry stakeholder to perform routine, limited operations; and
- to define under what conditions and constraints similar operations may be approved for future applicants.

Additional information can be found at https://www.faa.gov/uas/programs_partnerships/completed/.

Regulatory Outlook

The FAA is currently undertaking several regulatory efforts designed to increase access to the nation's

airspace while enabling more routine, complex operations. Below is a summary of each of these initiatives.

Registration and Marking

Viewed as one of the fundamental pillars of unmanned traffic management (UTM), UAS registration is a critical element for building a system that operates independent of, but complementary to, the traditional air traffic control system. Much like the registration data sets that states use for automobile license plates, UAS registration provides the FAA and approved authorities the ability to associate a drone operator with their specific drone(s).

For more information on the FAA DroneZone platform, visit https://faadronezone.faa.gov.

Remote Identification

Safety and security are top priorities for the FAA and remote ID of UAS is crucial to our integration efforts. Remote ID is the ability of a UAS in flight to provide identification information that can be received by other parties. It is envisioned that remote ID will help facilitate more advanced operations for UAS and lay the groundwork for future UTM. It will also assist the FAA, law enforcement, and federal security agencies when a UAS appears to be flying in an unsafe manner and/or where the drone is not authorized to fly.

In December 2018, the FAA issued a Request for Information (RFI) to establish an industry cohort to explore potential technological solutions for remote ID. Remote ID is the next step to enable safe, routine drone operations across our nation. This capability will enhance safety and security by allowing the FAA, law enforcement, and Federal security agencies to identify drones flying in their jurisdiction.

Throughout 2019, the FAA worked on a notice of proposed rulemaking (NPRM) for remote ID. This draft NPRM sought public input to identify major drone safety and security issues that may pose a threat to other aircraft, to people on the ground or to national security. This is a complex issue, and the FAA has worked diligently to draft a proposed rule that meets legal requirements and provides the most comprehensive proposal to enable the next phase of UAS operations. The NPRM was posted in December, 2019.

Updates and progress are noted on our website at
https://www.faa.gov/uas/research_development/remote_id/

Operations Over People and at Night

The sUAS Rule, or Part 107, established rules for routine, low-risk sUAS operations within the line of sight of the pilot. An increase in the interest of industry to fly complex operations under part 107 called for streamlining the process to obtain waivers. Examples of more complex operations that require a waiver under part 107 include BVLOS operations, flights over people, and night operations. The DroneZone portal is FAA's one-stop shop for registration and waivers and applicants are able to complete these processes online.

In an effort to make these types of operations more routine, a draft NPRM proposes changes to the Small UAS rule to balance the need to mitigate safety risks without inhibiting technological and

operational advances. The comment period for the Operations over People draft rule closed April 15, 2019. The FAA received over 930 comments on the proposed rule and is currently in the process of reviewing and assessing them.

Unmanned Traffic Management

UTM is essentially a set of concepts and tools that NASA, the FAA, and industry are developing to safely manage dense low-altitude drone operations. UTM is not a specific equipment system; rather it is a suite of systems and services that will be complementary to the existing air traffic management system and will not replace it.

The FAA is working closely with NASA, which has done some of the heavy lifting with its UTM technical capability level (TLC) demonstrations. A key element of these UTM tests is having some form of identification—the ability for those managing or monitoring the traffic to be able to contact the drone, its control station, or both, when necessary. For manned aircraft, we have tail numbers on the vehicle, and if they are flying in dense airspace, they are required to have transponders and VHF radio equipment onboard so that air traffic control can track or contact them. Remote ID, in combination with registration and communication connectivity, will allow UTM to work similarly, providing a link between UAS pilots, UAS Service Suppliers (USS), other aircraft, and, where applicable, air traffic control.
For more information on the vision for UTM and it specific components, as well as the FAA's latest published "UTM Concept of Operations Version 2.0" , visit https://www.faa.gov/uas/research_development/traffic_management/.

Research with NASA

The FAA is working with NASA on the development of UTM as it may serve as the "backbone" for future UAM operations. The FAA and NASA have transitioned initial UTM capabilities and associated data exchange requirements into FAA test facilities at the William J. Hughes Technical Center (WHJTC). NASA has already transferred to the FAA some prototype capabilities used in the UTM Pilot Program (UPP) and will continue to share new capabilities through FY 2020.

UTM Pilot Program

The FAA Extension, Safety, and Security Act of 2016[1] directs coordination/collaboration, development, and publication of a UTM Research Plan and establishment of a UPP. In 2015, a Research Transition Team was formed between NASA and the FAA to jointly develop and enable an sUAS traffic management ecosystem to provide management services to sUAS operations. Established in April 2017, the UPP's primary goal is to develop, demonstrate, and provide an enterprise service to support initial UTM operations.

In August 2019, the FAA completed UPP Phase 1 collaboration with NASA, three FAA UAS Test Sites, and their industry partners. Phase 1 included multiple successful demonstrations that tested capabilities like UAS volume reservation and sharing of intent between UTM participants and the FAA. In each case, both VLOS and BVLOS operations were conducted and UAS were safely deconflicted. For additional information regarding UPP Phase 1, please refer to the UPP Summary Report.

[1] Pub. L. 114-190 § 2208 (July 15, 2016)

As directed by the FAA Reauthorization Act of 2018, the UPP is required to meet additional objectives prior to completion. In the summer of 2020, the FAA plans to collaborate with NASA, FAA UAS Test Sites, industry stakeholders, and UAS Integration Pilot Program (IPP) to launch UPP Phase 2. Phase 2 will include testing of capabilities and services that support high-density UAS operations, including remote identification (Remote ID) and public safety operations. Data collected from Phase 2 demonstrations will help inform a UTM Implementation Plan that is currently in development by a cross agency team at the FAA.

More information about the UPP may be found at:
https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program/.

Airspace Access and Management

Routine and regularly documented communications with air traffic control (ATC) is a norm for manned aviation pilots. In order to address the growing number of UAS users, a similar process allowing authorized UAS into controlled airspace was developed through legislative, industry, and FAA activities to reduce the original burdensome process of requesting airspace authorization for both ATC and UAS operators. Current rules require that remote operators obtain ATC authorization prior to operation in controlled airspace. LAANC automates this process, allowing operators to obtain near-real time authorization prior to their operations. LAANC will continue fostering equitable access for all users and service providers while ensuring critical ATC technical and safety requirements are met for NAS operations.

Low Altitude Authorization and Notification Capability

LAANC is an innovative collaboration between FAA and industry. It provides access to controlled airspace near airports through near real-time processing of airspace authorizations below approved altitudes in controlled airspace for part 107 operators. It is available at approximately 400 air traffic facilities covering about 600 airports.

In July 2019, LAANC was expanded to provide airspace authorizations for recreational UAS flyers as required by the 2018 FAA Reauthorization Act. With this recently-expanded availability of LAANC, the FAA has automated the application and approval process for airspace authorizations for more flyers than ever before. This is a major step in building the infrastructure of our UTM system.

Viewed as a foundational component of the aforementioned UTM ecosystem, LAANC is a significant step forward in terms of automating systems to support the ever increasing volume of UAS operations. It has enabled near-real time issuance of airspace authorizations under part 107 using FAA-approved USS. LAANC facilitates the sharing of airspace data between the government and private industry, and also enables part 107 operators to obtain approval of airspace authorization requests for the UAS flight approval criteria indicated by the UAS Facility Maps (UASFMs). The creation and public release of UASFM,[2] in conjunction with LAANC, helped enable the FAA to shift a majority of airspace authorization requests from a labor-intensive manual process to a more streamlined, online, near real-time system.

