Unmanned Aircraft Systems Research (A11L)
Presented to the REDAC NAS Ops Subcommittee

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March 2022

Passengers On-Board

Agency Priority: AAM

- Aircraft certificate (standard)
- Pilot certificate
- Operator certificate
- Standard CofA, new flight rules

Part XXX

Commercial Cargo Delivery
Commercial Package Delivery

- Aircraft certificate (special or standard)
- Pilot certificate
- Operator certificate
- Standard CofA, new flight rules

Part XXX

Commercial Beyond Line-of-Sight

Agency Priority: BVLOS

- Aircraft certificate (special or standard)
- Pilot certificate
- New flight rules

Parts 21, 61, 91, 137

Commercial Line-of-Sight

- Pilot certificate
- Below 400 feet, UASFMs
- Aircraft compliance for operation over people

Part 107

Recreational Modelers

- No pilot certificate
- Below 400 feet, UASFMs
- Self-regulated through CBO guidelines

AC 91-57

Operational Complexity

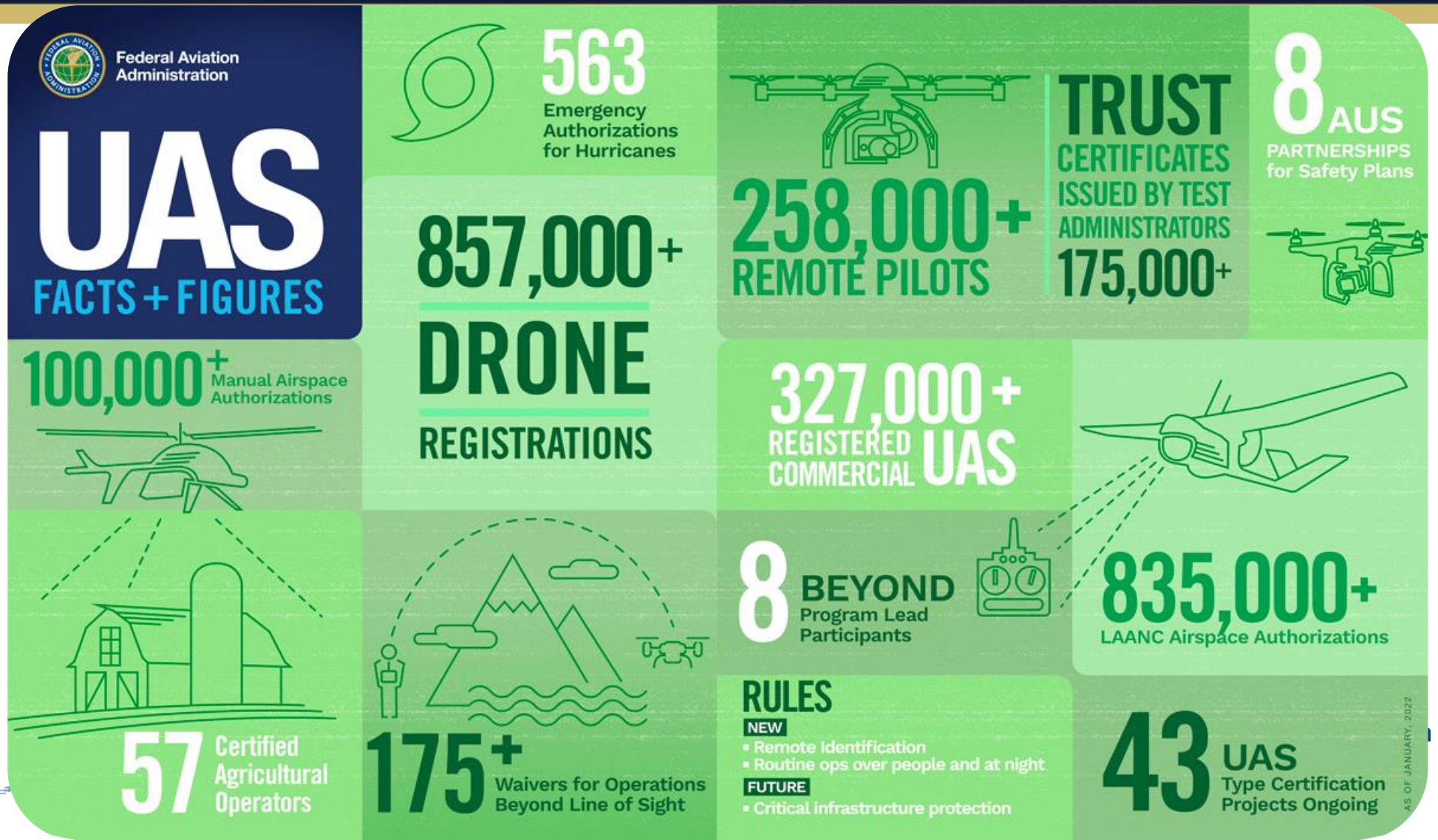
FAA Involvement & Regulatory Oversight

Pathway to Integration

NAS Ops Subcommittee March 2022

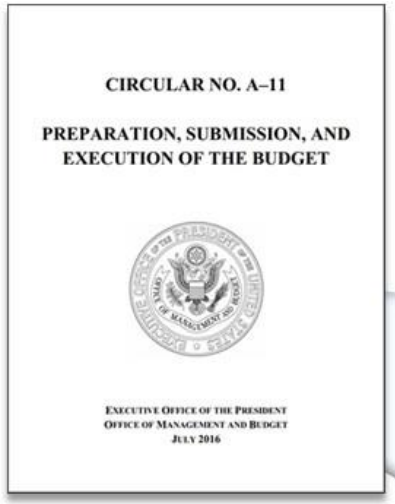
Federal Aviation Administration

SNAPSHOT: UAS Facts & Figures



FAA's Research Approach

OMB Circular A-11, Section 84.2


CIRCULAR NO. A–11

PREPARATION, SUBMISSION, AND EXECUTION OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
JULY 2016

1. **Basic research**

   Experimental or theoretical work for acquiring new knowledge of the underlying causes and based on observable facts.

2. **Applied research**

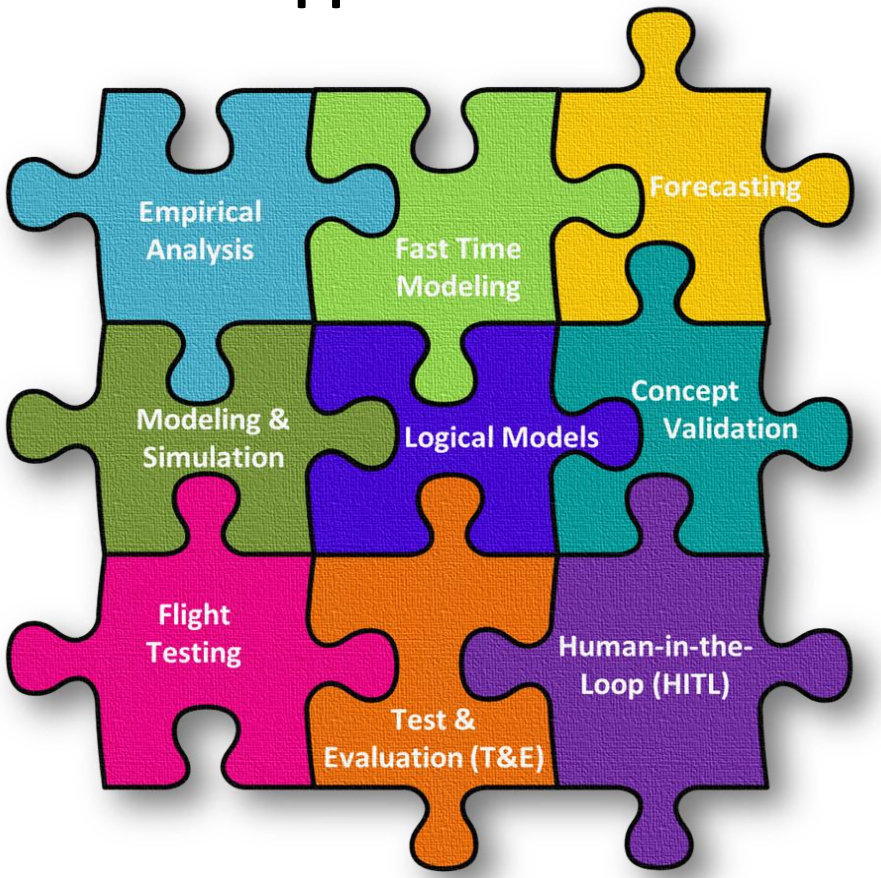
   Original investigation directed primarily towards a specific practical aim or objective.

3. **Experimental development**

   Creative and systematic work directed at producing new products or improving existing products or processes. Experimental development will result in gaining additional knowledge.

