FAA’s Approach to Unmanned Aircraft Systems (UAS) Concept Maturation, Validation & Requirements Development

Presented to: REDAC NAS Operational Concepts Subcommittee

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Date: August 12, 2015
Briefing Objectives

• Provide a history of FAA concept development and maturation efforts conducted to date towards achieving UAS integration into the National Airspace System (NAS) and the associated drivers for initiating the work

• Describe the systematic approach and process employed by the FAA UAS concept development team to identify proposed UAS concept maturation/research needs

• Demonstrate cross line of business, cross-organizational collaboration

• Discuss strategic plans for moving forward, near-term opportunities, and new research and development opportunities
## History - 2011 to Present

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
</table>
| **2011** | • ANG-C tasked to develop enterprise level concept of operations for UAS integration into the NAS  
• Multi LOB, multi-organizational team formed – AVS (AFS, AIR), ATO, ANG |
| **2012** | • Draft concept reviewed by AVS, ATO, ANG, ARP, & APL  
• Signed UAS ConOps, v2.0 document delivered Sept 2012 |
| **2013** | • Concept maturation effort initiated, sponsored by AJV-7  
• Continued refinement and development of concepts and operational requirements through multi-organizational team  
• Focus on integration (~2025) and mid-term (~2018-2020) timeframes |
| **2014** | • Continued concept maturation and identification of operational and system requirements for mid- and mature state integrated operations  
• NextGen operational analysis performed of UAS operations in Class A/B Airspace  
• Near-term Pathfinder efforts initiated |
| **2015** | • Develop operational scenario service/responsibility allocation tables  
• Engage UAS stakeholder community on vision and expectations of operating in the NAS  
• Develop concept for ‘modified IFR’, low altitude UAS operations  
• Update UAS operational requirements based on latest products |
Briefing Contents

- UAS Concept of Operations 2.0
- UAS Requirements Development
- UAS Steering Group
- UAS Concept Maturation
- Strategic Plans for Moving Forward
- UAS Concept Validation
- External Stakeholder Engagement
- Near-Term Opportunities – Pathfinder Industry Initiatives
- Research Opportunities – Center of Excellence (COE)
FAA UAS ConOps

Overview
Development Approach
Concept Highlights
Operational Scenarios
2011-2012: High-Level UAS ConOps Development

- Developed FAA UAS Concept of Operations (ConOps) for mature state integrated UAS operations, due to growing interest and demand for UAS access to airspace.

- FAA Modernization & Reform Act (February 2012), mandating that FAA integrate UAS into the NAS by 2015, further stressed importance and priority of FAA UAS concept and requirements development efforts.
ConOps Objectives

- Begin the systems engineering process of identifying operational and system-level requirements necessary to achieve integration
- Establish framework for alignment of UAS efforts across FAA (roadmaps, research plans and activities) to validate and inform path to integration
- Identify touchpoints and interactions with NextGen systems, capabilities, and operational improvements
- Document FAA expectations of UAS operators, in terms of operations, performance, and airworthiness, and identify pre-requisites to integration at an appropriate level
ConOps Development Approach

- Established multi-organizational team of FAA subject matter experts (SMEs) to encompass air traffic, safety, and system perspectives and foster early internal stakeholder acceptance of the vision

- Developed concept narrative and mature state operational scenarios, primarily from an air traffic perspective
  - Defined assumptions about certification, operating rules, and the operating environment
  - Described operations by phase of flight and airspace class (A-E, G)

- Assumed
  - All required policies, regulations, procedures, technologies, and training are in place to support integrated UAS operations (both civil and public) in the NAS
  - NextGen capabilities, enabling technologies, and operational concepts have matured
  - Timeframe is milestone-driven
ConOps Considerations & Scope

- Current day shortfalls and challenges, and a path forward from accommodation to integration
- Certification and operational approval processes
- NAS evolution in context of NextGen capabilities and improvements
- Normal operations
- Contingency operations
- Impacts and interactions with other NAS operational concepts

Concept does not address small UAS (aircraft weighing less than 55 lbs) operations conducted exclusively within visual line of sight of the flight crew
Summary of Key Integration Assumptions

- UAS are aircraft and behave in a manner similar to manned aircraft. This includes meeting the performance and equipage requirements established for the airspace class and/or route in which they are operating.

- Certification of airworthiness and a capability analogous to that required under “see and avoid” requirements of 14 CFR Part 91 are pre-requisites to NAS integration.

- UAS adhere to current and future ATC procedures, requirements, and instructions using standard phraseology. The FAA creates no new airspace classes specifically to support UAS.

- Autonomous operations are not authorized. The Pilot in Command (PIC) can always assume direct control of the aircraft during normal operations. There is a 1-to-1 relationship between the PIC and the UA.

- ATC remains responsible for separation services as required by airspace class and flight plan type using applicable separation minima.

- FAA policy, guidelines, and automation support priority for individual flights, and equitable access to airspace and air traffic services.
No “Visual” Compliance

For **beyond** visual line of sight operations

- UAS cannot comply with Visual Flight Rules (VFR) or with any clearance that includes a visual component, as these rules are based the use of human natural vision (not the use of technology to perform such functions)

- Current regulations that address the use of human visual references are not based on measurable or quantitative criteria; and therefore cannot be used as a basis for establishing instrument equivalency

- Today’s IFR provides a basis for flying without natural vision, however many visual operations exist under today’s IFR

- **New regulations/rulemaking and procedures are required**
### Summary of Mature State Operational Scenarios

