UAS Integration in the NAS Project
UAS Commercialization Industry Conference

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UAS-NAS Project Lifecycle

Prior Activities
Formulation
Early investment Activities
Sys Analysis: ConOps, Community Progress, etc.

Prior
FY11/12
FY13
FY14
FY15
FY16

Phase 1 (P1)
Initial Modeling, Simulation, & Flight Testing

Phase 2 (P2)
Integrated Modeling, Simulation, & Flight Testing

Key Decision Point (KDP)
Flight Validated Research Findings to Inform Federal Aviation Administration (FAA) Decision Making

Technical input from Project technical elements, NASA Research Announcements (NRA)s, Industry, Academia, Other Government Agencies, Project Annual Reviews
The FAA uses several domestic and international forums to lay out the pathway for their priorities and investments.

**FAA Pathway to UAS Access**

- **FAA UAS Center of Excellence**
  - Performed strategic research to guide the FAA, while the test sites contribute essential inputs through UAS testing.

- **World Radio Conference (WRC), International Civil Aviation Organization (ICAO)**
  - UAS RPAS Panel, and the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) are addressing UAS access from an international perspective.

- **Office of Secretary of Defense (OSD) Sense and Avoid (SAA) Science and Research Panel (SARP)**
  - Chartered by OSD to identify SAA Research Gaps.

- **NASA has a leadership role within many domestic forums and participates in the international forums**

- **RTCA SC-228**
  - Chartered to develop Detect and Avoid (DAA) and Command and Control (C2) MOPS

- **UAS Executive Committee (ExCom)**
  - Senior gov’t steering group focused on streamlining public UAS access

- **UAS Aviation Rulemaking Committee (ARC)**
  - Developed civil UAS Implementation Plan based on the FAA’s UAS Concept of Operations (CONOPs) & Roadmap

- **FAA UAS COE / Test Sites**
  - FAA Pathway

- **International Forums**

- **OSD SAA SARP**

- **FAA UAS ARC**

- **Chartered to develop Detect and Avoid (DAA) and Command and Control (C2) MOPS**
ARMD Strategic Plan Flow Down to UAS-NAS Project

AERONAUTICS STRATEGIC THRUST

Thrust 6: Assured Autonomy for Aviation Transformation

Outcome (2015 – 2025): Initial Autonomy Applications with Integration of UAS into the NAS

Goal: Provide research findings to reduce technical barriers associated with integrating Unmanned Aircraft Systems into the National Airspace System utilizing integrated system level tests in a relevant environment

AERONAUTICS OUTCOME

UAS-NAS Project Goal

UAS-NAS Research Themes

Research Theme 1: UAS Integration - Airspace integration procedures and performance standards to enable UAS integration in the air transportation system

Research Theme 2: Test Infrastructure - Test infrastructure to enable development and validation of airspace integration procedures and performance standards

UAS-NAS Technical Challenges

TC-SAA: Sense and Avoid Performance Standards

TC-C2: Command & Control Performance Standards

TC-HSI: Human Systems Integration

TC-ITE: Integrated Test & Evaluation
Project Goal, Research Themes, & Technical Challenges

Goal: Provide research findings to reduce technical barriers associated with integrating Unmanned Aircraft Systems into the National Airspace System utilizing integrated system level tests in a relevant environment.

Research Theme 1: UAS Integration - Airspace integration procedures and performance standards to enable UAS integration in the air transportation system.

Research Theme 2: Test Infrastructure - Test infrastructure to enable development and validation of airspace integration procedures and performance standards.

TC-ITE: Integrated Test & Evaluation

TC-SAA: Sense and Avoid (SAA) Performance Standards

TC-HSI: Human Systems Integration

TC-C2: Command & Control (C2) Performance Standards

Non-TC: UAS Restricted Use Certification

Non-TC: Small UAS Mission Support Technologies

TC = Technical Challenge
NASA UAS-NAS TC Project Activities

**SAA Performance Standards**
- Develop SAA Performance Testbed
- Develop SAA Interoperability Testbed

**C2 Performance Standards**
- Develop C2 Prototype System

**Human Systems Integration**
- Develop Prototype GCS

**Integrated Test & Evaluation**
- Develop LVC Test Infrastructure

**Key Products**
- SAA Performance Requirements to inform DAA MOPS
- C2 Performance Requirements to inform C2 MOPS
- HF Performance Requirements to inform DAA & C2 MOPS, HF Guidelines

**Resultant Outcomes**
- Re-usable Test Infrastructure

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**Develop SAA Flight Test and MS&A**
- Performance Trade-offs
- CONOPs
- Interoperability
- Well Clear
- Self Separation
- Collision Avoidance

**Develop C2 Flight Test and MS&A**
- Data Link
- CNPC Spectrum
- CNPC Security
- LOS
- BLOS
- ATC Interoperability

**Develop HF Guidelines for SAA, C2 & GCS**
- Contingency Management
- SAA
- Pilot Response
- C2
- Autonomy
- Displays

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**Develop SAA Performance & Interoperability Requirements**

**Develop C2 Requirements**

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**Conduct Human Factors (HF) Flight Test and MS&A**

**Conduct C2 Flight Test and MS&A**

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**Conduct SAA Flight Test and MS&A**

**Conduct TC Specific Testing**

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**Conduct IHITL**

**Conduct SAA Initial Flight Test Scenarios**

**Conduct FT3 Test Scenarios**

**Conduct FT4 Test Scenarios & Capstone**
Integrated Test Flow and MOPS Development

- Level 1 Milestone
- Reviews
- Annual Performance Indicator
- Development Milestones

Timeline Not To Scale
Other NASA UAS Access Efforts

Phase 2 MOPS ~FY17-20
- DAA MOPS for aircraft interoperating in Classes E and D Airspace
  - May require a suite of options including GBSAA, EO, cell technology, etc
- SATCOM MOPS for C2
- Necessary human systems integration guidelines

Early Implementation Program (through UAS ARC) ~FY17-20
- Research findings to enable routine operations above FL180 with required equipage

UAS Traffic Management (UTM) ~FY16-26
- Low altitude volume of airspace (e.g. 400 AGL and below)
- Enable operations including goods delivery, infrastructure surveillance, agricultural support, and medical services delivery
- Upcoming UTM Convention July 28-30 at NASA Ames Research Center

NASA will continue to pursue efforts to enable UAS access over the next decade
Benefits to the Commercial Industry

Overall NASA goal - Open airspace in safe/efficient manner for civil/commercial activities

UAS-NAS Project:
• Enable flights to/from Class A Airspace through Classes E and D Airspace

EIP:
• Enable routine operations above FL180 (Classes A and Upper E)

Phase 2 MOPS:
• Enable routine operations in Classes E and D Airspace

UTM
• Enable routine operations in low altitude volume of airspace

NASA efforts, in collaboration with the entire UAS Community of Interest, will maximize commercialization opportunities