[2] https://www.faa.gov/uas/request_waiver/uas_facility_maps/

More information on LAANC may be found at:
https://www.faa.gov/uas/programs_partnerships/data_exchange/.

Facility Maps

UAS Facility Maps (UASFMs) are maps the FAA developed to streamline the airspace authorization process and became the foundation for LAANC. These maps depict areas and altitudes near airports where UAS may operate safely. Facility maps display grid cells representing distances above ground level (AGL) in one square mile up to 400 feet where drones may fly. Areas of the map indicating 0 AGL help to identify critical locations around airports. UAS operations in these areas may not be pre-authorized. In order to obtain authorization to operate in these areas, further coordination between the operator and ATC is needed. FAA air traffic personnel will use the maps to process part 107 airspace authorization requests. Altitudes that exceed those depicted on the maps require additional safety analysis and coordination to determine if an application can be approved. UASFMs are intended to be informational maps and do not give operators permission to fly drones. However, these maps help to simplify the authorization process and increase the likelihood that the FAA will approve a request to operate in controlled airspace.

Outreach & Stakeholder Engagement

The FAA is heavily invested in educating today's drone community, especially hobbyists, on what they can and cannot do. An uninformed recreational flier in the wrong place at the wrong time could threaten manned aircraft or innocent bystanders. Since mid-April, 2019, the FAA has held seven drone webinars, three public safety seminars and two Facebook Live question and answer sessions that reached nearly 70,000 people, generating about 4,000 questions or comments. That's a success story for outreach, but we are just scratching the surface since there are more than 1.4 million registered drones. Below are some of the ways we conduct outreach to the various communities when it comes to UAS safety.

FAA UAS Symposium

For the past several years, AUVSI has partnered with the FAA to host the yearly FAA AUS Symposium. Attended by more than 1,500 members of all sectors from across the globe, the Symposium hosts keynote speakers, panels and "how to" meetings to discuss the latest topics related to the growing use of UAS and its integration into the national airspace.

For more information, visit https://www.faa.gov/uas/resources/events_calendar/archive/
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National Drone Safety Awareness Week

National Drone Safety Awareness Week helps educate the public about drone safety by highlighting how key sectors of the drone community are engaging with the public and spreading awareness throughout all 50 states on specific focus areas. It also offers an opportunity for drone stakeholders and users to kick off new safety initiatives.

Through National Drone Safety Week, the FAA promoted stakeholders' safety stories, successes, events, and educational programs. Everyone is encouraged to participate in this weeklong campaign. Drone safety is everyone's responsibility, and this event advanced public-private partnerships and collaboration.

For more information visit
https://www.faa.gov/uas/resources/events_calendar/drone_safety_awareness/.

Webinar Series

The FAA hosts a free drone webinar series to help drone pilots understand how to operate in the NAS, how to start a drone program, and how to fly during an emergency. FAA experts address a variety of topics including why airspace matters, how and where recreational flyers can fly their drone, how Public Safety organizations can start a drone program, and more.

For more information, visit https://www.faa.gov/uas/resources/webinars/.

B4UFLY Mobile Application Partnership

Recreational users who only fly their drone for fun now have an improved app – B4UFLY – to help show where they can and cannot fly with interactive maps.

The FAA has partnered with Kittyhawk to redevelop the FAA's first mobile application, to improve the user experience so that recreational flyers know whether it is safe to fly their drone. The app provides real-time situational awareness to recreational flyers and other drone users. It does not allow users to obtain airspace authorizations to fly in controlled airspace, which are available through LAANC. Airspace authorizations outside the FAA UAS facility map grid altitudes can be requested through the FAA DroneZone.

For more information, visit https://www.faa.gov/uas/recreational_fliers/where_can_i_fly/b4ufly/.

STEM

The FAA has developed multiple campaigns and outreach materials to educate students about UAS and UAS safety. These campaigns and collateral include Buzzy the Drone, UAS stickers, and more. In addition, FAA provides information on its website for educational UAS users included STEM and education as a focus day as part of National Drone Safety Awareness Week in November 2019. In addition, the FAA's UAS Integration Office participates in a variety of different events across the country to encourage students to learn about aviation, UAS, and STEM and consider careers in these fields. In May 2015, the FAA awarded its first Center of Excellence (COE) for Unmanned Aircraft Systems (AUS) to the Mississippi State University led academic consortium: Alliance for System Safety of UAS through Research Excellence (ASSURE). To fulfill its FAA COE requirement for providing benefit to the public, ASSURE established a UAS STEM education program to inspire minority and underserved middle and high school youth throughout the US to pursue scientific degrees and careers. The program has been conducted in the form of summer camps over the past several years.

Public Safety

Public Safety agencies, such as law enforcement, are in the best position to deter, detect, and investigate unauthorized or unsafe UAS operations. While drones can serve as a useful tool, these agencies also have an important role in protecting the public from unsafe and unauthorized drone operations.

Through the Law Enforcement Assistance Program (LEAP), the FAA's Office of Security and Hazardous Materials Safety has developed a toolbox for public safety entities on the enforcement of drone regulations and procedures to start a drone program. Additionally, the FAA is working on a robust outreach and education program targeting the law enforcement community. These initiatives include a series of webinars, printed materials, a 19-page document on legal operations, and a roll call training video, all of which are available online.

For more information, visit https://www.faa.gov/uas/public_safety_gov/.

Enforcement

Since the promulgation of 14 CFR part 107 (August 2016), the FAA has sought civil penalties in 42 cases - 21 cases involving controlled airspace violations (Class B, Class C, etc.), 7 cases involving prohibited or restricted airspace violations, and 8 cases involving notices to airman violations.

In 2016 Congress increased the civil penalty for anyone who recklessly interferes with wildfire suppression, law enforcement or emergency response efforts. (Sec. 2205 from the 2016 bill). Since the enactment of the bill, the FAA has initiated no less than 4 enforcement cases under the authority provided in Section 2205 (49 USC 46320). The FAA continues to work with law enforcement partners on identifying operators who violate 49 USC 46320.

Local authorities have a range of recourse in response to persons operating UAS in an unsafe manner in their jurisdictions. Localities can prohibit UAS activities in and around public gatherings. The FAA has published a media toolkit to assist local jurisdictions in their duties to protect public safety, and works with localities to facilitate a better understanding of the division of authority regarding UAS activities. The FAA strongly recommends proactive local public communication, education, and outreach. We have a wide range of resources available on the FAA.gov/UAS website to support both the use of drones and response to unauthorized drone activity by law enforcement.

For the time being, local law enforcement may apply their already existing authorities to interview and detain pilots who conduct prohibited drone operations. LEAP, run by FAA, takes regulatory enforcement actions and, as appropriate, provides aviation-related support to law enforcement agencies seeking criminal prosecution or conducting airborne drug interdiction. Agents also provide training to law enforcement officers in aviation smuggling techniques and FAA resources.

Key Research

The FAA supports UAS-related research in a number of key areas. Appendix A includes a summary of the FAA's UAS research portfolio efforts.

Included in the research portfolio are several key technical areas. A brief description of each is included below.

Remote Identification

This critical research focuses on establishing the capability to remotely identify every drone and determine who is operating it. Remote identification of UAS will address security and law enforcement concerns about UAS while also enabling greater operational capabilities for UAS.