<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Flight Plan</th>
<th>Airspace</th>
<th>Purpose of Flight</th>
<th>Aircraft</th>
<th>Mature State Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Planning</td>
<td>IFR</td>
<td>All</td>
<td>Any where IFR flight plans are appropriate</td>
<td>All</td>
<td>Negotiation of flight plan prior to departure and updates during flight. Define “unique.”</td>
</tr>
<tr>
<td>Surface Operations</td>
<td>N/A</td>
<td>Class C or Class D</td>
<td>N/A</td>
<td>All</td>
<td>For ground movement on towered airports. Interact with other traffic and ATC on the surface.</td>
</tr>
<tr>
<td>Border Patrol/ Monitoring</td>
<td>IFR</td>
<td>Class C arrival/departure, aerial work in Class A and Class E</td>
<td>Border patrol</td>
<td>Predator-B</td>
<td>Planned maneuver and unplanned deviation. Negotiated delay in return to airport. Go-around.</td>
</tr>
<tr>
<td>Atmospheric Monitoring (HALE)</td>
<td>IFR</td>
<td>Class A, Class E high altitude</td>
<td>Environmental Sensing</td>
<td>HALE</td>
<td>Slow transition through Class A. Long-endurance above FL600.</td>
</tr>
<tr>
<td>Search and Rescue</td>
<td>Notify</td>
<td>Class G</td>
<td>Survey at night</td>
<td>ScanEagle</td>
<td>Survey operations in Class G airspace.</td>
</tr>
<tr>
<td>Traffic Monitoring</td>
<td>IFR</td>
<td>Class D departure, Class B aerial work</td>
<td>Media and traffic reporting</td>
<td>Fire Scout helicopter</td>
<td>Follow defined route. Hovering operations.</td>
</tr>
<tr>
<td>Environmental Sampling</td>
<td>IFR</td>
<td>Class E with Class B transition</td>
<td>Monitor coal plant air emissions</td>
<td>Aerosonde</td>
<td>Class B transition, operations grid pattern in Class E. 4D trajectory operations. Early termination for weather.</td>
</tr>
<tr>
<td>Cargo/Mail Delivery</td>
<td>IFR</td>
<td>Class D departure, Class E en route and arrival</td>
<td>Cargo delivery</td>
<td>Cessna Caravan</td>
<td>ATM weather reroute and pilot weather deviation.</td>
</tr>
<tr>
<td>Oceanic Cargo/Mail Delivery</td>
<td>IFR</td>
<td>Class A oceanic, Class B arrival</td>
<td>International cargo</td>
<td>B747</td>
<td>Oceanic high altitude point-to-point operations. In-trail climb procedure. High-density airspace operations to include OPD.</td>
</tr>
<tr>
<td>Delegated Separation</td>
<td>IFR</td>
<td>Class E</td>
<td>Exploration in class E</td>
<td>Shadow</td>
<td>IFR flight with delegated separation for exploration in Class E airspace</td>
</tr>
<tr>
<td>Environmental Sampling</td>
<td>IFR</td>
<td>Class E</td>
<td>Demonstrate what Known and Predictable means</td>
<td>Any UA certified to operate in Class A</td>
<td>Talks about LL profile, Standardized LL Contingency Plans, LL recovery plans and procedures</td>
</tr>
<tr>
<td>Lost Link</td>
<td>IFR</td>
<td>Class A</td>
<td>Demonstrate what Known and Predictable means</td>
<td>Any UA certified to operate in Class A</td>
<td>Talks about LL profile, Standardized LL Contingency Plans, LL recovery plans and procedures</td>
</tr>
</tbody>
</table>
UAS Requirements Development

ConOps Decomposition
FAA
UAS Operator
# ConOps Decomposition

## Objectives

<table>
<thead>
<tr>
<th></th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decompose ConOps 2.0 narrative into a baseline set of draft <strong>concept level</strong> operational requirements* for integrated UAS operations</td>
</tr>
<tr>
<td>2</td>
<td>Categorize potential requirements as they pertain to services, systems, technologies, tools, procedures, training, and policies</td>
</tr>
<tr>
<td>3</td>
<td>Develop and maintain a <em>mature state</em> requirements database</td>
</tr>
<tr>
<td>4</td>
<td>Update requirements database**, as necessary, based on concept maturation activities, including those that support <em>other than mature state</em> UAS operations</td>
</tr>
</tbody>
</table>

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* “Requirements” is an umbrella term for concept level operational requirements, agency actions, and policy needs, as well as “expectations” of compliance and performance on the part of the UAS operator.

** Requirements/expectations are not static - they will continue to be matured, validated or invalidated, assessed, and updated.
ConOps Decomposition (cont’d)

UAS ConOps v2.0 Narrative

Potential Requirements for Integrated UAS Operations

Categorization

FAA

UAS Operator

Consolidation
Vetting
Validation
Review

Refined Set of Requirements for Integrated UAS Operations

Certification  Operations  Policy  Flight Planning  Safety  Operational Approval  Training
<table>
<thead>
<tr>
<th>Rqmt #</th>
<th>Category</th>
<th>Shortfall</th>
<th>FAA Requirement</th>
<th>Mid Term?</th>
<th>Concept maturation area(s) of interest, if any.</th>
<th>Status of Requirement &amp; Shortfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-126</td>
<td>Operations - Contingency</td>
<td>Standard UAS contingency procedures (associated with lost link) that require ATC interaction have not been established.</td>
<td>Airports routinely serving UAS shall designate a fix or volume of airspace for lost link containment and/or flight termination.</td>
<td>Y</td>
<td>AJV-7 Support/ Consult [R1.13 - ATC Procedures and Phraseology for Lost Link Events]</td>
<td>Requirement and shortfall allocated to ERAM Sector Enhancements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air traffic procedures in the terminal domain do not include airspace or fixes that support lost link events.</td>
<td>Airports routinely serving UAS may designate a fix or volume of airspace for lost link containment.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-89</td>
<td>Flight Planning</td>
<td>The current flight plan does not support the full range of UAS operations.</td>
<td>The FAA shall increase (currently at 1000) the number of characters in a flight plan route string. The FAA will assess and establish an appropriate number of characters (currently 1000) that may be needed to support UAS flight plans.</td>
<td>Y</td>
<td>AJV-7 Lead [R4.1.1 - Increasing Flight Plan Route Elements and Characters]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The number of characters within a flight plan route string does not support every type of UAS operation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
UAS Operator Requirements

- Shared with UAS test sites in 2014 in form of ‘Potential Research Areas’

<table>
<thead>
<tr>
<th>Category</th>
<th>Research Consideration</th>
<th>ConOps Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certification - Communications</td>
<td>UAS will comply with voice and data communications latency requirements (which may vary by class of airspace) between the flight crew and ATC. Includes research to validate standards for one or more acceptable thresholds for communications latency.</td>
<td>4.4.1.2</td>
</tr>
<tr>
<td>Operations - Sense &amp; Avoid</td>
<td>The UAS PIC will obtain ATC approval prior to performing a self-separation maneuver outside the IFR clearance issued in controlled airspace. <strong>Note:</strong> In Class A airspace, self-separation maneuvers should not be performed. Includes research to develop capabilities or validate standards to use Sense and Avoid system to self-separate from one or more other aircraft as approved by ATC.</td>
<td>4.5</td>
</tr>
</tbody>
</table>
UAS Steering Group (USG)

Mission
Participants
USG Participants

- Established March 2013, monthly meetings
- Executive level guidance: ATO, ANG, AVS
- Participants

<table>
<thead>
<tr>
<th>Air Traffic Organization</th>
<th>NextGen</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>AJV-7 – Operational Concepts, Validation, &amp; Requirements</td>
<td>ANG-2 – Chief Scientist</td>
<td>AFS-400 – Flight Technologies &amp; Procedures</td>
</tr>
<tr>
<td>AJV-8 – Air Traffic Procedures</td>
<td>ANG-C4 – Advanced Operational Concepts</td>
<td>AFS-80 – UAS Integration Office</td>
</tr>
<tr>
<td>AJV-1 – Airspace Services</td>
<td>ANG-C2 – New Entrants</td>
<td>AIR-130 – Systems &amp; Equipment Standards</td>
</tr>
</tbody>
</table>
USG Mission

• Provide executive direction and guidance for maturation and validation of UAS operational concepts across FAA lines of business (LOBs)

• Include participants engaged in various FAA UAS efforts to ensure continuity of UAS integration planning

• Provide a forum to
  – Review and provide input to concept maturation products at a working level
  – Gain agreement/consensus regarding scenarios’ narratives, objectives, outcomes, and requirements
  – Recognize and consider interdependency of issues and anticipated changes needed
UAS Concept Maturation

Drivers & Process
Research Gap Analysis
Mid-Term Environment Assessment
Mid-Term Operational Scenarios
Updated Mature State Operational Scenarios
Operational Scenario ATC Vetting
UAS Scenario Service/Responsibility Allocation Tables
Class A & B Analysis – NextGen Systems and OIs
Modified IFR Concept Development
2013-Present: Concept Maturation

