NASA SBIR 2011 Phase I Solicitation

A5.01 UAS Integration in the NAS

Lead Center: AFRC

Participating Center(s): ARC, GRC, LaRC

The following subtopic is in support of the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project under ISRP. There is an increasing need to fly UAS in the NAS to perform missions of vital importance to National Security and Defense, Emergency Management, Science, and to enable Commercial Applications. UAS are unable to routinely access the NAS today due to a lack of:

- Automated separation assurance integrated with collision avoidance systems.
- Robust communication technologies.
- Robust human systems integration.
- Standardized safety and certification.

The Federal Aviation Administration (FAA) regulations are built upon the condition of a pilot being in aircraft. There exist few, if any, regulations specifically addressing UAS today. The primary user of UAS to date has been the military. The technologies and procedures to enable seamless operation and integration of UAS in the NAS need to be developed, validated, and employed by the FAA through rule making and policy development. The Project goal is to develop capabilities that reduce technical barriers related to the safety and operational challenges associated with enabling routine UAS access to the NAS. This goal will be accomplished through a two-phased approach based on development of system-level integration of key concepts, technologies and/or procedures, and demonstrations of integrated capabilities in an operationally relevant environment. The project is further broken down into five subprojects: Separation Assurance; Communications; Human Systems Integration; Certification; and Integrated Test and Evaluation. The fifth sub-project, Integrated Test and Evaluation, integrates the other four subprojects. The Phase I technical objectives include:

- Developing a gap analysis between current state of the art and NextGen Concept of Operations.
- Validating the key technical elements identified by the project requirements.

- Initial modeling, simulation, and flight testing.
- Completion of subproject Phase I deliverables (Spectrum requirements, comparative analysis of certification methodologies, etc.) and continue Phase II preparation (infrastructure, tools, etc.).

The Phase II technical objectives include:

- Providing regulators with a methodology for developing airworthiness requirements for UAS, and data to support development of certifications standards and regulatory guidance.
- Providing systems-level, integrated testing of concepts and/or capabilities that address barriers to routine access to the NAS, through simulation and flight testing, address issues including separation assurance, communications requirements, and Human Systems Integration in operationally relevant environments.

This solicitation seeks proposals to develop:

- Desktop Simulation System for Rapid Collection of Human-in-the-Loop Simulation Data. Study, design and build a desktop human-in-the-loop simulation system that integrates UAS ground control stations, unmanned vehicles, manned aircraft, and controller interfaces to rapidly evaluate concepts for separation assurance, separation algorithms, procedures for off-nominal conditions, and other research questions. In addition, investigate training requirements and verification methods for the quality of the data, the types of tasks for which such a system could provide meaningful data, and the architecture required to ensure scalability. The simulation system could be based on the Multi Aircraft Control System (MACS), which already includes all those elements except the UAS ground control station. An initial implementation could include a single human operator with all other agents simulated, while advanced implementations would connect several instances of the simulator to capture interactions between human controllers, pilots and UAS operators.
- UAS Model Construction from Real-time Surveillance Data. In order to improve trajectory predictions for aircraft types without detailed models, a real-time system identification process is needed to automatically construct propulsion and aerodynamics models from available Air Traffic Control (ATC) surveillance data (primary or secondary radar, ADS-B, etc.) while the aircraft is in flight. Initial work would establish what real-time surveillance data is required for a model of sufficient fidelity to reliably predict aircraft trajectories ten or more minutes into the future and over tens of thousands of vertical feet, and what types of aircraft maneuvers would provide maximum observability of the unknown parameters (e.g., the vehicle's response to commanded doublets in altitude at max climb/descent speed or step changes in commanded aircraft velocity as observed by radar or ADS-B). These maneuvers would be commanded of the UAS by ATC to improve a poorly understood vehicle model in real-time. Model construction could also be done with archived surveillance data as a first step, but real-time construction is the preferred ultimate outcome.
- Certified control and non-payload communications (CNPC) system. Current civil UAS operations are significantly constrained by the lack of a standardized, certified control and non-payload communications (CNPC) system. The UAS CNPC system is to provide communications functions between the Unmanned Aircraft (UA) and the UA ground control station for such applications as: telecommands; non-payload telemetry; navigation aid data; air traffic control (ATC) voice relay; air traffic services (ATS) data relay; sense and avoid data relay; airborne weather radar data; and non-payload situational awareness video. New and innovative approaches to providing terrestrial and space-based high-bandwidth CNPC systems that are inexpensive, small, low latency, reliable, and secure offer opportunities for quantum jumps in UAS

utility and capabilities. Of particular interest are technologies for the enhancement/improvement of CNPC performance for UAS operations in urban locations, taking into account the propagation, reflection/refraction and shadowing/blockage environment encountered in the urban environment.

- System for Rapid Automated UAS Mission Planning. UAS mission planning is currently a very cumbersome and time-consuming activity that involves a highly manual process. In order to provide better UAS integration in the NAS, an automated mission planning system is required with the following capabilities:

    - During the pre-flight mission phase, automation is needed to identify emergency landing sites, ditch sites, and develop UAS responses to contingency events at all points along the route commensurate with UAS platform performance.

    - During the in-flight mission phase, automation is needed to assess and integrate real-time weather information, such as that provided via Flight Information Services - Broadcast (FIS-B), to dynamically re-plan the route for safe navigation. This includes fuel planning and weather assessment capabilities to select and fly to appropriate alternate destination airfields.

    - During the in-flight mission phase, automation is needed to assess real-time route deviations/changes imposed by Air Traffic Control (ATC). The assessment would consider fuel, weather and emergency landing/ditch site constraints to verify the route change is supportable and safe.