Detect-and-Avoid

A safe and effective DAA system is essential to ensure UAS remain well clear of all hazards, including manned aircraft and other UAS. DAA is needed to enable routine UAS flights operating BVLOS without the aid of visual observers, especially for long-range flights. DAA research is underway to support requirements and standards for DAA. A number of companies have developed technology intended to automatically detect and avoid other aircraft, but the technology is still maturing.

Command and Control (C2):

This includes research on the fundamental data links between the airborne vehicle and the operator for controlling the flight. C2 research is needed to support safe BVLOS operations and to mitigate the impacts of loss of radio links connecting the pilot to the aircraft.

Human Factors

This research is critical in understanding the connection between the human and the machine to incorporate the appropriate safeguards, alerts, and displays.

Forecasting

This research includes studies and accurate estimates in time and location of future types and numbers of UAS operations, and their effects on the NAS and ATM system.

UAS Studies

Safety research focuses on establishing safety cases for UAS operations and identifying appropriate safety targets for UAS based on the aircraft, its intended use, and level of airspace integration. This also includes research focused on classifying the risk of airborne and ground collisions of UAS based on the severity and likelihood of potential harmful outcomes. This research is necessary to develop FAA requirements and regulations needed to enable safe UAS integration.

The FAA collaborates on many UAS-related research activities with different research organizations, such as academia, NASA, UAS Test Sites, and standards bodies. The FAA has a Center of Excellence for UAS Research — also known as ASSURE — that brings together 23 of the leading UAS and aviation universities, including two international universities, to conduct UAS integration research. ASSURE has acted as the research arm of the FAA UAS integration effort to execute numerous research tasks in areas including C2, DAA, ground and airborne collision severity, human factors, UTM, and more. Results and

data from ASSURE research studies directly inform the FAA's UAS integration efforts as the FAA expands safe UAS operations via pilot programs, standards development, and rulemaking.

Ongoing research and further test validation are needed to meet the challenges before us. As technology solutions mature for BVLOS operations and as type certification helps mitigate risks for operations over people, programs like the IPP are helping the FAA make strides. Working actively with industry stakeholders to collectively identify challenges, gaps, and areas for potential harmonization is also valuable and helps inform regulators of the unique challenges facing this nascent industry. The FAA is also leveraging technological advances from industry, lessons learned from approved operations, and expertise from around the world.

Safety Risk Management

The FAA is working internally to streamline its approach to safety risk management (SRM) for UAS operations. Conducting SRM assessments holistically, with broad consideration of the interplay between potential hazards and mitigations, will ultimately enable progressively more complex operations as operators build on previous experience and the FAA leverages lessons learned from approving various operations. This streamlined approach is being targeted within various efforts currently in progress to expand the scope of safe UAS operations in the NAS.

As the technology evolves and matures, Aviation Safety will ensure the design and operation of a flying car/taxi is safe, and our Air Traffic Organization will integrate these new aircraft into the National Airspace System. Regarding UAS cyber security generally, our research portfolio includes a UAS-centric risk management framework, and a UAS security control capability. This R&D work will be conducted with a number of partners in both the public and private sectors. We will use the information gained through this R&D to inform our policy and guidance.

Five Year Outlook

Within the next five years, the FAA expects to make significant regulatory progress for Remote ID, and Operations Over People. In addition, we will work to solve the technical challenges, such as DAA, that must be addressed in order to support BVLOS operations, routine package delivery and the ongoing evolution of advanced air mobility. This regulatory and technical progress will enable more routine operations which will bring societal issues such as security, privacy, and noise to the forefront.

Remote Identification Implementation

To keep pace with and further enable tremendous growth in the UAS industry, the FAA is advancing a forward-leaning regulatory framework.

The first priority for the FAA is remote identification. We need to be able to identify drones in flight to find out who their operators are, much like a digital license plate for drones. Remote ID is also a critical building block for the FAA's UAS integration efforts in other arenas. We need Remote ID for routine BVLOS operations and package delivery or other operations in congested, low-altitude airspace.

The remote ID proposed rule was released at the end of 2019 and the final rule is scheduled to be published by the end of 2020.

Technical Challenges

There are a number of different technological challenges to integration. Our existing rules require pilots to "see and avoid" other aircraft. A number of companies have developed technology intended to automatically detect and avoid other aircraft, but the technology is still maturing. Solving that challenge could help enable more long-range BVLOS. As mentioned above, another challenge is being able to remotely identify every drone and determine who is operating it. We have been working with industry to solve that challenge as well. A third challenge is C2 technology. The IPP Lead Participants and their industry partners are helping us better understand the options for overcoming some of these common obstacles to full integration of drones into the airspace and are informing our policy and rulemaking going forward.

We are working with industry to overcome these challenges, and the evolution of airspace management may be part of the solution, but the industry is developing the technological solutions, not the FAA. In addition to working with industry, we are working closely with global aviation and communications partners, and our fellow Civil Aviation Authorities' regulators and Air Navigation Service Providers (ANSPs) from other parts of the world, international organizations and other stakeholders to ensure that we are developing regional and global solutions that align work everywhere and are in harmony with what other countries and regions are doing.

Counter UAS

The FAA is concerned about the use of drones for malicious purposes. UAS that are not compliant, or that we cannot identify, pose a security risk. The FAA believes registration and Remote ID requirements for all UAS operators will enable more effective identification and accountability, moving more operators into compliance with safe operational requirements. This will also help law enforcement to connect an unauthorized drone with its operator, supporting better threat discrimination, education, and enforcement. By moving clueless and careless operators into the compliant category, our security partners can focus attention and response on the criminal, for which the judicious use of counter-UAS (c-UAS) systems may be required.

To deal with malicious users, we face the need for not only defensive solutions, but also interagency collaboration. The 2018 FAA Reauthorization Act provides authority to the Departments of Homeland Security and Justice to engage in counter UAS activities to address security risks posed by UAS and requires authorized agencies to coordinate with the FAA when engaging in counter UAS activity that could affect the NAS. The FAA is working closely with federal security partners, including the Departments of Defense and Energy. It is clear that we do not want to create a safety hazard for other aircraft while addressing security risks that UAS may pose. As we conduct U.S. civil testing and implement the c-UAS authorities granted to DOD, DOE, DOJ and DHS, we are gaining experience, refining concepts of operations, and will see improved c-UAS systems with less potential for airspace safety impacts. This work is necessary prior to considering expanded c-UAS authorities in the future.

The FAA believes the most appropriate path is to focus on implementation of the UAS mitigation authority granted to DOD, DOE, DOJ and DHS, and analyze the results of UAS detection and mitigation

testing that FAA and our national security partners are planning and conducting. It is important to distinguish between UAS detection systems and UAS mitigation systems. Currently only DOD, DOJ, DHS, FAA and the DOE can legally use mitigation systems — defined as those that disrupt, damage, destroy or take control of a UAS posing a threat. The statutes granting such authority limit use of c-UAS systems to protect specific types of facilities, missions, operations, and assets under specified conditions, depending on the authorizing statutory language. The FAA was given relief from certain statutes, but only for testing impacts and performance of UAS detection and mitigation systems at airports — not for operational use. All other federal, state, local, and private sector entities are subject to applicable federal laws with respect to the acquisition, testing, or use of c-UAS mitigation systems, including, but not necessarily limited to, various criminal provisions of title 18 U.S.C., as well as relevant state and local laws. In terms of detection systems, there are some technologies that can be used by federal, state, local, and private sector entities to detect and track UAS, although not all forms of detection technology are clearly legal for use without statutory authority. However, planning and coordinating the use of UAS detection technology necessitates close collaboration to ensure security needs are balanced with airspace safety and efficiency.