- Drivers of activity include air traffic management (ATM) automation lead times to incorporate changes and uncertainty surrounding specific dates when significant commercial UAS operations are anticipated

- Maturation undertaken through multi-organizational team with emphasis on detailed scenarios to further:
  - Identify regulatory, policy, procedural, and other issues
  - Generate operational requirements for mid-term and mature state UAS operations (allocated to the FAA and to the UAS Operator)
  - Address issues/questions associated with the ConOps and detailed scenarios

- Team reviewed existing mature state scenarios (contained in the ConOps) and generated additional scenarios to ensure continuity of evolution

- Team generated 11 mid-term (~2018-2020) UAS scenarios

- Multi-year, cross-organizational, integrated work plan developed and executed
The Maturation Process

✓ Mapped several past and current research efforts to operational requirements to leverage existing data, identify gaps, and prioritize research/validation activities

✓ Developed additional mature state scenarios and operational requirements

✓ Conducted analysis to establish framework and assumptions for mid-term environment, based on demand forecasts, state of regulations and standards development, and NAS technologies and capabilities

✓ Assessed and documented current day operational needs based on UAS data collection activities (e.g., field visits/interviews with ATC personnel who work UAS)

✓ Developed operational scenarios that explore mid-term UAS operations and their impacts on ATC/ATM operations

✓ Vetted scenarios with ATC subject matter experts (SMEs) and other key FAA stakeholders

✓ Derived initial set of mid-term operational requirements from scenario development and discussions with ATC and UAS SMEs and added/reconciled them with mature state set
Resultant Products & Outputs

- Detailed, agreed mid-term scenarios consistent with set of mature state scenarios
  - This includes both allocation of responsibilities and narrative constructs.

- Updated, detailed, agreed mature state scenarios
  - This includes both allocation of responsibilities and narrative constructs.

- Inputs, based on the scenario sets, for potential update of the FAA UAS ConOps v2.0 (e.g., addendum)

- Initial shortfalls and operational requirements, driven by the scenarios, to inform Concept and Requirements Definition and Investment Analysis Readiness Decisions (CRDRD & IARD) of planned investments
Research Gap Analysis

- Gap Analysis conducted to identify UAS R&D gaps and begin framework for research plans forward

- Research reviewed
  - TCRG’s FY 2013 research
  - MITRE UAS research studies

- Methodology
  - Research analyzed to determine whether assumptions, goals, objectives, and results were consistent with ConOps
  - Analyzed appropriate studies to determine applicability to the major elements of the UAS ConOps
  - Applicable studies were assessed against each UAS integration concept requirement

- Completeness levels were not assessed
Mid-Term Assessment
Estimated UAS Growth Rates: All UAS

- Civil (sUAS)
- Military (sUAS)
- Public (sUAS)
- Civil (other)
- Military (other)
- Public (other)

Airspace Needs Determined
sUAS (VLOS) Rule
Restricted Cat Cert
Standard Type Cert
Update ACs, Orders, FARs and AIM
Airspace Procedures & Docs Implemented

Number of Aircraft

2013 2015 2020 2025 2030

50K 60K

10K 20K 30K 40K 50K

Federal Aviation Administration
NAS Programs

- TFMS WP includes Trajectory Options Set – may make UAS contingencies accessible to TFM
- ERAM R4 includes airborne re-routes (ABRR)
- TAMR (no FDP)
- En Route Data Comm in ERAM (initial services)
- (*No Terminal Data Comm)
- NVS Future with integrated phone & radio [implementation TBD]
- Flight Plan/ERAM changes – fields for contingency plans/access to ATC

Operational Milestones

- Commercial COA
- UAS undergoing certification
- COA for Ops: no DAA cap
- sUAS (VLOS) flying without COA
- Larger UAS ADV-B equipped
- On-board DAA not required for Class A: Positive Control Airspace
- C2 MOPS non-satellite
- C2 via non-satellite
- Authorized to transition through Classes D, E, G without a COA (limited duration)
- Authorized to fly in Class A w/out COA
- C2 MOPS satellite
- C2 via satellite
- G-G Comm
- Transit certified DAA
- Type Certs based on MOPS
- Fully certified DAA equipment
- Authorized to transition through Classes D, E, G without a COA
- Type certifications based on MOPS
# Summary of Mid-Term Operational Scenarios

<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Flight Plan</th>
<th>Airspace</th>
<th>Purpose of Flight</th>
<th>Aircraft</th>
<th>Mid-Term Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Planning</td>
<td>IFR</td>
<td>All</td>
<td>N/A</td>
<td>All</td>
<td>Negotiation of flight plan prior to departure and updates during flight. Define “unique.”</td>
</tr>
<tr>
<td>Surface Operations</td>
<td>N/A</td>
<td>Class C or Class D</td>
<td>N/A</td>
<td>All</td>
<td>Assumptions only. For ground movement on towered airports. Interact with other traffic and ATC on the surface.</td>
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<tr>
<td>Border Patrol/ Monitoring</td>
<td>IFR</td>
<td>Class D arrival/departure, aerial work in Class A</td>
<td>Border patrol</td>
<td>Predator-B</td>
<td>Planned maneuver and unplanned deviation. Go-around.</td>
</tr>
<tr>
<td>Atmospheric Monitoring (HALE)</td>
<td>IFR</td>
<td>Class A, Class E high altitude</td>
<td>Environmental Sensing</td>
<td>HALE</td>
<td>Slow transition through Class A. Long-endurance above FL600.</td>
</tr>
<tr>
<td>Search and Rescue</td>
<td>IFR</td>
<td>Class E, TFR</td>
<td>Search and Rescue at night</td>
<td>Scan Eagle</td>
<td>Search operations Class E airspace.</td>
</tr>
<tr>
<td>Agricultural Monitoring</td>
<td>Notify</td>
<td>Class G, D</td>
<td>Agriculture mapping</td>
<td>Trimble UX5</td>
<td>Survey of farmer’s land to provide detailed information to the farmer about his crops.</td>
</tr>
<tr>
<td>Pipeline Surveillance</td>
<td>Notify</td>
<td>Class G, transition Class D</td>
<td>Pipeline monitoring</td>
<td>Scan Eagle</td>
<td>Designated route specifically for UAS (under 500 ft. AGL).</td>
</tr>
<tr>
<td>Accident Scene (HazMat Investigation)</td>
<td>Notify</td>
<td>Class B</td>
<td>Monitoring specific situations on the ground</td>
<td>Small – Shadow Hawk, Aeryon Scout</td>
<td>Control in and around urban areas. Flyaway in terminal area</td>
</tr>
<tr>
<td>Maritime Surveillance</td>
<td>IFR</td>
<td>Class A oceanic</td>
<td>Surveillance</td>
<td>Global Hawk</td>
<td>Oceanic high and low altitude.</td>
</tr>
<tr>
<td>Offshore Surveillance with Due Regard</td>
<td>IFR</td>
<td>Oceanic off-shore, Class A, Class D airport</td>
<td>Surveillance Due Regard Operations off-shore</td>
<td>Scan Eagle</td>
<td>Oceanic Due Regard off-shore operations picking up IFR flight plan back into airport in Class D.</td>
</tr>
<tr>
<td>Lost Link</td>
<td>IFR</td>
<td>All</td>
<td>Demonstrate LL procedures for Terminal and En-route</td>
<td>All</td>
<td>Lost link/contingency route activation with &amp; without TOS/ABRR capability, ground-ground CPDLC, procedural changes</td>
</tr>
</tbody>
</table>
Operational Scenario ATC Vetting

