A2.01 Flight Test and Measurement Technologies

Lead Center: AFRC

Participating Center(s): ARC, GRC, LaRC

Technology Area: TA15 Aeronautics

Scope Description

NASA continues to use flight research as a critical element in the maturation of technology. This includes developing test techniques that improve the control of in-flight test conditions, expand measurement and analysis methodologies and improve test data acquisition and management with sensors and systems that have fast response, low volume, minimal intrusion and high accuracy and reliability. By using state-of-the-art flight test techniques along with novel measurement and data acquisition technologies, NASA and the aerospace industry will be able to conduct flight research more effectively and also meet the challenges presented by NASA and industry’s cutting edge research and development programs.

NASA’s Flight Demonstrations and Capabilities Project supports a variety of flight regimes and vehicle types ranging from low speed, sub-sonic applications and electric propulsion, through transonic and high-speed flight regimes. Therefore, this solicitation can cover a wide range of flight conditions and vehicles. NASA also requires improved measurement and analysis techniques for acquisition of real-time, in-flight data used to determine aerodynamic, structural, flight control and propulsion system performance characteristics. These data will be used to provide information necessary to safely expand the flight and test envelopes of aerospace vehicles and components. This requirement includes the development of sensors for both in-situ and remote sensing to enhance the monitoring of test aircraft safety and atmospheric conditions during flight testing. This subtopic supports innovative flight platform development for use in hypersonic flight testing, science missions and related subsystems development.

Flight test and measurement technologies proposals may significantly enhance the capabilities of major government and industry flight test facilities. Proposals may address innovative methods and technologies to reduce costs and extend the health, maintainability, communication and test techniques of flight research support facilities.

Areas of interest emphasizing flight test and measurement technologies include:

- High efficiency digital telemetry techniques and/or systems to enable high data rate and high volume telemetry for flight test. This includes Air-to-Air and Air-to-Ground communication.
- Architecture and tools for high integrity data capture and fusion.
- Real-time integration of multiple data sources from on-board, off-board, satellite and ground-based measurement equipment.
- Advanced in-situ/onboard sensing and/or integrated secured remote services for use in real-time decision-
making.

- Prognostic and intelligent health monitoring for hybrid and/or all-electric propulsion systems using an adaptive embedded control system.
- Methods for accurately estimating and significantly extending the life of electric aircraft propulsion energy source (e.g., batteries, fuel cells, etc.).
- Test techniques, including optical-based measurement methods that capture data in various spectra, for conducting quantitative in-flight boundary layer flow visualization, Schlieren photography, near and far-field sonic boom determination, and atmospheric modeling as well as measurements of global surface pressure and shock wave propagation.
- Measurement technologies for in-flight steady and unsteady aerodynamics, juncture flow measurements, propulsion airframe integration, structural dynamics, stability and control and propulsion system performance.
- Improved rugged wideband fiber optic sweeping laser system design for optical frequency domain reflectometry containing no moving parts, to be operated onboard NASA's wide range of aircraft. Improved development of polarization insensitive fiber measurements using optical frequency domain reflectometry.
- Wireless sensors, sensing technologies and telecommunication methods that can be used for flight test instrumentation applications for manned and unmanned aircraft. Emphasis should be on developing a variety of specialized low profile sensors that are capable of participating in a synchronized, high data rate and high data volume diverse wireless sensor measurement network with a capability to deliver time-stamped data to a central node. This area of technologies also includes wireless (non-intrusion) power transferring techniques and/or wirelessly powering remote sensors.
- Innovative measurement methods that utilize intelligent sensors for autonomous remote sensing in support of advanced flight testing.
- Fast imaging spectrometry that captures all dimensions (spatial/spectral/temporal) and can be used on unmanned aerial systems (UAS) platforms.
- Innovative new flight platforms, airframes and the associated subsystems development for use in all areas of flight tests and missions, e.g., X-planes testing, hypersonic testing, science missions, etc.

The emphasis of this subtopic is on flight test and flight test facility needs.

The technologies developed for this subtopic directly address the technical challenges in the Aeronautics Research Mission Directorate (ARMD) Integrated Aviation Systems Program (IASP), the Electrified Powertrain Flight Demonstration (EPFD) and Flight Demonstrations and Capabilities (FDC) projects. The FDC conducts complex flight research demonstration to support multiple ARMD programs. FDC is seeking to enhance flight research and test capabilities necessary to address and achieve the ARMD Strategic plan. They could also support Advanced Air Vehicle Program (AAVP) Projects: Commercial Supersonic Technology (CST), and AAVP - Aeronautic Evaluation & Test.

References

https://sbir.nasa.gov/
https://www.nasa.gov/centers/armstrong/research/X-56/index.html
https://www.nasa.gov/centers/armstrong/features/shock_and_awesome.html
https://technology-afrc.ndc.nasa.gov/featurestory/fiber-optic-sensing

Expected TRL or TRL range at completion of the project: 1 to 6

Desired Deliverables of Phase II

Prototype, Analysis, Hardware, Software, Research
**Desired Deliverables Description**

For a Phase I effort, at least a report is desired that describes the effort's successes, failures and the proposed path ahead.

For a Phase II effort, the small business should show a maturation of the idea or technology that allows for a presentation of detailed influential analysis or a thorough demonstration at least, and most ideally a delivery of a prototype that includes beta-style or better hardware or software.

**State of the Art and Critical Gaps**

Current atmospheric flight systems cover a large range of uses from point-to-point drones, to high performance small aircraft, to large transports, to general aviation. In all areas, advancements can be possible if insights can be gained, studied and used to create new technologies. New insights will require an evolution of current testing and measurement techniques as well as novel forms and implementations. Known gaps include: Wireless instrumentation for flight, advanced telemetry technique, intelligent internal state monitoring for air and space vehicles, techniques for studying sonic booms, advanced techniques for capturing all dimensions of system operation and vehicle health (spatial/spectral/temporal) and extreme environment high-speed large area distributive sensing techniques. Along with these comes secure telemetry of data to ensure informed operation of the flight system.

**Relevance / Science Traceability**

The technologies developed for this subtopic directly address the technical challenges in ARMD's IASP and FDC projects. FDC conducts complex flight research demonstrations to support different ARMD programs. FDC is seeking to enhance flight research and test capabilities necessary to address and achieve ARMD Strategic plan. Also, they could support IASP Electrified Powertrain Flight Demonstration Project, Advanced Air Vehicle Projects (AAVP) - Commercial Supersonic Technology (CST), and AAVP - Aeronautic Evaluation & Test.