Consistent with Congressional direction, the FAA executed a pilot program to evaluate the feasibility of integrating c-UAS equipment in the airport environment. The results of that pilot program suggested currently available, legal detection technologies could pose an aviation safety risk by interfering with aircraft navigation and air navigation services infrastructure. However, for airports who wish to deploy these technologies, the FAA helps make sure they are safely integrated into the airport environment.

More information is available at https://www.faa.gov/airports/airport_safety/#SafetyGuidance.

The FAA expects to provide supplemental information related to UAS detection system coordination as we refine our processes and procedures for safe UAS detection system use and coordinated operational response at or around airports. We are currently compiling a supplemental checklist of planning factors to consider, and key contacts, with which airport authorities can work in support of our common goal of safety in the National Airspace System. We are also working with our federal partners, major airports, and industry stakeholders to develop a pre-planned federal response to supports a persistent threat at a Core 30 airport. The goal is to identify the UAS operator(s) and end the disruption of airport operations as quickly and safely as feasible.

Under § 1602 of the 2018 FAA Reauthorization Act, Congress authorized mission-specific testing and use of c-UAS systems by DOJ, specifically for the protection of penal, detention and correctional facilities and operations conducted by the Federal Bureau of Prisons. The FAA is working closely with DOJ in executing this mission. Under § 1602 of the 2018 FAA Reauthorization Act, DHS and DOJ are authorized to provide support to State, local, territorial, or tribal law enforcement to ensure protection of people and property at mass gatherings. The supported event must be limited to a specified timeframe and location, within available federal resources, and without delegating any authority under this section to State, local, territorial, or tribal law enforcement.

The development of standards for the use of c-UAS technology is also critical. Many c-UAS technologies were designed for military use abroad—a context in which collateral impacts are not a significant concern. It is vital that c-UAS systems be tested in civil environments to determine both the impacts on the NAS and other critical systems as well as efficacy—especially before approximately 18,000 independent law enforcement agencies across the country have the authority to deploy c-UAS. Due to the spectrum-related impacts of many c-UAS systems, some current c-UAS technologies pose a potential risk to safety-of-life systems, specifically Air Navigation Services critical infrastructure and on-board

avionics. C-UAS technologies can impact air-ground communications, Global Positioning System (GPS) dependent navigation, and other surveillance systems. The operational use of c-UAS in the National Airspace System also poses an indirect risk to persons and property on the ground or other aircraft in flight depending on how the drone responds to the c-UAS technology. Lastly, some c-UAS systems can interfere with authorized or compliant drone activity that may be occurring in proximity to the unauthorized drone.

Evolving and Expanding Role of Public Safety

The FAA utilizes the relationships that our LEAP Agents have developed with federal, state and local law enforcement agencies to inform and assist in the awareness of UAS security-related best practices and counter-UAS (C-UAS) implementation initiatives. We continue to work closely with the law enforcement community to investigate and enforce the unlawful operation of UAS.

The FAA also has created a cross-agency team to support Section 366 of the 2018 Reauthorization Act. Through its webinars, videos, and events, the FAA provides outreach to state and local governments and provides guidance for local law enforcement agencies and first responders with respect to identifying and responding to public safety threats posed by UAS, as well as using UAS to enhance local law enforcement and first responder effectiveness.

More information can be found at https://www.faa.gov/uas/public_safety_gov/.

UTM Advancement

Drones can, of course, be used to deliver packages, monitor agriculture, inspect infrastructure, or conduct search-and-rescue missions. For all these uses and more, there must be a system in place that would enable safe, efficient air transportation of people and goods in uncontrolled and controlled airspace. This concept of UTM complements the ATM system that covers controlled airspace. The FAA considers UTM to be a set of federated services and an all-encompassing framework that enables UAS operators to conduct low altitude operations in an organized and safe manner, rather than a single system.

The FAA describes its specific vision, strategy, outlook, and ongoing activities related to UTM in a published Concept of Operations. This Concept of Operations reflects collaborative efforts across the FAA, as well as ongoing inter-agency efforts with NASA.

According to the latest UTM Concept of Operations, “the commercial applications and opportunities for unmanned aircraft system (UAS) operations, particularly at low altitudes, across a myriad of sectors from inspection, to survey, to monitoring, to package delivery, present enormously enticing incentives and business cases for an operating construct that allows for these operations within the regulatory, operational, and technical environment that comprises the National Airspace System (NAS). UAS operational needs and expected benefits are driving public and private stakeholder partnerships, led by the Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA), to develop and continually mature a Concept of Operations (ConOps) for UAS Traffic Management (UTM). This vision for UAS operations engenders a common desire to realize innovative solutions through public-private partnerships and the leveraging of technologies in support of emerging opportunities

while ensuring safety, security, efficiency, and equity of the NAS are maintained to the highest of standards."

The latest version (2.0) of the UTM Concept of Operations may be found on the FAA's UTM web page.

Advanced Air Mobility

In his remarks to the 2019 Uber Elevate conference, Deputy Administrator Daniel K. Elwell discussed the importance of taking a "crawl-walk-run" approach to integration and meeting safety mandates, done through collaboration between industry and government. AAM will become commercially available when companies have developed robust, reliable, scalable, and technically capable designs that have been shown to be compliant with the applicable airworthiness and safety regulations. Progress and results towards those goals are highly dependent upon the experience and rigor a company is able to put into their design.

The challenges presented by AAM cross multiple domains, including regulatory, societal, economic, technological, and environmental. As regulators, the FAA is focused on the policy and regulatory environment that sets the conditions for new entrants' integration without overburdening the existing NAS infrastructure.

The FAA acknowledges that there are challenges to fitting new things into the same regulatory box. We are working to collect data around new advanced technologies such as DAA technology. We understand that language in regulations may need to be updated. We also understand that there's a cultural change that will need to be managed, both across the aviation community and with the public. The FAA is working actively with industry stakeholders to collectively identify challenges, gaps, and areas for potential harmonization. In just under a year, we have hosted two AAM-focused executive roundtables to bring together FAA executives and industry leaders to discuss the challenges and strategic priorities of AAM.

Other Considerations and Challenges

The possibilities for drones are endless, but with every opportunity there are challenges that must be addressed. To keep UAS integration moving in the right direction, the FAA is committed to addressing the public's concerns and removing the roadblocks to innovation for industry. But because of the volume of operations – with nearly four times as many UAS as registered manned aircraft, – and because of the speed of innovation – where product cycles are in months, not years, – a tremendous amount of work remains to be done. With appropriate funding, the FAA can maintain its momentum and help industry bring to market UAS technologies that protect and improve safety in our skies. This will need to be done in tandem with sustainable public engagement to gain the buy-in needed to expand UAS operations for the benefit of all.

Pace of Innovation

Innovation is reshaping the NAS, and the pace of technological change is nothing short of amazing. Consider that we have registered approximately 1.4 million drones in less than four years; we have flying taxis in experimental design or flight testing phases at major aerospace companies like Airbus, Boeing and Embraer; and we have civilian space pioneers getting ready to take suborbital excursions.

When it comes to drones, there is sometimes a disconnect between Silicon Valley and the traditional FAA approach. Drone manufacturers typically create, market, and sell drones that are ready to fly, and then improve upon them with software and firmware updates. The FAA, however, has a safety culture that requires aircraft to be completely safe and fault-free before they're allowed to fly. This means that the industry is often moving faster than the FAA. The FAA is adjusting, working to improve its internal process so that it will enable more and more flights under the current rules. Partnering with industry is critical. Together the Agency and manufacturers will address the technical challenges—including security issues such as Remote ID and reliable onboard DAA systems—that must be addressed before routine, more complex operations are enabled.

