NASA UAS Integration in the NAS Project

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UAS Integration in the NAS Project
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Briefing Outline

• NASA ARMD Research
• NASA Project Organizational Chart
• Project Overview
• Project Technical Challenges and Technical Work Packages
• Capabilities Overview
• Integrated Test Overview
Aeronautics Mega-Drivers and R&T Thrusts

Mega-Drivers

Strategic Research & Technology Thrusts

Safe, Efficient Growth in Global Operations
• Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
• Achieve a low-boom standard

Ultra-Efficient Commercial Transports
• Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
• Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

Real-Time System-Wide Safety Assurance
• Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
• Develop high impact aviation autonomy applications
Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.

Preserve and promote the testing capabilities of one of the United States’ largest, most versatile and comprehensive set of flight and ground-based research facilities.
KDP (Phase 1/Phase 2 Transition)

**Phase 2 (P2)**

Prior

Preparation

Early investment Activities

Sys Analysis: ConOps, Community Progress, etc.

**Phase 1 (P1)**

Initial Modeling, Simulation, & Flight Testing

**Phase 2 (P2)**

Integrated Modeling, Simulation, & Flight Testing

Prior Activities

External Input

KDP

Flight Validated Research Findings to Inform FAA Decision Making

Technology Development to address Technical Challenges

Technical input from Project technical elements, NRAs, Industry, Academia, Other Government Agencies, Project Annual Reviews
UAS-NAS Project Formulation

Key Stakeholders and Influencing Factors

Project Focus:
Unencumbered NAS Access for Civil / Commercial UAS

The NASA UAS-NAS Project is influenced by several key stakeholders within the UAS Community which helped guide it’s formulation.
Phase 2 of the UAS-NAS Project has some fundamental characteristics of note

• The Technology Development outputs are primarily research findings (validated data, algorithms, and recommendations) which contribute to an outcome of the elimination or reduction of barriers to NAS access
  – Project timeframe for impact is 2015 - 2025

• The UAS-NAS Project is operating in an ever-changing environment and must remain agile and adapt as the customer/community needs change
  – While the base of what the Project is planning to deliver doesn’t change, the specifics of the final products may change to better meet the community need
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: SAA Performance Standards

TC-HSI: Human Systems Integration

TC-C2: C2 Performance Standards
UAS Integration in the NAS Project
Value Proposition Flow Diagram

**NASA UAS-NAS Project Activities**

**TC1** SAA Performance Standards
- Develop SAA Performance Testbed
- Conduct SAA Flight Test and MS&A
  - Perf. Trade-offs
  - Interoperability
  - Self Separation
- Develop SAA Performance & Interoperability Requirements

**TC2** C2 Performance Standards
- Develop C2 Prototype System
- Conduct C2 Flight Test and MS&A
  - Data Link
  - CNPC Spectrum
  - CNPC Security
- Develop C2 Requirements

**TC3** Human Systems Integration
- Develop Prototype GCS
- Conduct Human Factors (HF) Flight Test and MS&A
  - Conting. Mgmt
  - Pilot Response
  - Autonomy
- Develop HF Guidelines for SAA, C2 & GCS

**TC6** Integrated Test & Evaluation
- Develop LVC Test Infrastructure
- Conduct FT3 Test Scenarios
- Conduct FT4 Test Scenarios & Mission Based Flight Activity

**Certification & Safety**
- Analyze Classification Factors for UAS
- Conduct Restricted Category Study
- Analyze Case Study Results

**Key Products**
- SAA Performance Requirements to inform DAA MOPS
- C2 Performance Requirements to inform C2 MOPS
- SC-228 GCS & HF Whitepapers
- Re-usable Test Infrastructure
- Test Data to support SAA & C2 Standards Devlpmt

**Resultant Outcomes**
- RTCA
  - DAA MOPS
  - C2 MOPS
  - SAA Technical Standard Order (TSO)
  - C2 Technical Standard Order (TSO)