**Mid-Term Scenarios**
- Conducted 3 days in March, 2014
- 12 ATC SMEs from the ATO
  - 9 ATO Operational Concepts and Technical Analysis & Operational Requirements Groups
  - 2 ATO ATC Procedures Group
  - 1 NATCA
  - 1 NextGen Concept Development & Validation Branch
- **Key Areas of Concern**
  - Increased demand for small UAS operations beyond the provisions of the sUAS rule (low altitude, BVLOS) & potential impacts to ATC

**Mature State Scenarios**
- Conducted 3 days in April, 2014
- 8 ATC SMEs from the ATO
  - 5 ATO Operational Concepts and Technical Analysis & Operational Requirements Groups
  - 1 ATO ATC Procedures Group
  - 1 NATCA
  - 1 NextGen Concept Development & Validation Branch
- **Key Areas of Concern**
  - Increased demand for operations in Class E above Class A airspace & potential impacts to ATC
  - What IFR means to ATC vs UAS
Service/Responsibility Allocations

- Drivers of activity included the need to resolve specific uncertainties and unknowns associated with the UAS operational scenarios
- Work was based on mid-term and mature state scenario review and analysis
- Allocated responsibility among the air navigation service provider (ANSP) and pilot-in-command (PIC) of UAS / manned aircraft for functions such as:
  - Flight Planning
  - Flight Data Processing
  - NOTAMs
  - Separation
  - Hazard Avoidance (terrain/obstacles, weather)
  - Advisories (traffic, weather, wake turbulence)
- Identified gaps and shortfalls to inform rulemaking, airspace needs, and procedures development
- Reached consensus on the allocations via vetting with the USG
- Updated the detailed mid-term and mature state scenarios based on USG feedback on the Allocation Tables
Scenario Responsibility Allocation Tables – EXAMPLE

Mid-Term Scenario Category:
Low Altitude Operations in Sparsely Populated Areas – Allocated Airspace or Structured Route

### Example Applications
- Agricultural Monitoring
- Livestock Management
- Power Line Inspection
- Pipeline Surveillance
- Oil Field Security/Monitoring
- Canal Monitoring/Inspection

### Operational Domain:
Low altitude, primarily uncontrolled airspace without radar coverage; allocated airspace volume or route

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAS Type</td>
<td>Small</td>
</tr>
<tr>
<td>Altitude Range</td>
<td>Low (&lt;2,000’ AGL)</td>
</tr>
<tr>
<td>Aircraft Endurance</td>
<td>Medium (hours)</td>
</tr>
<tr>
<td>Expected Traffic Density</td>
<td>Very low</td>
</tr>
<tr>
<td>Aircraft Range</td>
<td>Variable, beyond visual line of sight</td>
</tr>
<tr>
<td>Conditions</td>
<td>Day</td>
</tr>
<tr>
<td>Potential Airspace Classes</td>
<td>D/E/G</td>
</tr>
<tr>
<td>Operational Limits</td>
<td>Route defined by ground features; Sparsely populated areas</td>
</tr>
</tbody>
</table>

### Pipeline Surveillance

**Scenario Synopsis:** UAS launches and recovers off airport and operates (in uncontrolled airspace) within a designated “UAS Route” that is NOTAM’d when active. The PIC obtains clearance from ATC to transit Class D airspace that includes a short segment of the allocated route.

**Note:** Detect & Avoid (DAA) options in the mid-term limit operational alternatives.

Red text in scenario tables indicate shortfalls that need to be addressed.
### Pipeline Surveillance - Class D

<table>
<thead>
<tr>
<th>Service/Responsibility</th>
<th>Allocation</th>
<th>Explanatory Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Separation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft (general)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFR aircraft – IFR aircraft</td>
<td>X</td>
<td>Applies to those UAs on an IFR flight plan.</td>
</tr>
<tr>
<td>IFR aircraft – VFR aircraft</td>
<td>X</td>
<td>Shared responsibility among UAS and manned aircraft. UAS use currently acceptable means of DAA.</td>
</tr>
<tr>
<td>VFR aircraft – VFR aircraft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UA from manned aircraft while on UR route</td>
<td>X</td>
<td>Procedural. UR route is designed and authorized for UA use only.</td>
</tr>
<tr>
<td>UA – UA (within allocated route)</td>
<td></td>
<td>For multiple UA aircraft on the same UR route, separation assurance is pre-coordinated as part of flight approval.</td>
</tr>
<tr>
<td><strong>Airspace</strong></td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td>All aircraft from allocated (and active) route</td>
<td>X X X</td>
<td>Procedural. Controller instructs participant aircraft to remain clear of UR route when active.</td>
</tr>
<tr>
<td>Collision avoidance (between all aircraft, including UAs)</td>
<td>X* X</td>
<td>Shared responsibility among UAS and manned aircraft. UAS use currently acceptable means of DAA. *Pipeline UAS not capable.</td>
</tr>
</tbody>
</table>

UAS may accept instructions & clearances with a visual component when the requirements for the specific visual application are satisfied.

### Hazard Avoidance

<table>
<thead>
<tr>
<th>Service/Responsibility</th>
<th>Allocation</th>
<th>Explanatory Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Terrain avoidance / obstacle clearance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFR aircraft, including IFR UAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For T/O &amp; initial climb on departure, transition to landing</td>
<td>X X</td>
<td></td>
</tr>
<tr>
<td>Upon effectiveness of the clearance on departure, and until at DH or MAP while on arrival route</td>
<td>X</td>
<td>Cleared route of flight meets IFR criteria for MEA, MOCA, MVA.</td>
</tr>
<tr>
<td>VFR aircraft, UAs that are approved to access the airspace</td>
<td>X X</td>
<td></td>
</tr>
<tr>
<td><strong>Weather avoidance</strong></td>
<td>X X</td>
<td></td>
</tr>
<tr>
<td><strong>Advisories</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wake turbulence advisories</td>
<td>X</td>
<td>Where applicable.</td>
</tr>
<tr>
<td>Traffic advisories</td>
<td>X</td>
<td>Workload permitting. Excludes advisories between participating aircraft authorized to operate within allocated airspace.</td>
</tr>
<tr>
<td>Weather advisories</td>
<td>X</td>
<td>Workload permitting.</td>
</tr>
</tbody>
</table>

*Pipeline UAS not capable.*
Class A & B Airspace Analysis

• Objectives
  – Identify operational and/or technical gaps and define future NAS and NextGen requirements associated with integrating UAS operations into Class A and B airspace.
  – Inform UAS operators about possible future requirements to operate in Class A and B airspace.