The pace of UAS integration will be determined by the combined ability of industry, the operator community, and the FAA to overcome technical, regulatory, and operational challenges. To realize the full economic promise and technological advances unmanned aircraft represent, all partners must adopt a proactive, collaborative approach.

The FAA regulatory framework has the flexibility to evaluate and approve novel and unusual aircraft designs. Our recently revised performance based requirements for small airplanes (Part 23, Amendment 64) can be combined with standards from other products, such as engines and rotorcraft. We are actively engaging with each AAM manufacturer prior to application to gain an understanding of both the vehicle and their planned operational construct, and to identify the appropriate airworthiness standards and determine the methods of compliance to those standards in advance of their application.

Societal Acceptance

Through our work with IPP partners, we've learned that there's an overall positive feeling toward integrating drones into communities, particularly where infrastructure inspection and public safety missions are involved. Societal acceptance will be predicated on the public expectation for safety in these new types of operations, as well as concerns with privacy, noise, and visual impacts. Working together, we can accelerate the development of the UTM ecosystem and usher in the necessary social transformation. It is an exciting challenge as we integrate unmanned aircraft into our nation's airspace and help write a new chapter in aviation history.

Since late 2017, the UAS Integration Pilot Program (IPP) has brought state, local, and tribal governments together with private sector entities, such as UAS operators or manufacturers, to test and evaluate the integration of civil and public drone operations into our national airspace system and to realize the benefits of unmanned technology in our economy. This initiative is dedicated to safely testing and validating advanced operations of differing types for drones in partnership with state and local governments in select jurisdictions.

Just as important as the technology and infrastructure roll-out is the community engagement and work that is being done on the local, state, and municipality level, as those entities will be hosting this infrastructure. The infrastructure roll-out activities will require detailed planning, zoning, and building that will need synchronization across our communities.

The public has real concerns regarding UAS operations with respect to safety and privacy. If people don't feel safe when drones are operating around them, or they have persistent fears of drones intruding in their private lives, then UAS commercial opportunities will be very limited.

We not only have to ensure safety and address privacy, but we also have to actively engage with the public to make sure they understand how they are being protected. This needs to be a collective effort. The FAA has a broad set of public engagement programs, many conducted with the private sector, designed to increase awareness of drone activities, guidelines, rules, and best practices.

Finally, it is important to note that societal acceptance is a two-way street. Not only must we engage and educate the public: we must also use our engagement efforts as a way to make adjustments to planned operations, policy and more.

Noise

The FAA has been working with NASA, industry, and academia to develop noise reduction technologies, noise metrics, and low-noise operational procedures. In addition, FAA is also developing noise certification requirements and procedures. The Agency has been collecting field measurement data to inform those requirements and procedures, as well as for improving our noise prediction models and tools.

Most of the proposed UAS will have vertical lift capability, forward flight capability, and will have distributed electric propulsion systems or hybrid propulsion. The operational mission and characteristic of the noise generated by these aircraft is expected to be different from existing helicopters and traditional general aviation aircraft. Further, the operation of UAS may be in closer proximity to noise receptors. In the example of AAM, vehicles are expected operate at vertiports located in urban areas. New noise exposure from these vehicles may cause serious noise concerns and affect the community acceptance of the vehicles and the flight operations.

Public acceptance will ultimately drive the success or failure of this emerging industry. As part of the IPP, we're collecting data about noise characteristics. And UAS manufacturers are beginning to respond to these concerns. For example, after feedback about perceived noise issues in their delivery operations in Australia, Wing undertook a redesign of the engines to reduce annoyance levels.

Cost

The National Aviation Research Plan (NARP) details how the FAA structures and executes its Research and Development (R&D) to ensure the Nation's investments are well placed and deliver results addressing national aviation priorities, including safely integrating UAS into the NAS. You can find the most recent NARP at https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/about/campus/faa_host/rdm/media/pdf/2017_2018NARP.pdf.

Annual President's budget submissions may include additional UAS-related funding information. They can be found at: https://www.faa.gov/about/budget/.

Together, all stakeholders can overcome the cost of integrating UAS into the NAS to leverage UAS and associated technologies for the greater benefit of society. Future success of the drone industry depends on both government and private sector funding, including public private partnerships (PPPs), to support and facilitate integration. The application of financial and human resources by academia and industry to support critical FAA initiatives will shorten the time required to develop technical and regulatory

standards. Significant portions of the FAA Reauthorization Act are dedicated to UAS; however, many of the provisions come with new rulemaking and reporting requirements, which require the FAA to actively engage with industry and other stakeholders to maximize available resources.

Conclusion

As the Roadmap makes clear, the path to full UAS integration is paved with both challenges and opportunities. Public acceptance of the technology's many potential uses will be linked to the UAS community's ability to ameliorate noise, privacy and other concerns. Without public acceptance, drones will face challenges with widespread societal acceptance.

Nevertheless, the possible uses of UAS are many, and the potential social and economic benefits are countless. The pace of innovation, while a challenge for the FAA to contend with, is also an opportunity to see the technology mature and make its way fully into the NAS quickly. The FAA must meet that pace. With partnership programs like the IPP, PSP, UPP, law enforcement, ASSURE and others, we are building the relationships needed to advance. With remote ID and UTM progressing, we're building the systems, infrastructure, and regulations needed to integrate safely. While safety and innovation are both key measures of success, as we plan for the future, we will continue to our overarching commitment to safety in all we do.

Appendix A: UAS Integration Research & Development Plan

UAS INTEGRATION RESEARCH

Edition 2

For Informational Purposes Only

Introduction

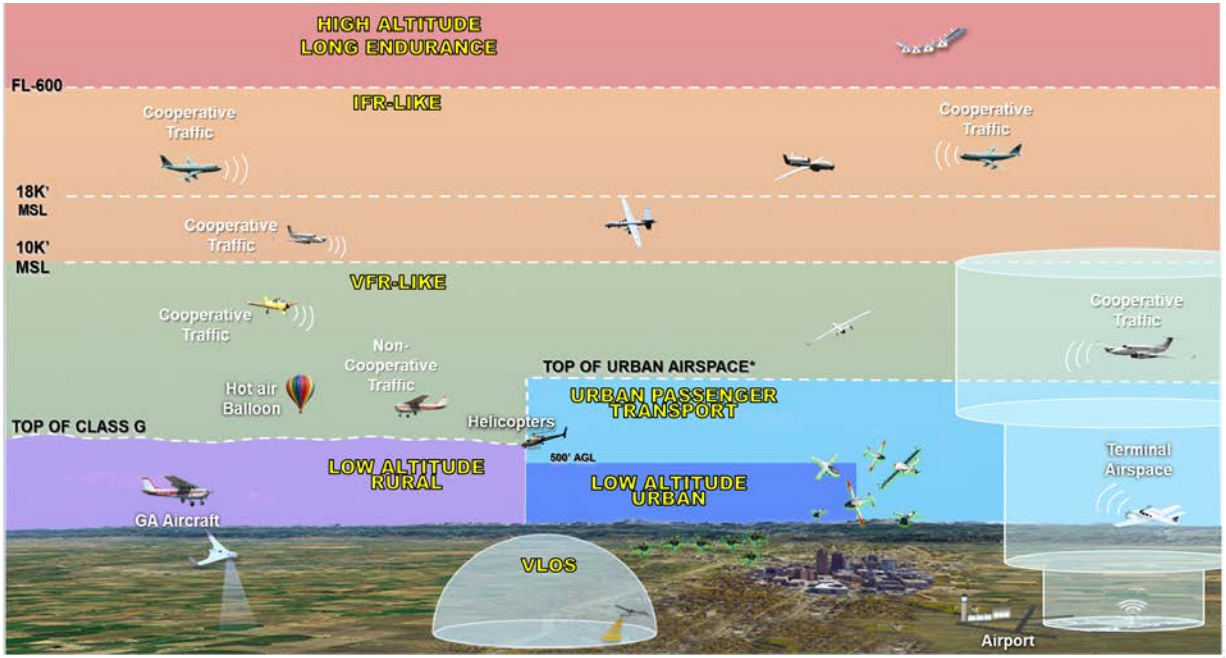
UNMANNED AIRCRAFT SYSTEMS (UAS) RESEARCH is the foundation of UAS integration activities. Research enables informed policies, procedures, and regulations. UAS integration research aligns to FAA Strategic Priorities, FAA Priority Initiatives, UAS Strategic Priorities, the five-year UAS Integration Approach, and the National Aviation Research Plan. While UAS integration research is a result of these strategic priorities and initiatives, it is also a vital component in an iterative process.

