

UAS Integration in the NAS Planning Overview

Briefing to the NAC Aeronautics Committee

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UAS Integration in the NAS

The need to fly UAS in the NAS is of increasing urgency to perform missions of vital importance to national security and defense, emergency management, and science (DOD, DHS, FEMA, NASA, DOC, NOAA)

UAS are unable to routinely access the airspace system today due to lack of:

- Adequate and automated separation assurance and conflict avoidance
- Robust communication technologies
- Robust pilot-vehicle interfaces
- Standardized safety and certification

No regulations for UAS exists – aviation regulations built upon condition of pilot being onboard vehicles

Need technologies and procedures to enable seamless operation and integration of UAS in the NAS

Issues and Factors

Today's airspace system "NowGen" vs NextGen

- We cannot solve the problem for today's environment only to have to solve it again when NextGen is implemented

Public vs civil UAS operations

- Civil UAS operations require FAA certification and those requirements/guidance don't exist
- Public agencies can "self certify" by supplying the FAA with an airworthiness statement

UAS represent a wider performance regime than current aircraft

- Smaller, autonomous, man in-the-loop, man on-the-loop, extremely long endurance, very slow,
- Requirements for access will need to account and vary for each "class"

Philosophy:

What we invest in needs to benefit a broad spectrum of the UAS community

Goal

Transition design guidelines, algorithms, technologies, operational concepts, and knowledge to the FAA and the UAS stakeholder community to assist them in establishing requirements for routine UAS NAS operations

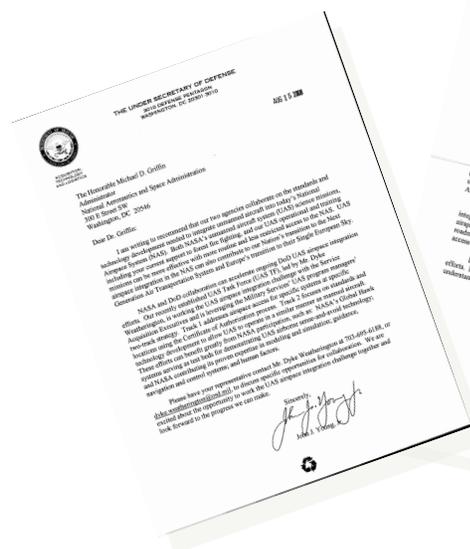
- NASA is not a regulator – we do not levy requirements – FAA and standards organizations do
- NASA can provide the data and analysis that support regulatory and standards bodies

Alignment

Proposed effort aligns with the:

- Air Transportation Management Systems Guidelines (section VII) identified in the National Aeronautics Research and Development Policy, dated December 2006,
- National Plan for Aeronautics Research and Development and Related Infrastructure section “Mobility Through the Air is Vital to Economic Stability, Growth, and Security as a Nation”, dated December 2009.
- NASA Strategic Subgoal 3E: Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.

Further Alignment



GAO Report

- D10 Safe operation of unmanned aerial vehicles in the national airspace The use of UAVs for a variety of civil applications (e.g., farming, border communications relays, pipeline monitoring, power line and pipeline monitoring, and firefighting) will continue to increase. Flight operations of military UAVs in civil airspace is also expected to increase. To facilitate these operations, UAVs should be integrated into the air transportation system...

Decadal Survey



NRC Report

Under Secretary of Defense for Acquisition, Technology, and Logistics and NASA Administrator Correspondence

SEC. 1116. COOPERATIVE UNMANNED AERIAL VEHICLE ACTIVITIES.
 The Administrator, in cooperation with the Administrator of NOAA and in coordination with other agencies that have existing civil capabilities, shall continue to utilize the capabilities of unmanned aerial vehicles as appropriate in support of NASA and interagency cooperative missions. The Administrator may enter into cooperative agreements with universities with unmanned aerial vehicle programs and related assets to conduct collaborative research and development activities, including development of appropriate applications of small unmanned aerial vehicle technologies and systems in remote areas.

Scope

Focus on enabling seamless UAS operations in the NextGen time frame and those technologies that provide a bridge from “NowGen” to NextGen

- Collaborate with the UAS ExCom (FAA, DOD, NASA, DHS), the JPDO, and industry standards organizations to define and conduct research
 - NASA will work with the FAA and DOD to support their focus on “NowGen” Public UAS access problems through UAS ExCom engagement
 - Complement DOD and FAA work to ensure that a coordinated portfolio of high priority UAS access R&D elements for NextGen are addressed
- Support an R&D and technology development portfolio that will ensure continual UAS access to the NAS as current operations transform to NextGen capabilities
- Build upon our existing Research Transition Team process to actively engage implementers and stakeholders to transfer technology and accelerate implementation

Approach

- Build on the Concept of Operations (CONOPS) Work done in FY 10 with ARRA funds
 - Develop a UAS NextGen CONOPS in collaboration with JPDO
 - At completion, JPDO takes ownership of the CONOPS and incorporates it in appropriate working documents
- Use CONOPS to flow down top level access requirements in collaboration with UAS ExCom
- Focus NASA research on identified gaps that align with NASA skill sets

Approach (cont.)

