NASA SBIR/STTR — Small Business Innovation Research / Small Business Technology Transfer

NASA SBIR 2014 Phase I Solicitation

A2.01 Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Research

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 the Integrated Systems Research Program (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. The UAS Integration in the NAS Project is structured under the following technical challenges:

- *Airspace Integration* - Validate technologies and procedures for UAS to remain an appropriate distance from other aircraft, and to safely and routinely interoperate with NAS and NextGen Air Traffic Services (ATS).
- *Standards/Regulations* - Validate minimum system and operational performance standards and certification requirements and procedures for UAS to safely operate in the NAS.
- *Relevant Test Environment* - Develop an adaptable, scalable, and schedulable relevant test environment for validating concepts and technologies for UAS to safely operate in the NAS. The Federal Aviation Administration (FAA) regulations are built upon the condition of a pilot being in an 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 provide research findings to reduce technical barriers associated with integrating UAS into the NAS utilizing integrated system level tests in a relevant environment. The project is currently broken down into five subprojects:

- Separation Assurance/Sense and Avoid Interoperability (SSI)
- Communications
- Human Systems Integration
- Certification
- Integrated Test and Evaluation

The fifth subproject, Integrated Test and Evaluation, is responsible for developing a live, virtual, and constructive test environment for the other four subprojects. During the first phase, (May-2011 to September-2013) the project has:

- Conducted initial modeling, simulation, and flight testing.

- Completed early subproject-focused deliverables (spectrum requirements, comparative analysis of certification methodologies, etc.).
- Validated the key technical elements identified by the project.

The plan for the second phase includes the following:

- Conduct systems-level, integrated testing of concepts and/or capabilities that address barriers to routine access to the NAS.
- Develop a body of evidence (including validated data, algorithms, analysis, and recommendations) to support key decision makers in establishing policy, procedures, standards and regulations, enabling routine UAS access in the NAS.

This solicitation seeks proposals, but is not limited, to develop concepts that can reduce the technical barriers related to the safety and operational challenges of routine UAS operations in the NAS.

- *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 High power C-band amplifiers and highly linear C-band power amplifiers/linearization of high power C-band amplifiers.
    - Miniaturization of C-band terrestrial radio components/systems and C- Ku- and Ka-Band satellite communications components/systems.
    - Conformal steerable antennas for satellite communications links in C-, Ku- and Ka Band.
- *Weather Information Systems for GCS* - On-board, real-time graphic aviation weather information products have been developed and successfully implemented for manned cockpits. Their use is now widespread and their safety impact widely recognized. The applicability of such products for operators and ground control pilots to enhance situation awareness and improve mission planning and execution is of interest to NASA. Systems such as the NASA developed Aviation Weather Information (AWIN) system that included software, data and data-link applications, color weather graphics such as composite-radar mosaic, lightning-strike data, wind data, satellite images and forecasts could be integrated into a ground control station to provide pilots with weather awareness before and during mission execution. Improved weather awareness should allow aircrews to avoid most weather-related problems through both pre-flight and en-route planning. While the use of these systems has been explored for military UAS operations, their applicability to civil and public operations has not yet been explored.
- *Safety Analysis and Methodologies* - UAS operations are untried in the civil NAS. Unlike other aircraft, there is not an extensive record of civil operations upon which to forecast the safety of UAS operations in the NAS. The introduction of UAS into the NAS raises many safety issues and concerns. Typically, anytime a new capability is added into the NAS, an Operational Safety Assessment (OSA) is performed by the FAA, to determine whether that introduction of new capability will enhance or detract from the safety of the NAS. As these UAS represent a wholly new operational system, traditional approaches cannot suffice. Research is needed to identify and develop new safety analysis approaches, as well as prognostic indicators and potential new safety metrics.
- *Autonomous Operations* - As vehicle capabilities and machine intelligence continue to evolve, it is expected that future air vehicles, especially unmanned vehicles, will assume an increasing level of independent decision-making, flight monitoring and management, and trajectory management. As the Next-Generation Air Traffic Management System (NextGen) continues to evolve and expand, the future system will need to concurrently develop operational accommodations for these aircraft that manifest increasing levels of autonomy. Thus, autonomous vehicles and NextGen must evolve in complementary ways to accommodate these future operational considerations. At a minimum, future autonomous systems must demonstrate successfully the following characteristics:
    - Collision/hazard avoidance.

    - Autonomous navigation under uncertain conditions.
    - Cooperative task completion (if more than one aircraft is needed for a particular operation).
    - Recognition of anomalies.
    - Long term system diagnostics, failure prediction and correction.
- *Development of a UAS Flight Inspection and Cargo Aircraft Capability Concept* - Currently the FAA conducts flight inspections of the ground based air navigational aids and guidance systems (MLS, TACAN, VASI) in Antarctica using a CL-601 Challenger corporate executive jet type of aircraft, not certified for operations from ice and gravel runways. The risk for damage to these costly aircraft is high and no flights are made to remote areas, like Antarctica, without the inclusion of maintenance personnel among the crew. A UAS, RPV equipped for flight inspection work in Antarctica and other remote areas utilizing a simple rugged STOL type of vehicle, ski or wheel equipped, (thus capable of operating from rough snow, ice and short gravel runways) would greatly reduce the risks and costs of flight inspecting and light air logistics in Antarctica. The environment in Antarctica is a perfect venue to demonstrate an efficient, practical and environmental friendly use of unmanned aircraft technologies to a worldwide audience. Basic requirements for a drone utilized in this type of operation include:
    - Ability to carry a 1000-pound payload 800 nautical miles and return with no need for additional fuel.
    - Be TCAS responsive and “visible” to other traffic.
    - Be equipped with bubble observation windows and mounts for various surveillance and photography systems.
    - Have the capability to operate from the short gravel runways.