The FAA has established and maintains partnerships with entities including the National Aeronautics and Space Administration (NASA), numerous federal agencies, a dedicated UAS Center of Excellence (COE), UAS Test Sites, Federally Funded Research and Development Centers (FFRDCs), industry, academia, independent research organizations, and domestic and international standards groups.

Integrating UAS into the National Airspace System

AIRSPACE ACCESS for UAS in the National Airspace System (NAS) will expand incrementally as the FAA implements a phased approach over the next few years. Current, planned, and future UAS-related research activities and results will enable the FAA to revise regulations and keep pace with the growing demand of NAS users. UAS operations are in development that span the airspace environment, from High Altitude Long Endurance (HALE) aircraft flying for days or weeks, to aircraft flying only a few hundred feet or less above the ground.

Concept for UAS Airspace Environment

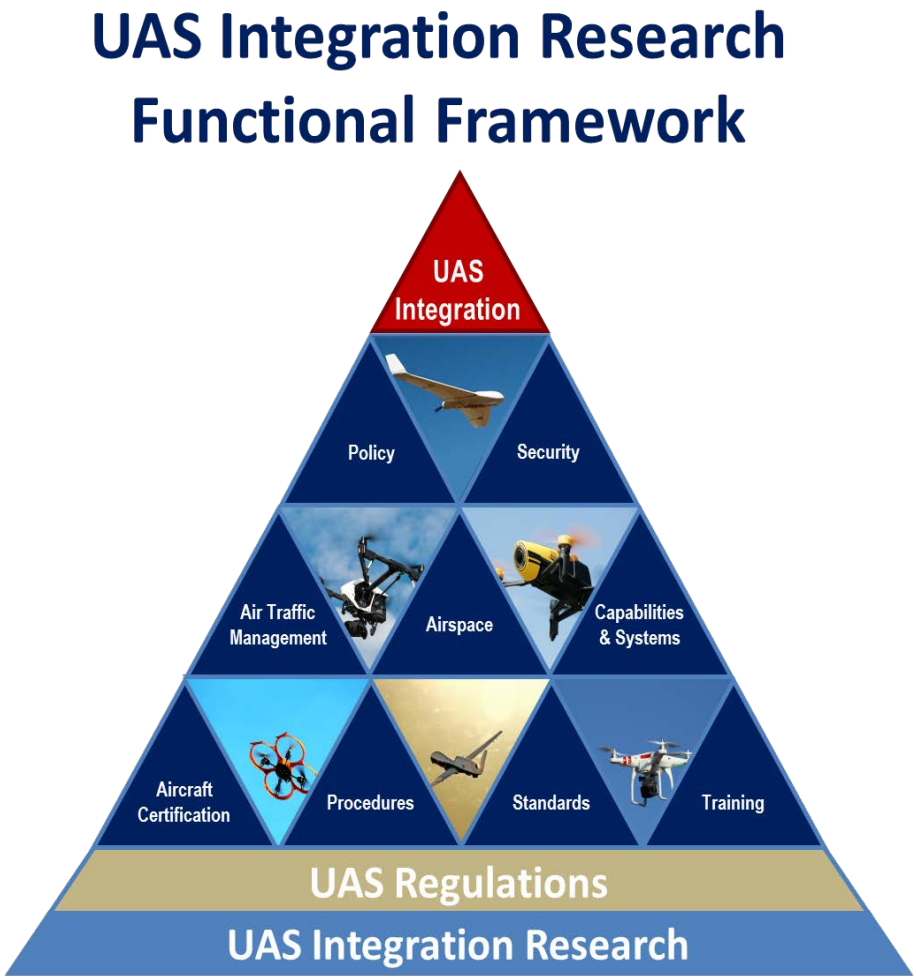


Source: Adapted from NASA, Aeronautics Research Mission Directorate

Current UAS Research Landscape

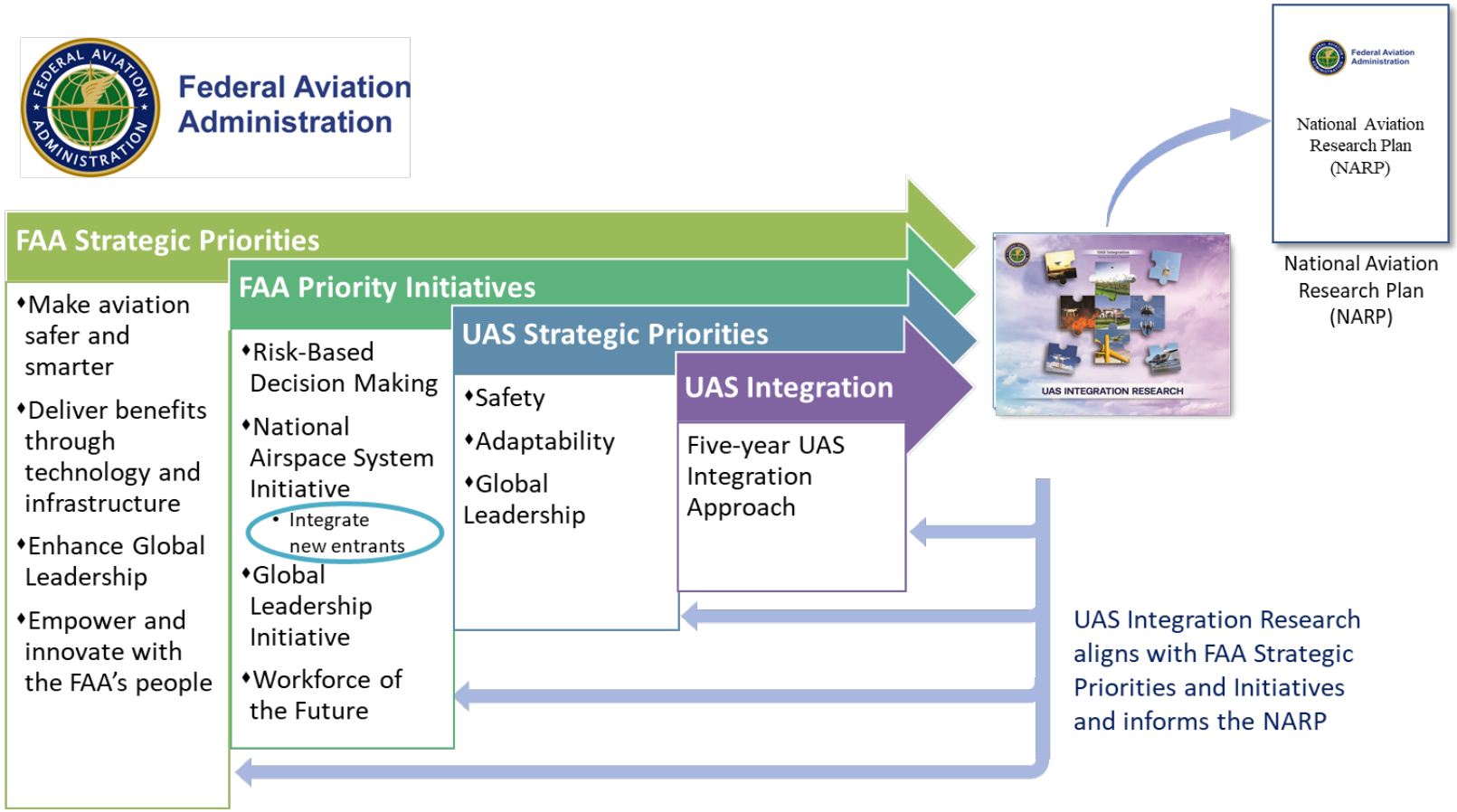
The FAA plans to incrementally expand the operational envelope, allowing UAS operations with increasing levels of complexity, while fully maintaining critical safeguards for existing users of the NAS. This will ultimately allow UAS to safely conduct routine operations. The FAA is leveraging many UAS-related research activities across different research organizations, such as academia, NASA, UAS Test Sites, and standards bodies. It is leveraging technological advances from industry, lessons learned from approved operations, and expertise from around the world. It is expected that the demand for UAS integration will accelerate as technology advances and market opportunities evolve.