UAS ExCom Collaboration

- UAS ExCom is establishing a UAS NAS Access Work Group to plan how Federal Agency UAS will ultimately achieve routine access
- NASA will participate in that work group and refine specific technical objectives based on the results of the work groups plans
- NASA will vet objectives with the ExCom to ensure alignment with important national needs

Approach (cont.)

JPDO Collaboration

- Throughout the project life cycle NASA will provide updates to assist JPDO in maintaining a UAS Concept of Operations Document
- NASA will participate and support UAS work groups formed by JPDO that focus on achieving access

Industry Standards Organizations

- NASA will establish working relationships (through participation on their committees) with industry standards organizations to ensure an efficient transfer of knowledge to these organizations
- NASA will utilize inputs from these organizations to help refine its specific technical objectives

Major Technical Barriers

Separation assurance and conflict avoidance

- Automated separation assurance algorithms for seamless and safe operation of UAS in high density NextGen operating environment
- Allocation of roles and responsibilities between automation and humans in identifying conflicts and providing separation assurance

Communications

- Allocation of spectrum
- Robust data-link and satellite communications

UAS vehicle interface

- Definitions of roles and responsibilities between pilots and controllers, remote pilot control interface, autonomous flight operations

Certification and Interoperability

- Research/Analytical based approach, built on the FAA regulatory framework, to provide data that supports development of UAS airworthiness standards and operational requirements to address the unique certification issues of UAS

Separation Assurance and Collision

Avoidance

How is it done today?

- Separation assurance is provided by air traffic controllers to pilots on board the aircraft.
- Collision avoidance is provided by pilots on board looking out the window
- The current system does not accommodate autonomous vehicles as it relies on air traffic controllers providing verbal instructions to pilots

What are the technical barriers?

- Demonstrating that automation can provide effective and safe separation assurance
- Understanding the effects of time delay and uncertainty on the separation algorithms accuracy
- Appropriately allocating roles and responsibilities between humans and automation systems

What is NASA's approach

- Utilize human in the loop simulations to document the pros and cons of various allocations of responsibilities among software and humans
- Build up through increasing sophisticated simulations and flight tests to quantify the effects of time delay and uncertainty in higher density traffic
- Quantify in flight the effects of time delay and uncertainty on algorithms accuracy and applicability to UAS operations
- Demonstrate in flight the ability to automatically provide separation assurance commands to highly automated UAS

Communications

How is it done today?

- UAS currently use military frequencies, satellite-based communications links, or low-power line-of-sight (LOS) links in unlicensed Instrument/Scientific/Medical (ISM) frequencies
- Limited loss-of-communication contingencies

What are the technical barriers?

- Dedicated UAS spectrum does not exist, without which routine UAS operations will be impossible
- Increasing demand for limited frequency spectrum

What is NASA's approach?

- Demonstrate in flight a data-link compliant with international frequency spectrum requirements for UAS
- Develop a prototype UAS command and control link that operates in the frequency band proposed for UAS by the international telecommunications union

UAS Vehicle Interface

How is it done today

- UAS pilot-vehicle interfaces are designed by software engineers with limited aviation experience

What are the technical barriers?

- No broadly accepted guidelines exist to enable effective and safe human-automation integration

What is NASA's approach?

- Apply proposed pilot interface design guidelines to assess categories of existing pilot interfaces for compliance
 - Pilot-in-the-loop
 - Pilot-on-the-loop
 - Radio controlled visual line of sight
- Define roles and responsibilities between pilots and controllers, human and automation for UAS flight operations
- Utilize NASA expertise in operating the full spectrum of UAS in NextGen defined high density environments

Certification & Interoperability

How is it done today?

- Aviation regulations and standards are based largely on experience gained from incidents and accidents
- Existing system safety standards include implicit assumptions based on the presence and capabilities of an onboard pilot

What are the technical barriers?

- Lack of UAS operational and accident data while operating in a civil airspace environment

What is NASA's approach?