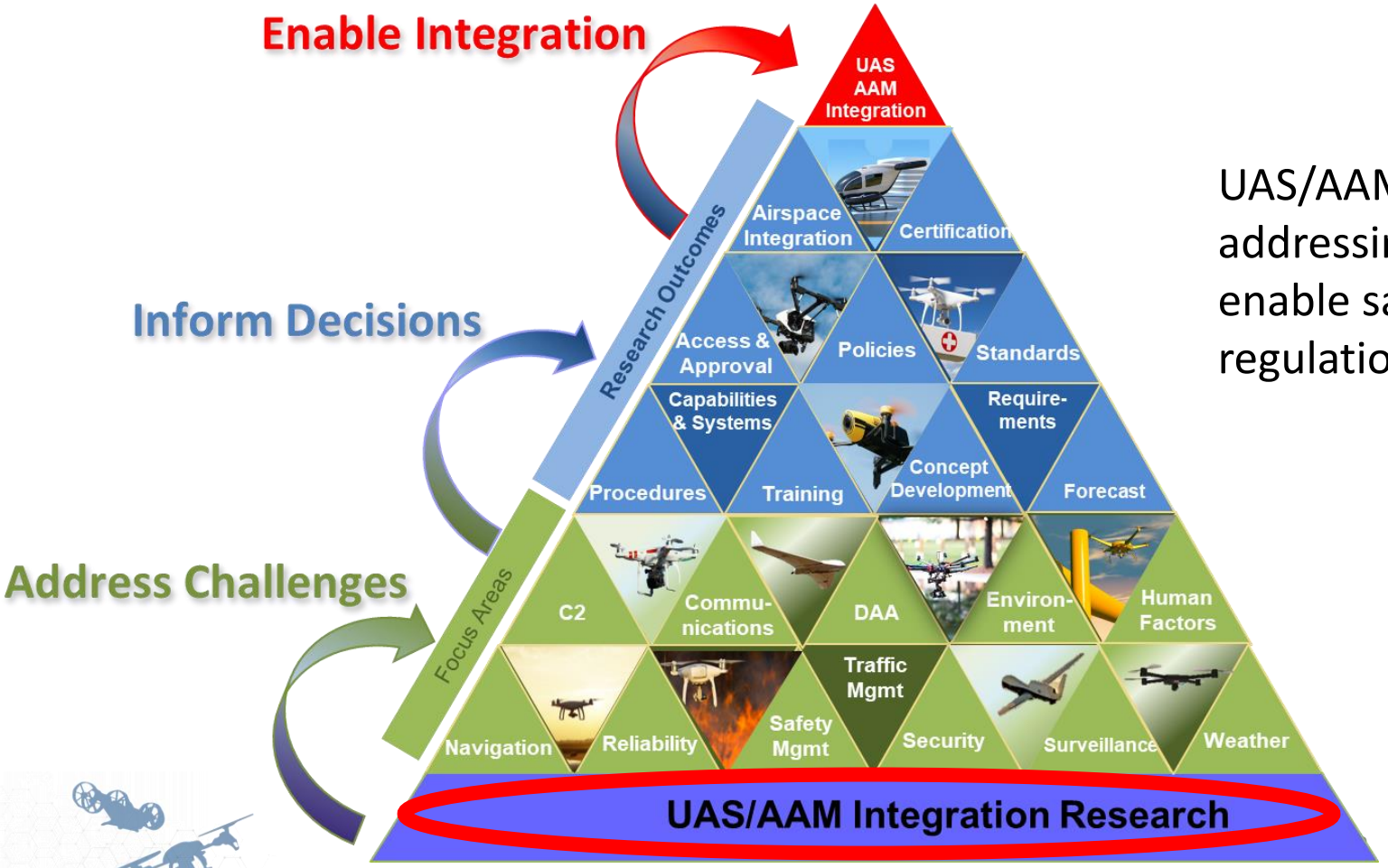
FAA's Applied Research Methods

What is applied research?



Applied research is directed towards a specific practical aim or objective.

UAS/AAM Integration Research



UAS/AAM Integration Research is the foundation for addressing challenges and informing decisions to enable safety driven policies, procedures, and regulations.