The FAA and its partners have various efforts in progress to expand the scope of safe UAS operations in the NAS. For instance, the FAA is currently working with state, local and tribal governments through the UAS Integration Pilot Program (IPP). This White House initiative partners the FAA with local, state and tribal governments, which then partner with private sector participants to safely explore the further integration of UAS operations into the NAS. The focus of the IPP activities, like all UAS research, is guided by the need to safely expand the current state of UAS integration.



Alignment to FAA's Strategic Priorities and Initiatives

UAS integration research aligns to FAA Strategic Priorities, FAA Priority Initiatives, UAS Strategic Priorities, and the five-year UAS Integration Approach, and informs the *National Aviation Research Plan*. UAS integration research is a result of these strategic priorities and initiatives and is a vital component in an iterative process.



UAS Research Collaboration and Partnerships

INTEGRATION OF UAS operations is a multifaceted global challenge, requiring coordinated efforts within the FAA and across multiple agencies. To enable industry objectives while maintaining the security, safety, and civil rights of the public requires meeting multiple objectives in different domains.

The FAA is taking advantage of independent, non-sponsored UAS research efforts. It is leveraging an evolving spectrum of UAS research and analyses being conducted by government agencies, industry, academia, international organizations, standards bodies, etc. to inform rulemaking and operational changes that will enable full UAS integration into the NAS.

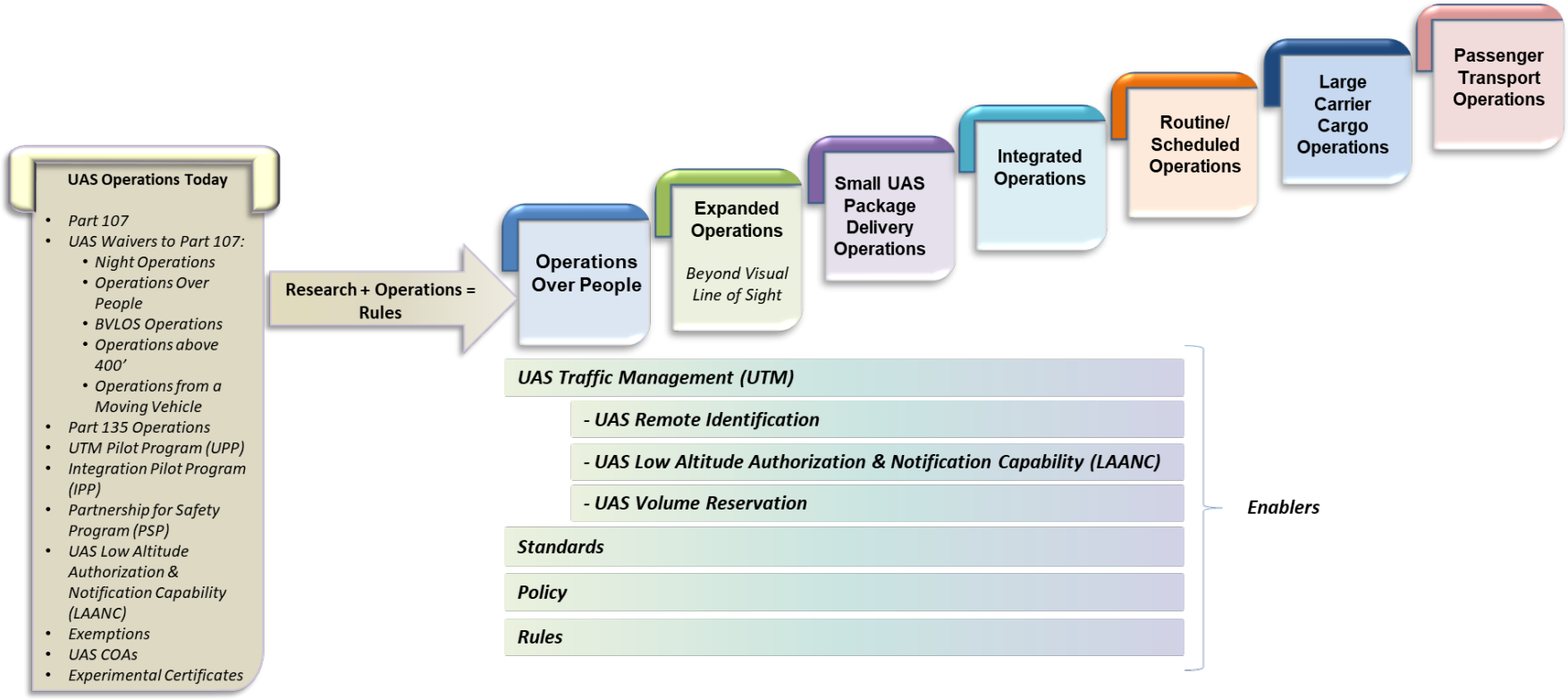
UAS Research Partners

- **AFRL**: Air Force Research Lab
- **ANSI**: American National Standards Institute
- **ASEB**: NAS Aeronautics and Space Engineering Board
- **ASSURE**: Alliance for System Safety of UAS through Research Excellence
- **CAA**: Civil Aviation Authority
- **CANSO**: Civil Air Navigation Services Organization
- **CTA**: Consumer Technology Association
- **EASA**: European Aviation Safety Agency
- **EuroCAE**: European Organisation for Civil Aviation Equipment
- **EXCOM SSG SARP**: Executive Committee – Senior Steering Group – Science And Research Panel
- **FAA CAMI**: Civil Aerospace Medical Institute
- **FAA WJHTC**: William J. Hughes Technical Center
- **ICAO**: International Civil Aviation Organization
- **IEEE**: Institute of Electrical and Electronics Engineers
- **ITU**: International Telecommunications Union
- **JARUS**: Joint Authorities for Rulemaking on Unmanned Systems
- **MIT/LL:** Massachusetts Institute of Technology Lincoln Laboratory
- **MITRE CAASD**: Center for Advanced Aviation System Development
- **NASA**: National Aeronautics and Space Administration
- **NATO**: North Atlantic Treaty Organization
- **NSF**: National Science Foundation
- **NIST:** National Institute of Standards and Technology
- **REDAC:** Research and Development Advisory Committee
- **TRB**: NAS Transportation Research Board

UAS Research Partners

Operational Capabilities Towards Full UAS Integration

THE FAA'S APPROACH to UAS research is phased by operational capability. This phased approach will enable a managed risk-based incremental expansion of airspace access for UAS in the NAS over the next few years. The FAA will enable initial phases of UAS operations by issuing Experimental Airworthiness Certificates and processing waivers and exemptions for part 107 operations on a case-by-case basis. By collecting information and lessons learned, the FAA will be more informed and better positioned for rulemaking.