• Results
  – Description of the CO, OI or increment taken directly from the NAS EA
  – Discussion of interactions between the CO, OI or increment and future Unmanned Aircraft System (UAS) operations, where applicable
  – Potential implications for systems, capabilities, impacts on both the NAS and UAS

• Will enable preliminary UAS requirements decomposition for Class A and B airspace
Modified IFR Concept Development

• Explore the UAS ‘file and fly IFR’ requirement to determine under what circumstances it is not practical or doable and/or where a new operating concept needs to be described

• Develop notification requirements and appropriate mechanisms for delivering information about UAS operations (in lieu of IFR flight plan)

• Develop narrative based on scenarios and scenario responsibility allocation tables that fall outside the scope of the UAS ConOps (e.g., low altitude segregated operations)

• Derive associated operational requirements for both the FAA and the UAS operator
Pulling it all together

Enable small commercial UAS operations within line of sight and outside busy airspace
- Small UAS (sUAS) Rule
- Notification Requirements Dev’t

Enable specified and routine operations within visual line of sight over populated areas and expanded visual line of sight in rural environments
- Near-Term Strategy/Pathfinders
- Mid-Term Scenarios

Enable beyond line-of-sight UAS operations in low population, segregated airspace
- Mid-Term Scenarios
- Near-Term Strategy/Pathfinders
- Service/Responsibility Allocation Tables
- UAS Requirements Database
- Planned concept maturation & validation activities

Enable segregated UAS operations over densely populated areas
- Mid-Term Scenarios
- Service/Responsibility Allocation Tables
- UAS Requirements Database
- Planned concept maturation & validation activities

Enable UAS transit in the NAS
- UAS ConOps 2.0
- Mature State Scenarios
- Mid-Term Scenarios
- Service/Responsibility Allocation Tables
- UAS Requirements Database
- Planned concept maturation & validation activities

Enable integrated UAS operations
- UAS ConOps 2.0
- Mature State Scenarios
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- Planned concept maturation & validation activities
Strategic Plans for Moving Forward

Inputs & Artifacts
Operations Evolution Strategy
L2 Program Plan
Collection of Inputs/Artifacts

FAA UAS ConOps

Mid-Term UAS Scenarios

UAS Requirements & Shortfalls Allocated to FAA

Service/Responsibility Allocations for Mid-Term & Mature State UAS Scenarios

ATO UAS Operations Evolution Strategy (OES)

AJV-7 UAS Concept Maturation Plan
UAS Operations Evolution Strategy (OES)

Provides a plan of action for enabling UAS operations in the NAS from an air traffic management perspective.

Discusses key air traffic related milestones that must be achieved to transition from current day accommodation of UAS on a case-by-case basis to integration of UAS operations in the NAS.

Provides insight into how these milestones contribute to enabling a number of representative UAS operations in the mid-term and mature state timeframes.

Matures concept for UAS integration and path forward to achieve that vision, building on vetted operational scenarios and operational requirements for mid-term and mature state UAS operations.

Living document that will continuously evolve to incorporate findings and lessons learned from research and ongoing concept development and maturation efforts.
AJV-7 UAS Program Schedule

See handout
Concept Validation

UAS Concept Maturation Plan
UAS Impact Analysis
UAS Concept Maturation Plan

- Provides an overview of concept maturation activities to be undertaken by the Operational Concepts, Validation and Requirements Directorate (AJV-7) in support of the ATO UAS OES

- Focuses on activities that require AJV-7 involvement to address existing FAA shortfalls associated with the provision of air traffic services to UAS airspace users in the mid-term and beyond (2020-2025+)

- Describes how concept maturation activities will be carried out by AJV-7 in collaboration with other FAA stakeholders
  - In some cases AJV-7 will assume a leadership role with accountability and responsibility for directing and executing the efforts for UAS concept exploration, development, and validation
  - In other cases, AJV-7 will assume a support and consultation role and provide expertise to other FAA offices that will be responsible for specific concept maturation activities
<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Concept Maturation Activity</th>
<th>Associated Shortfall</th>
<th>Associated FAA Req(s)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1.16</td>
<td>ATC Obtainment of Lost Link Contingency Route Information</td>
<td>S1.16</td>
<td>1-120</td>
<td>High</td>
</tr>
<tr>
<td>R4.1.1</td>
<td>Increasing Flight Plan Route Elements and Characters</td>
<td>S4.1.1</td>
<td>1-89, 1-102</td>
<td>High</td>
</tr>
<tr>
<td>R4.6</td>
<td>Incorporating UAS Type Designations and Performance Characteristics into ATC Automation</td>
<td>S4.6</td>
<td>1-129</td>
<td>High</td>
</tr>
<tr>
<td>R1.10</td>
<td>Impact of UAS Performance Limitations in the Terminal Domain</td>
<td>S1.10</td>
<td>1-133</td>
<td>High</td>
</tr>
<tr>
<td>R4.2</td>
<td>Trajectory Modeling of Unique (Planned and Unplanned) UAS Flight Profiles</td>
<td>S4.2</td>
<td>1-7, 1-91</td>
<td>High</td>
</tr>
<tr>
<td>R1.15.1</td>
<td>Thresholds for Lost Link Duration</td>
<td>S1.15.1</td>
<td>1-65</td>
<td>High</td>
</tr>
<tr>
<td>R4.3</td>
<td>Conflict Detection and Resolution for Unique UAS Flight Profiles</td>
<td>S4.3</td>
<td>1-92</td>
<td>High</td>
</tr>
<tr>
<td>R4.8</td>
<td>Impact of Proposed Control Link and Communications Latency Thresholds on ATC</td>
<td>S4.8</td>
<td>1-51, 1-70</td>
<td>High</td>
</tr>
<tr>
<td>R4.12</td>
<td>UAS Flight Data for Flight Object</td>
<td>S4.12</td>
<td>1-68</td>
<td>High</td>
</tr>
<tr>
<td>R1.19</td>
<td>Impact of Communications Latency Exceeding Acceptable Thresholds on ATC</td>
<td>S1.19</td>
<td>1-108</td>
<td>High</td>
</tr>
<tr>
<td>R2.2</td>
<td>Radar Detection, Differentiation, and Tracking of Non-Cooperative UAS with Small Radar Cross Sections</td>
<td>S2.2</td>
<td>TBD</td>
<td>High</td>
</tr>
<tr>
<td>R5.12</td>
<td>ATC Interaction with Airborne DAA</td>
<td>S5.12</td>
<td>1-111</td>
<td>High</td>
</tr>
<tr>
<td>R4.1.3</td>
<td>Flight Planning Capabilities for Long Duration Flights</td>
<td>S4.1.3</td>
<td>1-6, 1-93</td>
<td>Medium</td>
</tr>
<tr>
<td>R4.1.4</td>
<td>Flight Plan Feedback for UAS</td>
<td>S4.1.4</td>
<td>1-8, 1-78</td>
<td>Medium</td>
</tr>
<tr>
<td>R4.1.6</td>
<td>Incorporating UAS 4D Trajectory Data into Flight Plans</td>
<td>S4.1.6</td>
<td>1-97</td>
<td>Medium</td>
</tr>
<tr>
<td>R1.5</td>
<td>Impact of Long Duration UAS Operations on ATC</td>
<td>S1.5</td>
<td>1-96</td>
<td>Medium</td>
</tr>
<tr>
<td>R4.5</td>
<td>Automation Support for Demand and Capacity Balancing</td>
<td>S4.5</td>
<td>1-134</td>
<td>Low</td>
</tr>
<tr>
<td>R4.9</td>
<td>Data Communications for UAS</td>
<td>S4.9</td>
<td>1-42</td>
<td>Low</td>
</tr>
<tr>
<td>R4.4</td>
<td>Incorporating Operational Priority Assignments into ATC/TFM Automation</td>
<td>S4.4</td>
<td>1-44, 1-123</td>
<td>Low</td>
</tr>
<tr>
<td>R4.1.5</td>
<td>Processing Flight Plans with Fixes in Latitude/Longitude Format</td>
<td>S4.1.5</td>
<td>1-132</td>
<td>Low</td>
</tr>
<tr>
<td>R4.1.2</td>
<td>Identifying UAS Type Designations and Performance Characteristics</td>
<td>S4.1.2</td>
<td>1-80, 1-105</td>
<td>N/A (Addressed)</td>
</tr>
<tr>
<td>R4.11</td>
<td>Lost Link Beacon Code</td>
<td>S4.11</td>
<td>1-114</td>
<td>N/A (Addressed)</td>
</tr>
</tbody>
</table>
UAS ATC Impact Analysis