Collaboration and Partnerships

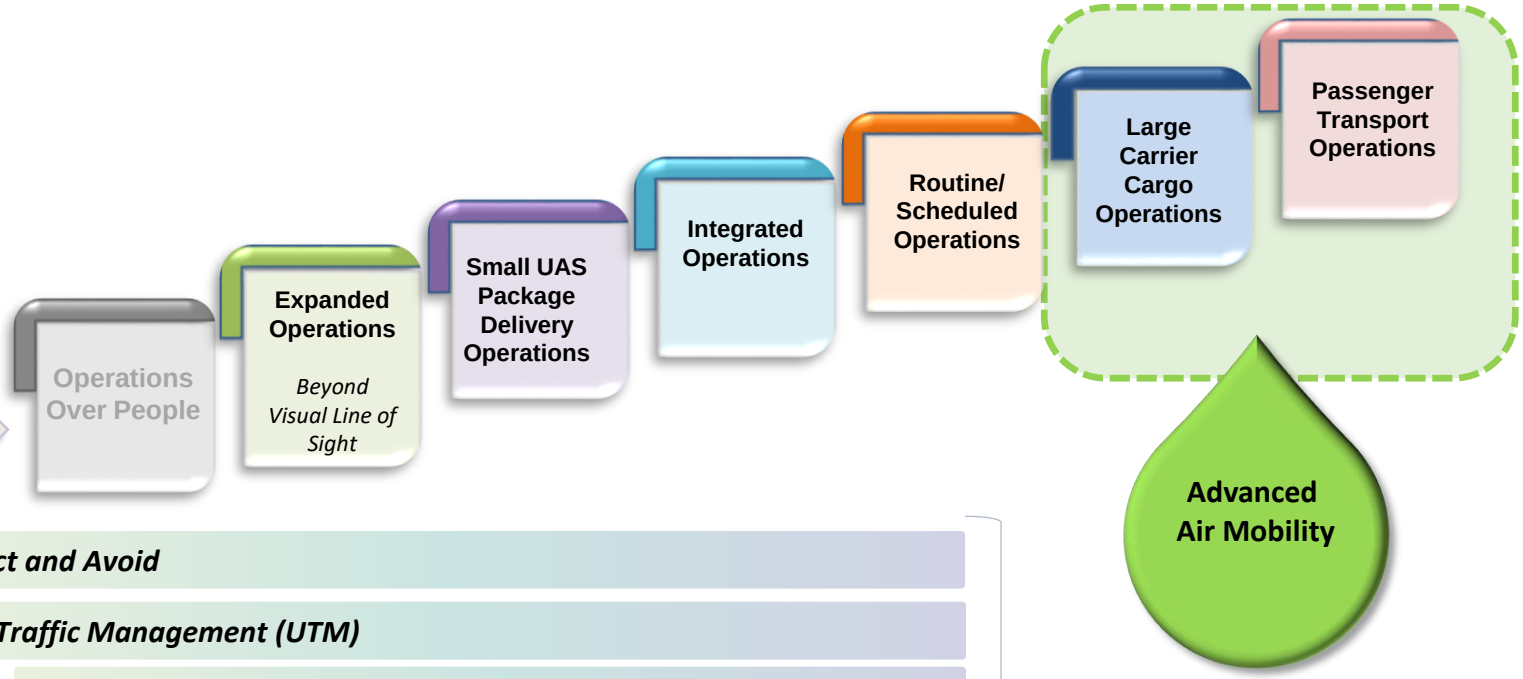
- **ANSI:** American National Standards Institute
- **ASSURE:** Alliance for System Safety of UAS through Research Excellence
- **CANSO:** Civil Air Navigation Services Organization
- **CTA:** Consumer Technology Association
- **DOC:** Department of Commerce
- **DOT:** Department of Transportation
- **DOT Volpe:** Volpe National Transportation Systems Center
- **EASA:** European Union Aviation Safety Agency
- **EUROCAE:** European Organisation for Civil Aviation Equipment
- **EXCOM SARP:** Executive Committee –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
- **NIST:** National Institute of Standards and Technology
- **REDAC:** Research, Engineering, and Development Advisory Committee

Categorizing UAS/AAM Integration *Research to Inform Operational Capabilities*

UAS Operations Today

- *Part 107*
- *UAS Waivers to Part 107:*
  - *BVLOS Operations*
  - *Operations above 400'*
- *Operation of Unmanned Aircraft Systems Over People Final Rule*
  - *Operations Over People*
  - *Night Operations*
  - *Operations Over Moving Vehicles*
- *Part 135 Operations*
- *UTM Pilot Program (UPP)*
- *IPP & BEYOND Programs*
- *Partnership for Safety Program (PSP)*
- *Advanced Air Mobility (AAM) National Campaign*
- *UAS Low Altitude Authorization & Notification Capability (LAANC)*
- *Exemptions*
- *UAS COAs*
- *Experimental Certificates*

Research + Operations = Rules



Detect and Avoid

UAS Traffic Management (UTM)

- ***UAS Remote Identification***
- ***UAS Low Altitude Authorization & Notification Capability (LAANC)***
- ***UAS Volume Reservation***