- Research/Analytical based approach, built on the FAA regulatory framework, to provide data that supports development of UAS airworthiness standards and operational requirements
- Work with standards organizations (i.e., RTCA) to define and conduct analyses that includes current, knowledgeable UAS industry and address unique UAS certification issues

Acquisition Strategy



- Proposed Budget: \$30M / year
- The UAS project will be supported by a cross-center balance of FTEs that will vary over the project life cycle as dictated by milestone requirements. All four research centers (Ames, Dryden, Glenn and Langley) will participate with their unique competencies and facilities.
 - Approximately 30 FTE: project management; algorithm development; test requirements, conduct, and analysis
- Competitively awarded off-site contracts will be used to engage the external community in collaborative development and field trials ensuring contributions from key technical expertise
 - NRA awards will be used as appropriate
- External procurements will represent more than half of project funding

Note: This is a draft acquisition strategy that is likely to change during the remaining formulation process. A final plan can be presented when it is complete.

NASA Contributions

NASA will provide singular contributions such as:

- Simulations and field trials of flight control algorithms designed to achieve safe separation of UAS in NextGen traffic densities
- Validated design guidelines and prototypes for UAS pilot-vehicle interfaces to improve safety and reliability
- Agreements with partners and stakeholders to effectively transition matured technology and inform Investment Readiness and Implementation Decisions for measurable systems benefits

Technology Transfer Strategy: Utilize Research Transition Team

Goal:

Ensure that R&D needed for UAS Integration in NextGen is identified, conducted, and effectively transitioned to the FAA and other stakeholder agencies

Objectives:

- Provide a structured forum for researchers and implementers to constructively work together
- Ensure that planned research results can be fully utilized and will be sufficient to enable implementation of UAS Integration in NextGen Operational Improvements

Approach:

- Collaborate among researchers, implementers, and users employing cross-agency Research Transition Teams. (These will include but not limited to: FAA Research and Technology Development office, Technical Center, Unmanned Aircraft program office, Flight Standards, Avionics, and Air Traffic organizations.)
- Identify and reach agreement on distinct Research Transition Products (RTPs):
- Researchers provide description, NASA provided elements, NASA research milestones, maturity, transition date
- Implementers provide intended use and application towards key decision points (Mission Shortfall/Investment Readiness/Initiation Investment/Final Investment/Implementation Decision, etc.)
- Identify barriers to implementation and other significant issues requiring resolution and ensure an approach exists to resolving these concerns during the conduct of the research.

Near Term Plans

NASA will measure its early progress in UAS research by tracking milestones such as these:

- Fast time simulation assessment of the applicability of current separation assurance and trajectory algorithms, technologies, and procedures for seamless integration of UAS operations in the NAS
- Simulations and in-situ spectrum measurements for communication system prototype development
- Define and conduct analyses to identify critical certification issues for enabling routine UAS access to the NAS



Project Formulation Timeline

- 2/1/10 Planning Guidance Document Submitted and Concurred by ASP and ARMD
- 2/15/10 Planning Team Submitted Draft Proposal to ASP and ISRP
- 3/3/10 Planning Team Submitted Draft Proposal to ARMD
- 3/12/10 OMB Approval to Proceed Planning
- 3/26/10 Project Formulation Team Submits Resource Request
- 4/1/10 Formulation Resource Commitment from PDs and Center POCs
- 4/28/10 ISRP/DFRC/UAS Integration in the NAS Project Planning Kick-Off Meeting (2 day)
- 6/16/10 *NRC Meeting of Experts***
- 6/30/10 Project Formulation Team Submits Draft Project Plan to ISRP/DFRC
- 7/15/10 ISRP/DFRC provides Feedback to Draft Project Plan
- 7/31/10 Acquisition Strategy Meeting
- 8/15/10 Project Formulation Team Revises Project Plan with ISRP feedback
- 8/15/10 Project Formulation Team Dry-Run Presentation to ISRP/DFRC Aero Lead
- 9/1/10 UAS Integration in the NAS Project Formulation Review (2 day)
- 9/30/10 Project Plan Submission to ISRP
- 10/1/10 ISRP to Submit Updated Program Plan and PCA to ARMD

Summary

- UAS Planning team has developed a proposal to address enabling seamless integration of UAS operations into the NAS and NextGen
- Proposed work will be coordinated with other Government Agencies and stakeholders to prevent duplicative efforts and take advantage of NASA's unique capabilities
- Proposed work is in alignment with the National Aeronautics R&D Plan, and NASA Strategic Plan Sub-Goals 3A & 3E
- Proposed work addresses findings identified in NRC's Decadal Surveys, and GAO Report
- Proposal will focus on key research issues related to separation assurance & collision avoidance, communications, human factors and certification and interoperability requirements
- UAS Planning Team has initiated project formulation efforts for an FY11 start

Questions?