The following are descriptions of the UAS Integration operational capabilities:

Operations Over People: Expansion of Title 14 of the Code of Federal Regulations (14 CFR) part 107 rule to enable small UAS to operate over persons not directly participating in the operation.

Expanded Operations: Builds upon part 107 small UAS operations over people while expanding to beyond visual line-of-sight (BVLOS) operations (such as infrastructure or agriculture inspection), swarms, and on-airport operations.

Small UAS Package Delivery Operations: Enables small UAS fleet operators to conduct external load and agricultural operations that involve multiple launches and landings for delivering or retrieving packages or material.

Integrated Operations: Enables UAS operations to co-exist, with restrictions, in controlled airspace with manned aircraft. Includes UAS operations with large, properly equipped UAS at varying altitudes and on instrument flight rules (IFR) flight plans. Includes interstate delivery and small cargo operations.

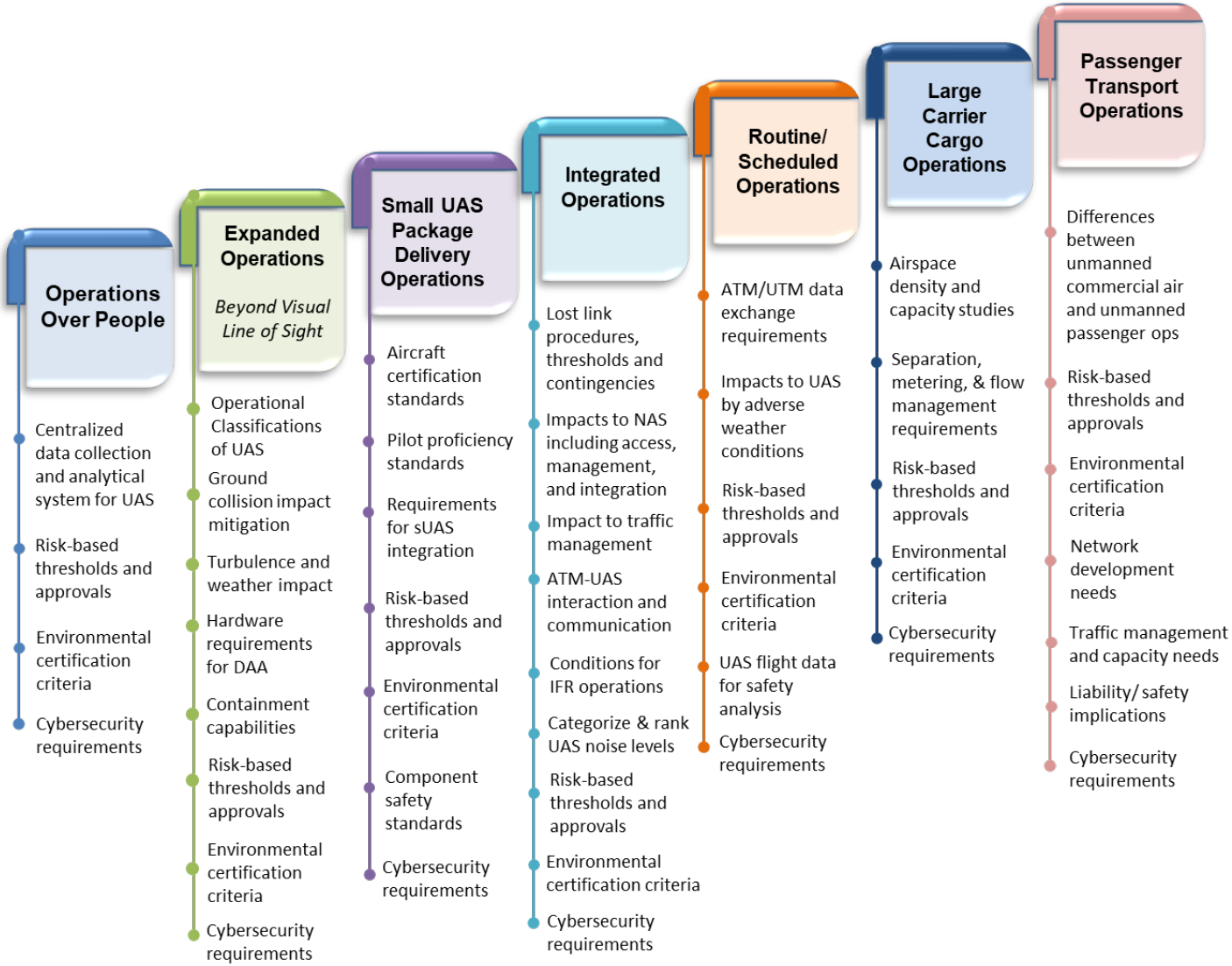
Routine/Scheduled Operations: Enables regularly scheduled UAS arrivals and departures at Class B, C, and D airports and permits optionally piloted aircraft for large cargo operations. Air traffic control (ATC) services will be available to UAS operators filing IFR flight plans, and routine or scheduled operations will occur as the equipment and automation on the UAS and in the ATC infrastructure can accommodate them.

Large Carrier Cargo Operations: Enables the transport of cargo to be conducted by remote pilots in U.S. domestic airspace and arrivals of remotely piloted cargo flights.

Passenger Transport Operations: Enables air taxi services to be conducted by remote pilots, based on vehicle performance requirements and type certification of the aircraft, its equipment, and the automation technology that replaces pilot functions on board the aircraft.

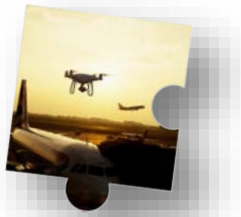
These operational capabilities use a “building block approach” where successive capabilities are informed by previous research. It is important to note that the research path differs from the path used by rulemaking, as research informs rulemaking and policy activities. This reflects the fluid nature of the UAS regulatory environment.

Summary of Identified Needs for Operational Capabilities



Advancing FAA's UAS Research Program

As UAS technologies and business cases evolve, so will the demand for increased UAS operations. The FAA must keep up with the UAS community as operations expand, in order to ensure the safety of the NAS and to people on the ground. Therefore, research needs that were previously unanticipated may arise due to the rapid pace of the UAS progression, increased operations, and the associated safeguards and mitigations.



The FAA will continuously re-evaluate its UAS research program to determine the required level of effort and to account for unanticipated changes. Because UAS integration challenges span multiple FAA Lines of Business (LOBs), any of which may sponsor UAS research, estimated levels of effort will account for cross-agency research resources and leverage collaboration with partners to the extent possible.

The FAA will continue to work with research partners to determine a path forward for addressing gaps, and will continue to revise research plans to reflect the dynamic nature of the UAS landscape.