Standards

Policy

Rules

Enablers

Large Carrier Cargo Operations

Passenger Transport Operations

Advanced Air Mobility

- Develop Models to Inform Safe AAM Integration into the NAS
- Identify Models for AAM/UAM Safe Automation
- Investigate and Identify the Key Differences Between Commercial Air Carrier Operations and Unmanned Transport Operations
- Understand UAM Safety and Certification Challenges Mapping Impact on Market Feasibility and Growth Potentials
- Understand the Transition Between Using Manned Aircraft Cargo Delivery, and Introducing UAS Cargo Delivery

Part XXX

Part XXX

- Explore the Impact of Lost Link in Air Traffic Control (ATC) Airspace
- Design Guidance and Best Engineering Practices for Automated Systems
- Develop a Framework to Incorporate UAS Flight Data into ASIAS

Routine/ Scheduled Operations

Package Delivery + Integrated Operations + Routine/Scheduled Operations

(Commercial Package Delivery)

- Develop Receiver Channel Model & Test Simulation for UAS C2 Radio
- Assess Collision Risk between UAM vehicles, UAM & UAS, UAM & Manned Aircraft
- Evaluate the Impacts and Operational System Needs to Support Deployment of C-UAS…to Protect Safety and Security of the NAS
- Evaluate Impacts & Needs to Support Deployment and Use of Counter-UAS
- Explore the Impact of Lost Link in ATC Airspace
- Establish Minimum Performance & Repeatable Guidance for UAS and Autonomous Tech
- Determine the Collision Severity of small UAS in Flight Critical Zones
- Propose Right-of-Way Rules for UAS Operations
- Evaluate UAS Air-to-Ground NAS Communications Latency and Voice Intelligibility
- Evaluate small UAS Traffic Trends to Determine the risk of Collisions with Manned Aircraft
- Evaluate UAS Detection and Mitigation Technologies & Enforcement Actions in the NAS
- Identify Standards for UAS to Mitigate Wake Turbulence
- Define Safety Risks and Mitigations for UAS Operating around Airports
- Demonstrate and Assess Technologies for Detecting and Mitigating Unauthorized UAS Near Airports
- Capture the Potential Impacts of small UAS Ingestion in the NAS
- Determine Severity of Structural Impact for an Airborne Collision between a small UAS and Manned Aircraft
- Evaluate the Command and Control (C2) Link Compatibility with UAS

Integrated Operations

Small UAS Package Delivery Operations

- Develop a Strategy for Certification and Approval of Automation and Intelligent Systems for Use with UAS
- Identify and Evaluate UTM Risks and Establish Threat Management Mitigation Recommendations
- Illustrate the Need for UAS Cybersecurity Oversight and Risk Management
- Evaluate UAS Electromagnetic Compatibility (EMC)
- Design Guidance and Best Engineering Practices for Automated Systems
- Determine Impacts of Expanded and Integrated UAS Operations on Traffic Trends & Safety in the NAS
- Identify Cybersecurity Needs for UAS Operations
- Evaluate UAS Disaster Preparedness and Emergency Response Operations

