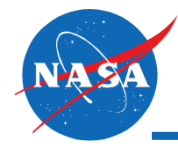


# Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project

## Systems Integration and Operationalization (SIO) Demonstration

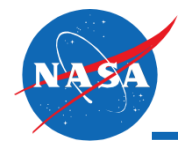




# SIO Update

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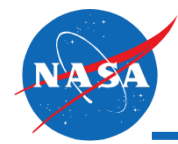
- NASA reviewed the RFIs that were provided by industry
- Procurement mechanism will be a Cooperative Agreement
  - Expected to be released by the end of March
  - Proposers will have ~60 days from release to develop and submit proposals
  - Partner award(s) made by end of FY2018
- This presentation includes:
  - Brief overview of SIO
  - NASA and industry partner responsibilities
  - Planned SIO resources
  - Planned deliverables



# SIO Goal and Objectives

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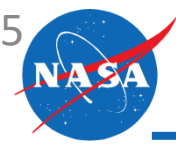
- SIO stands for **Systems Integration and Operationalization**
  - **Systems Integration:** Includes integration of all UAS systems required for a mission
  - **Operationalization:** Make progress toward enabling UAS operations in the NAS
- The goal of SIO is to accelerate routine commercial UAS operations in the NAS
- The objectives of SIO are to:
  - Demonstrate UAS operations in the NAS by leveraging integrated DAA, C2, and other state of the art UAS technologies on an unmanned aircraft
  - Ensure relevant project research transitions into UAS stakeholder community
  - Accelerate certification basis for UAS new entrants
  - Advance the state of the art (SOA) for UAS technologies



# Planning Considerations

- UAS Integration focused demonstration flight(s) with one or more partner provided UAS
- Considers all ground and flight needs necessary to implement the proposed UAS mission (e.g. all phases of flight, including take-off, landing, and surface operations)
- All UAS equipped with operationally relevant, DAA and C2 systems that have a pathway to certification (not necessarily SC-228 developed standards)
- Mission Operating Environment with primary operating altitude being above 500 feet above ground level (AGL) in controlled airspace

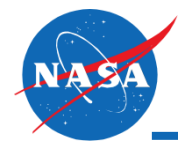
**Obtain Industry partner(s) who demonstrate integrated DAA and C2 technologies in the NAS, leverage vehicle technologies that enable end-to-end mission performance without operational restrictions, and compile the necessary artifacts and data to support regulatory compliance**



# Partnership Model Considerations

- Vehicle Original Equipment Manufacturers (OEMs)
  - OEMs are an essential part of the realizing future UAS markets.
  - OEMs are expected to be the primary party responsible for developing and certifying vehicles.
  - OEMs will need to integrate essential technologies and sensors designed to meet the operational needs of service providers that will offer UAS services.
- Sensor, surveillance, software, ATM, and other relevant partners
  - In many cases vehicle providers integrate SOA technologies being developed across the aerospace industry.
  - In some cases, there may be a desire for additional ATM related services
- Service provider and/or end user partnerships
  - Many ConOps or use-cases are designed with a specific end-user in mind that is not the OEM or other technology developer.
  - In these cases, representation of the service provider as part of the partnership strategy can be an indicator of market interest, and serve as validation to the ConOps.
- Airworthiness and operational location
  - Experience with Airworthiness
  - Provide location to perform demonstration that also has viability to be the location for the initial operating locations

**In an effort to further the development of partnerships and collaborations for the SIO effort, NASA requests a high-level summary of what your company could provide to assist others in meeting the goals of SIO or what your company needs from others to meet the goals of SIO**



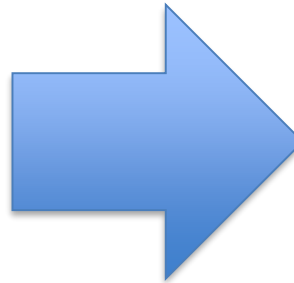
# SIO Overview



NASA will provide a foundation of expertise from years of research



Industry is expected to provide vehicle development, integration, and operations



Flight Demonstration in FY2020



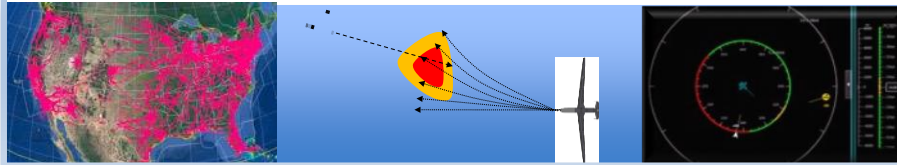
NASA produced Certification Documentation and Lessons Learned