• Methodology developed to assess the impact of UAS operations on ATC
  – Provides a means to evaluate needs and impacts resulting from UAS concept maturation efforts in a systematic manner
  – Provides data-driven results to inform FAA decisions about potential changes to ATC systems, procedures, and policies regarding UAS

• Status
  – Pilot test of methodology completed in FY15
  – Plan being developed to assess potential impacts of FAA UAS midterm scenarios
External Stakeholder Engagement

Objectives
Approach
External Stakeholder Session Objectives

- Inform public and civil UAS stakeholders of FAA’s concept maturation work completed to date addressing air traffic concepts for managing UAS operations

- Walk through and discuss operational scenarios – covering a range of potential UAS missions in various airspace classes, and including allocations of Air Navigation Service Provider (ANSP) services and UAS operator responsibilities

- Engage the community and discuss several ongoing and planned ATM enhancements required to enable increased numbers and types of UAS operations in the NAS

- Solicit input and feedback across the detailed scenarios to develop a comprehensive perspective on UAS operational concepts for mid-term and mature state operations
FAA Participants

- Operational Concepts, Validation, & Requirements (AJV-7)
- Airspace Services (AJV-1)
- Air Traffic Procedures (AJV-8)
- Advanced Operational Concepts (ANG-C4)
- New Entrants (ANG-C2)
- UAS Integration Office (AFS-80)
- Flight Technologies and Procedures (AFS-400)
- Program Management Office (PMO)
- Others TBD
External Stakeholder Participants - Public

Knowledge & expertise in operations

- PICs/operators
- Mission/flight coordinators, planners, specialists
- Personnel from operations centers
- Air traffic controllers (Department of Defense)
- Experts with knowledge on aircraft performance

Department of Homeland Security (DHS)
Department of Commerce (DOC)
Department of National Aeronautics and Space Administration (NASA)
Department of Homeland Security (DHS)
Department of Commerce (DOC)
Department of Justice (DOJ)
Others?

- Civil stakeholder session planned
- Participant criteria and expertise TBD
Next Steps

- Continue development and refinement of UAS operational concepts and requirements
- Continue to leverage the USG forum for information sharing and execution of detailed technical efforts needed for success
- Initiate external stakeholder engagement
- Socialize UAS Concept Maturation Plan within FAA ATO
- Begin executing UAS Concept Maturation Priorities, as funding/resources allow
Pathfinder Industry Initiatives
Expanding Access beyond the sUAS Rule
Current Operations

• Civil
  – Variety of purposes
    • Experimental
    • Private
    • Incidental to business
    • For compensation or hire:
      – <55 lbs, < 500’ AGL, < 87 kts, VLOS, not over people
    • Special Airworthiness Certs and Section 333 of P.L. 112-95

• Public
  – Certain government operations in U.S. airspace
    – Title 49 U.S.C. § 40102(a)(41) and § 40125

• Hobby and recreation
  – Section 336 of P.L. 112-95
Operations in the NAS

AIRCRAFT: Airworthiness Certificate & Registered
- Standard (Including special class)
- Special (Experimental, restricted)
- Section 333 – Not applicable

CREW: Certificated Airman
- Sport, Recreational, Private, Commercial, Airline Transport (Section 333)
- sUAS Operator Certificate (NPRM)

OPERATION: Compliance with part 91 and applicable operating regulations
Expand Safe Integration Envelope

sUAS rule

Over People

BVLOS

EVLOS
Focal Area Outcomes

• Authorization of an expanded envelope of UAS operations
• Development of repeatable, risk-based processes for similar UAS operations
• Data to inform further envelope expansion, standards, policy, and rulemaking
Focus Areas

Focus Area (FA) 1: UAS in Visual Line of Sight (VLOS), Over people

Example operation: Journalism, sports, construction, advertising, insurance, etc.

Focus Area (FA) 2: UAS Extended Visual Line of Sight (EVLOS), Rural

Example operations: Agriculture and inspection

Focus Area (FA) 3: UAS Beyond Visual Lone of Sight (BVLOS), Rural

Example operations: Long range critical infrastructure inspection, i.e. railroad, power transmission, pipelines, environmental survey, etc.
Approach

• Repurpose what works
  – Public operation authorizations
  – Experimental and restricted category certificates
  – Section 333 exemptions
  – sUAS NPRM

• New or modified approaches and processes

• Safety Risk Assessment – hazard identification and control
Pathfinder Program

Part 107

Focus Area 1

Operational Mitigations
- Section 333 conditions and limitations

Design Mitigations
- Type certification
- Experimental certification
- Hybrid approach

VLOS*
< 55 lbs
< 500 feet
< 87 knots

*Visual Line of Sight
Pathfinder Program

Part 107

Focus Area 2

VLOS

< 55 lbs
< 500 feet
< 87 knots
Not Over People

Extended VLOS

Operational Mitigations
- Section 333 conditions and limitations

Operational / Design Mitigations
- Hybrid approach
Pathfinder Program

Part 107

Focus Area 3

VLOS
< 500 feet

< 55 lbs
< 87 knots
Not Over People

Beyond VLOS
> 500 feet

Operational Mitigations
- Section 333 conditions and limitations

Design Mitigations
- Type Certification
Work Plan

- Integrated Program Plan
  - Common nomenclature across Focal Areas
- CONOPS
- CRDAs
- Safety Risk Assessments
- Certifications and Exemptions
- Testing
  - Ground & flight
FAA’s UAS Center of Excellence (COE)
Alliance for System Safety of UAS through Research Excellence (ASSURE)
UAS COE Basics

• The FAA selected a Mississippi State University led team (ASSURE) as the FAA's Center of Excellence for Unmanned Aircraft Systems (UAS) on May 8, 2015

• ASSURE is comprised of twenty-one of the world's leading research universities and more than a hundred leading industry/government partners, including Disney (ABC), Amazon Prime Air, Fedex, Etc.