Expanded Operations

Beyond Visual Line of Sight

Operational Complexity

FAA Involvement & Regulatory Oversight

Pathway to Integration + Key Applied NAS Operations Research

NAS Ops Subcommittee March 2022

Federal Aviation Administration

UAS/AAM Research Related to NAS Operations

Operational Capability	Research Project Title	Research Purpose Statement	Research Performer	Period of Performance	Research Status
Expanded Operations	Evaluate Unmanned Aircraft Systems (UAS) Disaster Preparedness and Emergency Response Operations	Conduct research to help inform requirements, technical standards, and regulations needed to enable disaster preparedness and emergency response operations for UAS. This research will help support UAS involved in disaster and emergency management preparedness in the National Airspace System (NAS) by informing requirements, technical standards, regulations, policies, and procedures necessary for emergency responders operating UAS.	ASSURE COE	FY19-FY25	In-Progress
Expanded Operations	Identify Cybersecurity Research Needs for Unmanned Aircraft Systems (UAS) Operations	This effort will bring together multiple FAA organizations to define UAS cybersecurity challenges, identify gaps, and develop research strategies to address the gaps.	ASSURE COE	FY20-FY22	In-Progress
Expanded Operations	Determine Impacts of Expanded and Integrated Unmanned Aircraft System (UAS) Operations on Traffic Trends & Safety in the NAS	Analyze existing data to determine safety impacts and trends. This research will help establish and inform a risk-based framework to quantify the impacts to safety in the National Airspace System (NAS).	ASSURE COE	FY20-FY22	In-Progress
Expanded Operations	Evaluate Global Positioning System (GPS) and Automatic Dependent Surveillance - Broadcast (ADS-B) Data Signals Communication Failures in small Unmanned Aircraft Systems (sUAS) for Risk and Mitigation Management)	Evaluate the risks associated with the loss of GPS and ADS-B signals used to transpond information during sUAS operations. This will enable the identification of appropriate, effective, low cost, and easy to implement mitigations. Research findings will inform updates to standards and FAA policies for safe and secure sUAS operations.	ASSURE COE	FY21-FY22	In-Progress
Expanded Operations	Design Guidance and Best Engineering Practices for Automated Systems	Assess common failure modes in automated systems and propose specific guidance for assessing and mitigating risks in automated UAS operations.	ASSURE COE	FY21-FY23	In-Progress
Expanded Operations	Illustrate the Need for Unmanned Aircraft Systems (UAS) Cybersecurity Oversight and Risk Management	Establish a baseline model, guide, tool, or process to identify cybersecurity risks for all UAS operational capabilities. This research will establish a UAS Cybersecurity Oversight and UAS Cybersecurity Risk Management program that will assist in identifying current methods to oversee/audit the handling of UAS Cybersecurity management.	ASSURE COE	FY22-FY24	In-Progress
Expanded Operations	Evaluate Unmanned Aircraft Systems (UAS) Electromagnetic Compatibility (EMC)	Assess the risks, identify UAS design vulnerabilities, identify material and procedural mitigations, and propose guidance for safer UAS electromagnetic compatibility with emitted and static fields.	ASSURE COE	FY22-FY23	In-Progress
Expanded Operations	Identify and Evaluate Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Risks and Establish Threat Management Mitigation Recommendations to Address Potential Threats to the National Airspace System (NAS), Critical Infrastructure, and Data Protection	Provide a complete ontology of UAS and Counter UAS (C-UAS) detection and mitigation terms and definitions to provide standardized UAS and C-UAS nomenclature as it relates to security. This research will expand awareness of UAS and Advanced Air Mobility (AAM) security issues and cybersecurity.	TBD	FY24-FY26	Planned

UAS/AAM Research Related to NAS Operations

Operational Capability	Research Project Title	Research Purpose Statement	Research Performer	Period of Performance	Research Status
Small UAS Package Delivery Operations	Develop a Strategy for Certification and Approval of Automation and Intelligent Systems for Use with Unmanned Aircraft Systems (UAS) and Urban Air Mobility (UAM)	Establish a long-term strategy for approving UAS and UAM Operations that utilize automation and intelligent systems. The research identifies a phased strategy approach that begins with UAS and moving toward cargo and passenger carrying aircraft. The intent is to identify considerations for certification, including general human factors.	FAA Technical Center	FY19-FY23	In-Progress
Integrated Operations	Evaluate the Command and Control (C2) Link Compatibility with Unmanned Aircraft Systems (UAS)	Conduct testing of the interoperability, safety, security, and performance of the C2 link management with UAS (control capabilities of UAS). This will further inform the development and validation of C2 standards.	FAA Technical Center	FY16-FY22	In-Progress
Integrated Operations	Determine the Severity of Structural Impact for an Airborne Collision between a small Unmanned Aircraft Systems (sUAS) and Manned Aircraft	Develop high fidelity computer models to help understand and replicate impact scenarios of sUAS with General Aviation (GA), commercial, and rotorcraft aircraft components. The goal of this research is to inform evaluation of risks for operational approval for sUAS and sUAS design requirements to reduce the severity of impact.	ASSURE COE	FY18-FY22	In-Progress
Integrated Operation	Capture the Potential Impacts of small Unmanned Aircraft Systems (sUAS) Ingestion in the National Airspace System (NAS)	Validate high-fidelity computer models of an ingestion event between a sUAS and mid- to high-bypass turbofan engine to determine the potential severity of sUAS mid-air collisions with an aircraft. This research will understand the potential and unique hazards presented with an increase public use of sUAS in the National Airspace System (NAS).	ASSURE COE	FY20-FY22	In-Progress
Integrated Operations	Demonstrate and Assess Technologies for Detecting and Mitigating Unauthorized Unmanned Aircraft Systems (UAS) Near Airports	Develop a plan for the certification, permitting, and authorizing of technologies or systems for the detection and mitigation of unmanned aircraft systems near Airports. This research will ensure that Counter UAS (C-UAS) technologies do not adversely impact or interfere with safe airport operations, air navigation, air traffic services, or the safe and efficient operation of the National Airspace System (NAS)	FAA Office of Airports	FY20-FY22	In-Progress
Integrated Operations	Define Safety Risks and Mitigations for Unmanned Aircraft Systems (UAS) Operating around Airports	Identify the potential risks with regards to UAS operations near manned aircraft and around airports. This research will inform needs for systems, services, and capabilities to mitigate safety risks and address gaps in knowledge that are currently a barrier to Integrated UAS operations at or near airports.	ASSURE COE	FY21-FY23	In-Progress
Integrated Operations	Identify Standards for Unmanned Aircraft Systems (UAS) to Mitigate Wake Turbulence	Analyze wake-induced turbulence hazards to UAS operations. This research will inform minimum standards needed for wake turbulence separation.	ASSURE COE	FY20-FY23	In-Progress
Integrated Operations	Evaluate Unmanned Aircraft System(s) (UAS) Detection and Mitigation Technologies & Enforcement Actions in the National Airspace System (NAS)	To test, operate, and evaluate technologies designed to detect, track, identify and mitigate Unmanned Aircraft Systems (UAS) in the United States under identified circumstances	ASSURE COE	FY20-FY22	In-Progress
Integrated Operations	Evaluate small Unmanned Aircraft Systems (sUAS) Traffic Trends to Determine the risk of sUAS Collisions with Manned Aircraft	Evaluate existing UAS traffic trends to monitor the effectiveness of existing UAS regulations and forecast future UAS Integration needs. This research will use detection data to analyze sUAS traffic at several urban locations across the NAS.	ASSURE COE	FY21-FY24	In-Progress

