NASA's UAS NAS Access Project

NASA's Aeronautics Research Mission Directorate (ARMD) Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project has made significant progress over the past year. The project received funding in May, 2011 ($150M over 5 years), and has been producing benefits to the UAS community from that point forward. In order to stay aligned with the needs of our customers and key stakeholders, the project has had numerous interactions with the FAA's Unmanned Aircraft Program Office (UAPO), and with RTCA Special Committee 203 (SC-203). These interactions have shaped our Technical Challenges and our technical deliverables. The Technical Challenges are:

- Airspace Integration - There is a lack of validated technologies and procedures for unmanned aircraft systems to remain an appropriate distance from other aircraft, and to safely and routinely interoperate with NAS and Next Generation Air Transportation System (NextGen) Air Traffic Services;
- Standards/Regulations - There is a lack of validated minimum system and operational performance standards and certification requirements and procedures for unmanned aircraft systems to safely operate in the NAS;
- Relevant Test Environment - There is a lack of an adaptable, scalable, and schedulable relevant test environment for validating concepts and technologies for unmanned aircraft systems to safely operate in the NAS.

The UAS Integration in the NAS Project is addressing these Technical Challenges through work under our five subprojects. These subprojects are explained in the following paragraphs.

Separation Assurance/Sense and Avoid Interoperability (SSI) - Under the SSI subproject, Separation Assurance (SA) algorithms are being developed to assess functional allocation of separation authority between controllers and UAS pilots. The subproject will develop the overall operational concept for SSI interoperability including the articulation of the operational concept for the allocation of separation authority between the controller and the UAS pilot. After favorable operational concepts are established, algorithms and concepts will be developed for a range of allocations of separation responsibility that may provide NAS-wide benefits when applied to UAS operations. These concepts include controllers having decision support tools to assist in SA for UAS, controllers accepting recommendations from UAS operators for separation maneuvers, and controllers delegating authority for separation to UAS operators.

The lack of an onboard pilot is the most obvious difference between UAS and standard aircraft, which drives the problem of how to deal with the legal requirement identified in the US Code of Federal Regulations (CFR) that pilots "see and avoid" other aircraft (specifically 14 CFR 91.113). Future Sense and Avoid (SAA) systems will provide operators with some level of surveillance information about aircraft near the unmanned aircraft and, as learned from experiences with the Traffic Alert and Collision Avoidance System (TCAS), this information is likely to lead the operator to want to maneuver the unmanned aircraft to avoid those aircraft, with or without controller coordination. NASA will measure

the impact of SAA concepts on the Air Traffic Control System through fast-time and human-in-the-loop simulation experiments. These simulations will be validated during flight testing during 2015 and 2016.

Human Systems Integration (HSI) - Under the HSI subproject, a research test-bed and database to provide data and proof of concept for Ground Control Station (GCS) operations in the NAS will be developed. UAS characteristics that make them different from manned aircraft and how to display airspace information without increasing workload will be addressed. Human-automation interaction and responsibility between onboard automation and the aircraft operator will also be assessed. The output will be a body of work which will be coordinated with standards organizations to develop human factors guidelines for GCS operation in the NAS. These guidelines will help the FAA develop specific standards against which to assess UAS GCS compliance.

Communications - Under the Communications subproject, data and rationale to obtain appropriate frequency spectrum allocations to enable the safe and efficient operation of UAS in the NAS will be developed. There is currently no spectrum allocated for civil UAS use. This work will support the United States' efforts to obtain dedicated UAS spectrum at the World Radio Conference. Candidate UAS command and non-payload control (CNPC) system/subsystem test equipment, which complies with UAS frequency regulations, International Civil Aviation Organization Standards and Recommended Practices, and FAA/RTCA Minimum Operational Performance Standards/Minimum Aviation System Performance Standards for UAS will also be developed. This will include analysis of proposed CNPC security recommendations for public and civil UAS operations in the NAS.

Certification - Under the Certification subproject, a UAS airworthiness classification scheme will be proposed along with an approach to determining airworthiness requirements applicable to all UAS digital avionics. The current aircraft classification scheme and corresponding airworthiness requirements will likely serve as the basis for any new proposal, but may need some modification to be directly applicable to the full range UAS. Hazard and risk-related data is also crucial to the development of certification standards and regulations; yet little UAS specific data (incident, accident, and reliability) exists in a civil context. The Certification subproject will investigate hazard and risk-related data needed to support development of type design criteria and best development practices for standard airworthiness certification.

Integrated Test and Evaluation (IT&E) - Under the IT&E subproject, the technologies developed within the SSI, HSI, and Communications subprojects will be validated through a series of fast time simulations, high-fidelity human-in-the-loop simulations, and integrated flight tests in a relevant environment. A Live Virtual Constructive (LVC) distributed test infrastructure is the cornerstone of all IT&E tests. Preparing the LVC infrastructure for NASA flight tests will include modifications to simulation facilities, unmanned aircraft, and GCSs with critical enabling capabilities. Through the LVC environment, the Project anticipates developing nodes with our domestic and international partners. This will provide the Project with low cost options to expand the flight and simulation asset base (such as linking simulators at the FAA Technical Center or live flights flown by domestic and international partners). It will also allow for the inclusion of piggy-back experiments with the Project's partners (such as testing candidate SAA sensors/algorithms in the LVC environment).

The final deliverables from the IT&E subproject will provide decision makers with an evaluation of UAS integration in the NAS from integrated tests with UAS separation assurance algorithms, UAS GCS concepts, and UAS safety-of-flight communication systems concepts.

At the end of the five-years, the Project expects to have developed data, analysis, and recommendations to key stakeholders based on actual flight tests in a relevant environment. The Project will work with these key stakeholders to ensure that it is delivering what is requested by them. This will produce validated and significant evidence leading to the reduction or elimination of NAS access barriers. In addition, the project will have created a national capability through the LVC to conduct distributed flight testing of any new concept (manned or unmanned) in the context of the current NAS or NextGen.