• Research anticipated to commence prior to end of FY15

• 1:1 Matching Grants

• 5-year initial phase w/ additional 5-year option

• Yearly report to Congress and NARP
UAS COE Program Management

Oversight & Coordination

FAA COE Program Mgr
(Patricia Watts, ANG-E)

UAS COE Program Mgr
(Sabrina Saunders-Hodge, ANG-C2)

UAS R&D Objectives
(FAA Stakeholders: AVS/ATO/etc.)

UAS COE Deputy PM
(Paul Rumberger, ANG-C2)

UAS ASSURE COE Lead

University 1
University 2
University n

Path 1
Path 2
ASSURE Composition

Core Members (15)
- Mississippi State University - Lead
- Drexel University
- Embry Riddle Aeronautical Univ.
- Kansas State University
- Montana State University
- New Mexico State University
- North Carolina State University
- Oregon State University
- University of Alabama - Huntsville
- University of Alaska - Fairbanks
- University of Kansas
- University of North Dakota
- Wichita State University
- Ohio State University
- University of California - Davis

Affiliate Members (6)
- Auburn University
- Concordia University – Canada
- Louisiana Tech University
- Tuskegee University
- Indiana State University
- University of Southampton - UK

Corporate Partners (114+)
- Includes: Disney (ABC), Amazon Prime Air, Fedex, Etc.
- Visit website for complete list
Executive Director
Maj Gen (Ret.) James Poss
Vice Executive Board Director
University of Alaska Fairbanks

- Training
  Kansas State University

- Air Traffic Integration
  Embry Riddle Aeronautical Univ.
  University of Alabama in Huntsville

- C2 & Spectrum
  North Carolina State University
  Wichita State University

- Human Factors
  Drexel University
  New Mexico State University

- DAA
  University of North Dakota

- Airworthiness – Wichita State
- Low Altitude Safety Scenarios – Alaska
UAS COE Technical Focus Areas

1. Air Traffic Control Interoperability
2. Airport Ground Operations
3. Control and Communication
4. Detect and Avoid (DAA)
5. Human Factors
6. Low Altitude Operations Safety
7. Noise Reduction
8. Spectrum Management
9. Unmanned Aircraft (UA) Crew Training and Certification, Including Pilots
10. Unmanned Aircraft Systems Traffic Management
11. UAS Wake Separation Standards for UAS Integration into the NAS
Questions?
Backup
General Requirements & Assumptions for Integration

- UAS operators comply with existing, adapted, and/or new operating rules or procedures as a prerequisite for NAS integration.

- All UAS are equipped with transponders with altitude-encoding capability.

- UAS are aircraft. They meet performance and equipage requirements as do manned aircraft for the environment in which they are operating and adhere to relevant procedures.

- Each UAS has a flight crew appropriate to fulfill the operators’ responsibilities, and includes a PIC. Each PIC controls only one UA.*

- Autonomous operations are not permitted.** The PIC has full control, or override authority to assume control at all times during normal operations.

- No new classes or types of airspace are designated or created specifically for UAS operations.

- Spectrum is available to support UAS operations.

* This restriction does not preclude the possibility of a formation of UA (with multiple pilots) or a ‘swarm’ (one pilot controlling a group of UA) from transiting the NAS to/from restricted airspace, provided the formation or swarm is operating under a COA.

** Autonomous operations refer to any system design that precludes any person from affecting the normal operations of the aircraft.
General Requirements & Assumptions for Integration (cont’d)

- FAA policy, guidelines, and automation support air traffic decision-makers on assigning priority for individual flights (or flight segments) and providing equitable access to airspace and air traffic services.

- Air traffic separation minima in controlled airspace apply to UA.

- ATC is responsible for separation services as required by airspace class and type of flight plan for both manned and unmanned aircraft.

- The UAS PIC complies with all ATC instructions and uses standard phraseology per FAA Order (JO) 7110.65 and the Aeronautical Information Manual (AIM).

- ATC has no direct link to the UA for flight control purposes.
Detect & Avoid

Conditions where pilot’s eyes are used

- Avoiding terrain, obstructions, and hazardous weather.
- Following instructions on the surface.
- Adhering to airport signage, lighting, and runway/taxiway markings.
- Operating with vehicles and other aircraft on the ground.

Detect and Avoid

Incorporates two functions for airborne conflicts analogous to see and avoid functions in 14 CFR Parts 91.111 and 113.

Detect and Avoid in context of traditional visual responsibilities
Operational System Description

• Equipage
  – The UA is equipped to comply with the operational requirements of the airspace in which it flies
  – A control link enables the exchange of data between the UA and the control station and uses spectrum that is allocated specifically for UAS operations

• Communications with ATC
  – The control station includes the systems and interfaces required to operate the UA, including communicating with ATC
  – A communications link independent of the control link connects the PIC in the control station with ATC
  – UAS operating in controlled airspace communicate on radio frequencies or through an ATC-to-PIC ground communications link assigned to that sector, terminal area, or airport
FAA UAS Product Relationships for Pathfinders

NAS UAS ConOps Scenarios (2012) – Integration Timeframe

- **Flight Planning**: FFR, All, Class C or Class D, N/A
- **Surface Operations**: AIL, Class B or Class C
- **Grid Protocol**: FFR, Class B or Class C
- **Lateral Airway/Summit Slope**: FFR, Class C or Class D
- **ATS/Other**: FFR, Class B, Class C
- **Planned-En Route**: FFR, Class B, Class C
- **Decommissioning**: FFR, Class B
- **Physical Monitoring and Operation M&O**: FFR, Class B
- **Maneuvering in High Density Airspace**: FFR, Class B

**FAA Integration Strategy: 8 Focus Areas (2014)**

**Options and Challenges**

| Focus Areas | Challenge
d | Options |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban, Low Altitude</td>
<td></td>
</tr>
<tr>
<td>Aerial Photography</td>
<td>Photography, real estate, public safety, homeland security</td>
</tr>
<tr>
<td>Urban, Dynamic</td>
<td>Traffic monitoring, public safety, infrastructure, emergency response, environmental monitoring</td>
</tr>
<tr>
<td>Urban, Dynamic</td>
<td>Traffic monitoring, public safety, infrastructure, emergency response, environmental monitoring</td>
</tr>
</tbody>
</table>

**Basis for Defining Integration Strategy Focus Areas**

- **FAA UAS Working Group**: Selected 3 Near-Term Priority Focus Areas
  - Urban, Low Altitude
  - Urban, Dynamic
  - Urban, Dynamic

**UAS Steering Group Focus: ATC Services**

- **Example Applications**: Aerial Photography, Drone Surveillance, Hazard Detection, and Security

**Focus Areas of Interest**

- **Urban, Low Altitude**: Aerial Mapping, High-Resolution Imaging, Traffic Monitoring
- **Urban, Dynamic**: Aerial Mapping, High-Resolution Imaging, Traffic Monitoring
- **Urban, Dynamic**: Aerial Mapping, High-Resolution Imaging, Traffic Monitoring
Example: Delegated Separation
FAA UAS ConOps Excerpts

• **Delegated separation** – refers specifically to the transfer of separation responsibility from ATC to the UAS PIC, wherein the UAS PIC, while operating under IFR, uses a certified DAA capability to maintain safe separation from other aircraft (analogous to VFR operations for manned aircraft).