UAS/AAM Research Related to NAS Operations

Operational Capability	Research Project Title	Research Purpose Statement	Research Performer	Period of Performance	Research Status
Integrated Operations	Evaluate Unmanned Aircraft Systems (UAS) Air-to-Ground National Airspace System (NAS) Communications Latency and Voice Intelligibility	Measure the actual latencies that exist in current FAA voice communication systems, including Voice Switching Control System (VSCS), Interim Voice Switch Replacement (IVSR), and legacy systems. This research will provide the RTCA and industry with up-to-date data to inform requirements for UAS to FAA Air Traffic Control (ATC) communications in the NAS.	FAA Technical Center	FY22-FY23	In-Progress
Integrated Operations	Propose UAS Right-of-Way Rules for Unmanned Aircraft Systems(UAS) Operations and Safety Recommendations	Identify right-of-way rules for diverse UAS operations and make safety-based recommendations. This research will be used to assess UAS operations and their systems when reviewing waivers, creating certification criteria, creating policy, and working on proposed rulemaking briefings and proposed updates to industry standards.	ASSURE COE	FY22-FY24	In-Progress
Integrated Operations	Determine the Collision Severity of small Unmanned Aircraft Systems (sUAS) in Flight Critical Zones	Investigate the severity metrics of the collision dynamics between multi-rotor and fixed wing UAS weighing 10, 25 or 55 lbs with a piloted helicopter. The research will evaluate the collision dynamics during key phases of flight such as hover, forward flight, and cruise. The outcomes will inform future Advanced Air Mobility (AAM)/Urban Air Mobility (UAM) research and progress the completion of a key phase of collision severity investigations for UAS.	ASSURE COE	FY22-FY24	Planned
Integrated Operations	Establish Minimum Performance Specifications and Repeatable Guidance for UAS and Autonomous Tech	Conduct testing and evaluations to identify suitable technologies, performance specifications, and standard and repeatable guidance for each unique UAS/autonomous technology airport application (obstruction analysis, pavement inspections, wildlife hazard management, perimeter security, and emergency response). The outcomes of this research will assist with creating/updating the FAA Office of Airports guidance documentation for UAS/autonomous technology integration at our nation's airports.	FAA Office of Airports	FY22-FY24	Planned
Integrated Operations	Explore the Impact of Lost Link in Air Traffic Control (ATC) Airspace	Explore impacts on Air Traffic Control (ATC) due to variations between manned and unmanned operations and unique aspects of Unmanned Aircraft Systems (UAS) operations. This research will support UAS integration into controlled airspace.	ASSURE COE	FY23-FY23	Planned
Integrated Operations	Evaluate the Impacts and Operational System Needs to Support Deployment and Use of Counter-Unmanned Aircraft Systems (C-UAS) within Different Environments and Scenarios to Protect Safety and Security of the National Airspace System (NAS)	Investigate the efficacy of UAS detection and mitigation systems using risk based analyses to determine potential impacts on UAS/ Advanced Air Mobility (AAM) operations, UAS Traffic Management (UTM), and critical aviation infrastructure. This research effort will evaluate supply chain and data collection associations for UAS and C-UAS activities.	TBD	FY24-FY25	Planned
Integrated Operations	Assess the Risk of Collision between Urban Air Mobility (UAM) vehicles, UAM and Unmanned Aircraft, and UAM and Manned Aircraft	Evaluate the risk of introducing and operating a UAM and propose guidelines for safer integration of UAM into the National Airspace System (NAS). The result will contribute in identifying risk of operating UAM in the NAS, and contribute in mitigating fatal accidents involving UAM.	TBD	FY24-FY25	Planned
Integrated Operations	Develop Receiver Channel Model and Test Simulation for Unmanned Aircraft Systems (UAS) Command and Control (C2) Radio Operating in C-Band	Develop models and evaluate technology options to inform development of a test bed. This research will advance the verification and validation requirements of receiver performance of C-band radio.	ASSURE COE	FY24-FY25	Planned