- NASA UAS-NAS Project Activities
  - Resultant Outcomes
    - DAA MOPS
    - C2 MOPS
    - SAA Technical Standard Order (TSO)
    - C2 Technical Standard Order (TSO)

- Key Products
  - SAA Performance Requirements
  - C2 Performance Requirements
  - SC-228 GCS & HF Whitepapers
  - Re-usable Test Infrastructure
  - Test Data to support SAA & C2 Standards Devlpmt

- Resultant Outcomes
  - Safety Substantiation Final Report & Safety Metrics Data
UAS-NAS Modeling & Simulation
Tools and Capabilities Phase 2

Legend: Also Used in Phase 1 = Black text, New for Phase 2 = Purple text

Tools/Capabilities not integrated into LVC

Note: All acronyms are defined in the Notes Page
Self-Separation Timeline

- **110 sec**: Detect Intruders
  - Alert Pilots
  - Gain Situational Awareness
  - Pilots Determine Resolution

- **95 sec**: Negotiate Clearance with ATC and uplink maneuver to aircraft

- **85 sec**: Aircraft Maneuvers

- **55 sec**: Well Clear Threshold

**Time until CPA**

- **TASATS Simulation**
- **Beale Pilot Feedback**
- **Part Task 4** (SAA Traffic Display Evaluation)
- **Full Mission Simulation** (Levels of Automation)
- **TCAS Definition**

Controller Acceptability Study
Communication Subproject Focus

Possible Future ATC and ATS Ground Connectivity
2015, 2016 Flight Test (i.e. FT3, FT4)

Live Ownship

DFRC Ikhana

OR

GRC S-3B

Need Common Airspace

Virtual/Constructive Intruders

Honeywell King Air
- ADS-B
- TCAS II Instrm
- High speed

ADS-B Out

GRC T-34C
- ADS-B
- 2nd CNPC
- SAA

Ikhana Data Link
- C2
- Voice
- Health & Status
- Video
- Traffic (ADS-B and Radar)

CNPC Data Link
- C2
- Voice
- Health & Status
- Video
- Traffic (ADS-B and Radar)

Pseudo Pilots

ATC as Subject

Multi-Aircraft Control System

Research GCS

Displays of Proximal Traffic SAA/DAA Algorithms

VPN

Distributed Environment/Connectivity
## Integrated Test Progression

|--------------|--------------|-------------|-------------|
| **GCS**      | Research Ground Control Station (RGCS) with traffic displays and alerting logic | RGCS with UAS Surrogate (T-34C) Command and Control | RGCS with UAS Surrogate (T-34C) C2  
• Multiple GCSs |
| **SAA Algorithms** | Self separation, idealized sensor data | Multiple SAA algorithms  
• Collision avoidance on UAS and surrogate | Multiple SAA algorithms  
• Collision avoidance on UAS and surrogate |
| **UAS**      | Simulated   | UAS Surrogate (T-34C)  
• SAA equipped UAS | UAS Surrogate (T-34C)  
• SAA equipped UAS |
| **Sensor**   | Simulated   | On board SAA  
• On board SAA  
• Possible SAA on surrogate aircraft |  |
| **Surveillance** | Modeled mixed ADS-B and radar | ADS-B/TIS-B, modeled and real | ADS-B/TIS-B, modeled and real |
| **Traffic**  | Simulated   | UAS/UAS Surrogate  
• Live Traffic  
• Simulated Traffic | UAS/UAS Surrogate  
• Live Traffic  
• Simulated Traffic |
| **Command and Control Link** | Modeled | Prototype Equipment – single aircraft | Prototype Equipment – multiple aircraft |

**Test Scope**  
- Simulation sessions over an 8 week period  
- Multiple flights over an 8 week period (~30 flight hours)  
- Multiple flights over an 8 week period (~30 flight hours)
Flight Test 3 and 4 schedules are being updated. Anticipated dates are:

- **Flight Test 3**, June-July 2015
- **Flight Test 4**, January-February 2016