• There can only be one separation provision for two IFR aircraft – either ATC or an aircraft to which ATC has delegated this responsibility.

• From an air traffic control perspective, these new IFR rules do not necessarily translate into the need for ATC separation services. In controlled airspace, ATC may delegate separation responsibility, provided the PIC accepts. This is analogous to VFR operations, but is based on instruments and technology.

• UAS flight plan submissions may require data including: Flight segments where delegated separation is requested.
Requirements & Shortfalls

- **S1.9.1**: The FAA has not developed flight rules, criteria, phraseology, or procedures that enable delegated separation. – The FAA has not developed the concept for delegated separation.
  - **Req 1-10**: The FAA will provide for (and approve/disapprove) flight plan segments for which delegated separation has been requested.

- **S1.9.2**: The FAA has not developed flight rules, criteria, phraseology, or procedures that enable delegated separation. – The FAA has not developed procedures for delegating separation to the UAS PIC.
  - **Req 1-112**: The FAA will develop procedures (and associated phraseology) specific to delegated separation under instrument flight rules.
Allocation Tables

Mature State Scenario Category: Delegated Separation

**Operational Domain:** Operations with delegated separation in controlled airspace. Analogous to VFR

<table>
<thead>
<tr>
<th>Example Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance</td>
</tr>
<tr>
<td>Search and Rescue</td>
</tr>
<tr>
<td>Environmental Sampling</td>
</tr>
</tbody>
</table>

**Environmental Sampling**

**Scenario Synopsis:** UAS operates on an IFR flight plan, departs from and returns to an uncontrolled airport in Class E airspace. ATC delegates separation to UAS for separation and obstacle/terrain clearance for exploration in Class E at 3000 ft. UAS returns IFR to point of departure.

Green text in scenario tables indicates enhancements to capabilities and/or technologies expected by the mature state, as described in the FAA UAS ConOps v2.0

Orange text indicates areas that previously were not addressed during mature state concept development.

**Class E**

<table>
<thead>
<tr>
<th>Class E</th>
<th>Manned</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Domain:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UAS Type</td>
<td>Small/Medium/Large</td>
<td></td>
</tr>
<tr>
<td>Altitude Range</td>
<td>Primarily 0 – 17,000' MSL, above FL600</td>
<td></td>
</tr>
<tr>
<td>Aircraft Endurance</td>
<td>Medium (hours)/Long (days)</td>
<td></td>
</tr>
<tr>
<td>Expected Traffic Density</td>
<td>Low/Medium</td>
<td></td>
</tr>
<tr>
<td>Aircraft Range</td>
<td>Variable</td>
<td></td>
</tr>
<tr>
<td>Conditions</td>
<td>Day/Night</td>
<td></td>
</tr>
<tr>
<td>Potential Airspace Classes</td>
<td>E/C/D</td>
<td></td>
</tr>
<tr>
<td>Operational Limits</td>
<td>Unknown/Varies, certified DAA capability required</td>
<td></td>
</tr>
</tbody>
</table>

**Explanatory Notes**

- Does not include delegated separation portion of flight.
- ATC delegates separation to the UAS. UAS has certified DAA capability. Analogous to VFR.
- Shared responsibility among all. UAS has certified DAA capability.
- ATC delegates separation to the UAS. UAS has certified DAA capability. Analogous to VFR.
- Shared responsibility among all aircraft. ConOps did not consider UAS in VLOS. UAS BVLOS cannot comply with VFR.
- Shared responsibility among all. UAS has certified DAA capability.

- Cleared route of flight, including amendments, meets IFR criteria for MEA, MOCA, MVA. Does not include delegated separation portion of flight.
- NA for operations in Class E above Class A.
- Workload permitting – depends if UAS remains on frequency. Where applicable based on wake category assignment.
- Workload permitting – depends if UAS remains on frequency.
# ATO UAS OES Milestones

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Non Mission-Specific Operations</strong></td>
<td><strong>Flight Planning / Notification</strong></td>
<td><strong>Delegated Separation</strong></td>
<td><strong>Lost Link</strong></td>
</tr>
<tr>
<td><strong>AMP-9</strong></td>
<td>Develop Policy and Procedures for Delegated Separation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ <strong>SAF-12</strong></td>
<td>→ SMS for Procedures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ <strong>TR-5</strong></td>
<td>→ Train ATC on Procedures</td>
<td></td>
</tr>
<tr>
<td><strong>AUTO-1</strong></td>
<td>Develop Initial UAS ERAM Reqs. (ERAM Sector Enhancements)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ <strong>SAF-6</strong></td>
<td>→ SMS for Functionality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ <strong>TR-1</strong></td>
<td>→ Train ATC on Functionality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>→ <strong>AUTO-6</strong></td>
<td>→ Achieve Operational Use of Functionality</td>
<td></td>
</tr>
<tr>
<td><strong>CERT-5</strong></td>
<td>Update FARs 91.113/115/181 to Incorporate UAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CERT-6</strong></td>
<td>Achieve Operational Use of DAA Functionality</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **AMP** – 2, 3, 4, 5, 9
- **SAF** – 6, 9, 13
- **TR** – 1, 2, 6, 9
- **AUTO** – 1, 2, 5, 6, 7, 10
- **CERT** – 5, 6

**AMP-2** Develop Automation Reqs. for UAS Flight Planning and Trajectory Modeling Functionality (including Contingencies)

- → **SAF-9** → SMS for Functionality
- → **TR-6** → Train ATC on Functionality
- → **AUTO-7** → Achieve Operational Use of Functionality

**AUTO-5** Develop Reqs. for UAS Communications Functionality

- → **SAF-13** → SMS for Functionality
- → **TR-9** → Train ATC on Functionality
- → **AUTO-10** → Achieve Operational Use of Functionality
### Concept Maturation Activities

<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Concept Maturation Activity</th>
<th>Associated Shortfall</th>
<th>Associated FAA Req(s)</th>
<th>AJV-7 Role</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1.9.1</td>
<td>Concept for Delegated Separation [OES MS Supported: AMP-9]</td>
<td>S1.9.1</td>
<td>1-10</td>
<td>Support</td>
<td>High</td>
</tr>
<tr>
<td>R1.9.2</td>
<td>ATC Procedures and Phraseology for Delegated Separation [OES MS Supported: AMP-9]</td>
<td>S1.9.2</td>
<td>1-112</td>
<td>Support</td>
<td>Medium</td>
</tr>
</tbody>
</table>

#### R1.9.1 – Concept for Delegated Separation
- Is delegated separation a viable option for UAS?
  - Under which specific conditions (e.g., VMC)?
  - What flight rules apply under instances when separation responsibility is delegated to the UAS PIC?
  - What criteria will ATC use to approve/disapprove requests for delegating separation to the UAS PIC?

#### R1.9.2 – ATC Procedures and Phraseology for Delegated Separation
- What ATC procedures are required when delegating separation responsibility to the UAS PIC under IFR?
- What phraseology is required for use by controllers when delegating separation responsibility to the UAS PIC under IFR?
- Are the proposed ATC procedures and phraseology adequate to support delegated separation under IFR?