UAS/AAM Research Related to NAS Operations

Operational Capability	Research Project Title	Research Purpose Statement	Research Performer	Period of Performance	Research Status
Routine/ Scheduled Operations	Develop a Framework to Incorporate Unmanned Aircraft Systems (UAS) Flight Data into Aviation Safety Information Analysis and Sharing (ASIAS)	Compile and assess UAS flight data (parameters, exceedances, and recording rates) for incorporation with commercial, general aviation, and surveillance data currently in the Aviation Safety Information Analysis and Sharing (ASIAS) program.	ASSURE COE	FY19-FY20	Completed
Routine/ Scheduled Operations	Design Guidance and Best Engineering Practices for Automated Systems	Assess common failure modes in automated systems and propose specific guidance for assessing and mitigating risks in automated UAS operations.	ASSURE COE	FY21-FY24	In-Progress
Routine/ Scheduled Operations	Explore the Impact of Lost Link in Air Traffic Control (ATC) Airspace	Explore impacts on Air Traffic Control (ATC) due to variations between manned and unmanned operations and unique aspects of Unmanned Aircraft Systems (UAS) operations. This research will support UAS integration into controlled airspace.	ASSURE COE	FY23-FY24	In-Progress
Large Carrier Cargo Operations	Understand Transition Between Using Manned Aircraft for Cargo Delivery, and Introducing Unmanned Aircraft Systems (UAS) Cargo Delivery	Examine UAS cargo operations, and their impacts on the National Airspace System. This will identify and assess safety risks and mitigations, as well as the rules, standards, and procedures needed to safely integrate UAS cargo operations.	ASSURE COE	FY21-FY23	In-Progress
Passenger Transport Operations	Understand Urban Air Mobility (UAM) Safety and Certification Challenges Mapping Impact on Market Feasibility and Growth Potentials	Understand the Advanced Air Mobility/UAM market, aircraft certification, and integration challenges into the National Airspace System (NAS). This research will provide a comprehensive analysis of market, feasibility, and projections of future demand. Lessons and recommendations gained will help the FAA understand challenges with AAM integration.	ASSURE COE	FY21-FY22	In-Progress
Passenger Transport Operations	Investigate and Identify the Key Differences Between Commercial Air Carrier Operations and Unmanned Transport Operations	Evaluate trends and considerations in Unmanned Aircraft Systems (UAS) passenger transport operations. This will provide a comprehensive analysis of market, feasibility and projections of future demand and recommendations. These lessons learned will enhance the FAA understanding of UAS passenger transport requirements.	ASSURE COE	FY21-FY23	In-Progress
Passenger Transport Operations	Identify Models for Advanced Air Mobility (AAM)/Urban Air Mobility (UAM) Safe Automation	Develop system safety control models to identify and mitigate risks for automated safety critical tasks. The results from this project are intended to inform future FAA decision making which may include waivers, policy decisions, certification approaches, advisory circulars, rulemaking, and so on. The results from this project may also inform a variety of UAS standards.	ASSURE COE	FY23-FY25	Planned
Passenger Transport Operations	Develop Models to Inform the Integration of Advanced Air Mobility (AAM) into the NAS	Inform the FAA priority of AAM by identifying likely passenger flow scenarios and evolving networks of AAM, and by projecting and modeling the evolution of the commercial aviation transportation network to inform the integration of AAM. This research will support the expansion of AAM while maintaining the safety of the NAS.	ASSURE COE	FY23-FY25	Planned

Questions

Thank you!