Acceleration of commercial UAS operations in the NAS

## Detect and Avoid (DAA)

- Support for Phase 1 and 2 RTCA MOPS
- Cooperative Agreement with Honeywell to build and test a DAA system
- Several simulations and flight tests
  - NAS-wide simulations
  - Human-in-the-loop simulations



## Command and Control (C2)

- Support for Phase 1 and 2 RTCA MOPS
- Cooperative Agreement with Rockwell Collins to build and test a C2 radio
- Lab and flight tests



## Integrated Test and Environment (IT&E)

- Flight test support
- No Chase Certificates of Waiver or Authorization (COA)
- Live Virtual Constructive (LVC) test environment

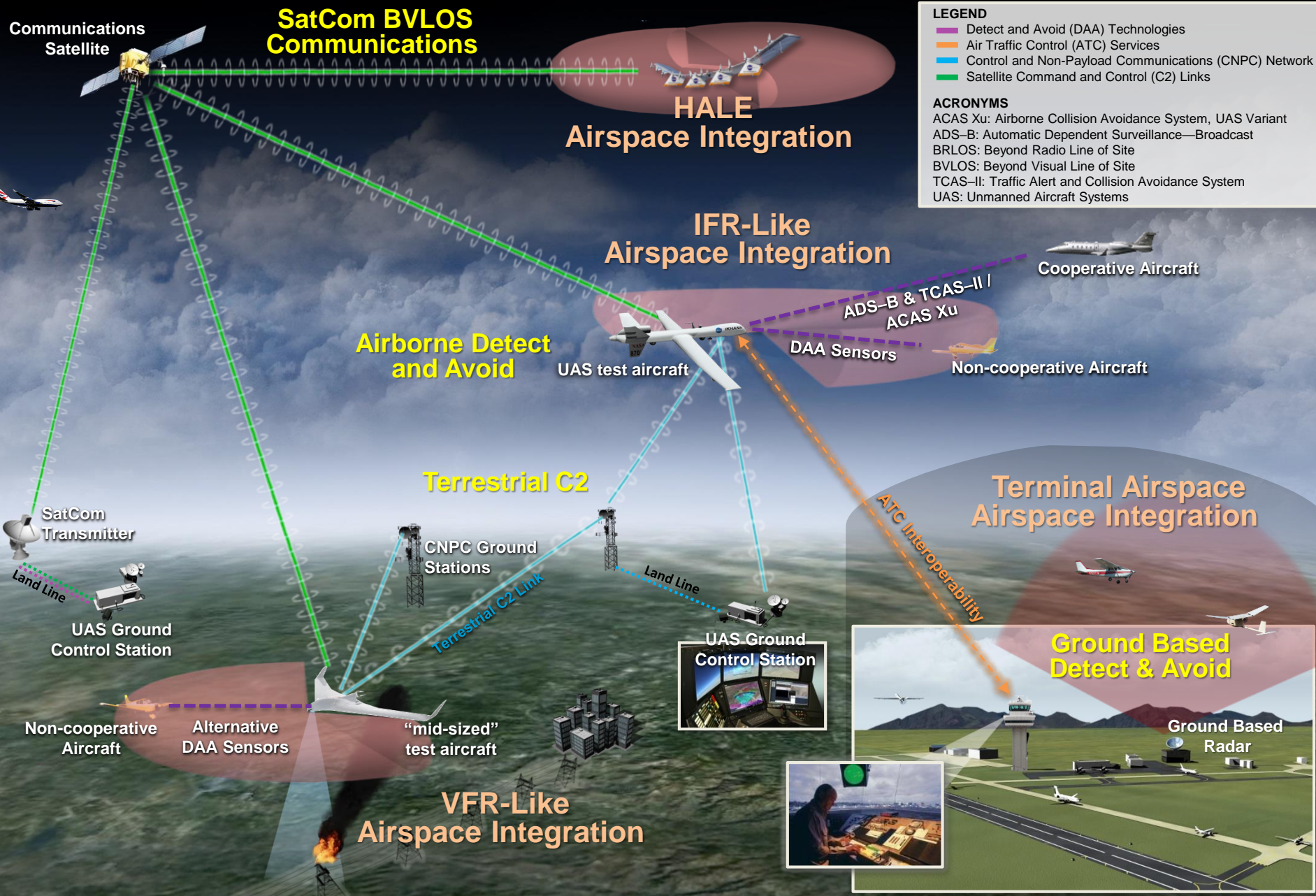


## Certification

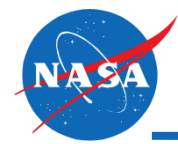
- NASA conducted an evaluation of certification requirements for a UAS
  - Developed concept of operations for low risk UAS operations
  - Identified design requirements from an analysis of hazards



# UAS-NAS Project – SIO Operational View Representation

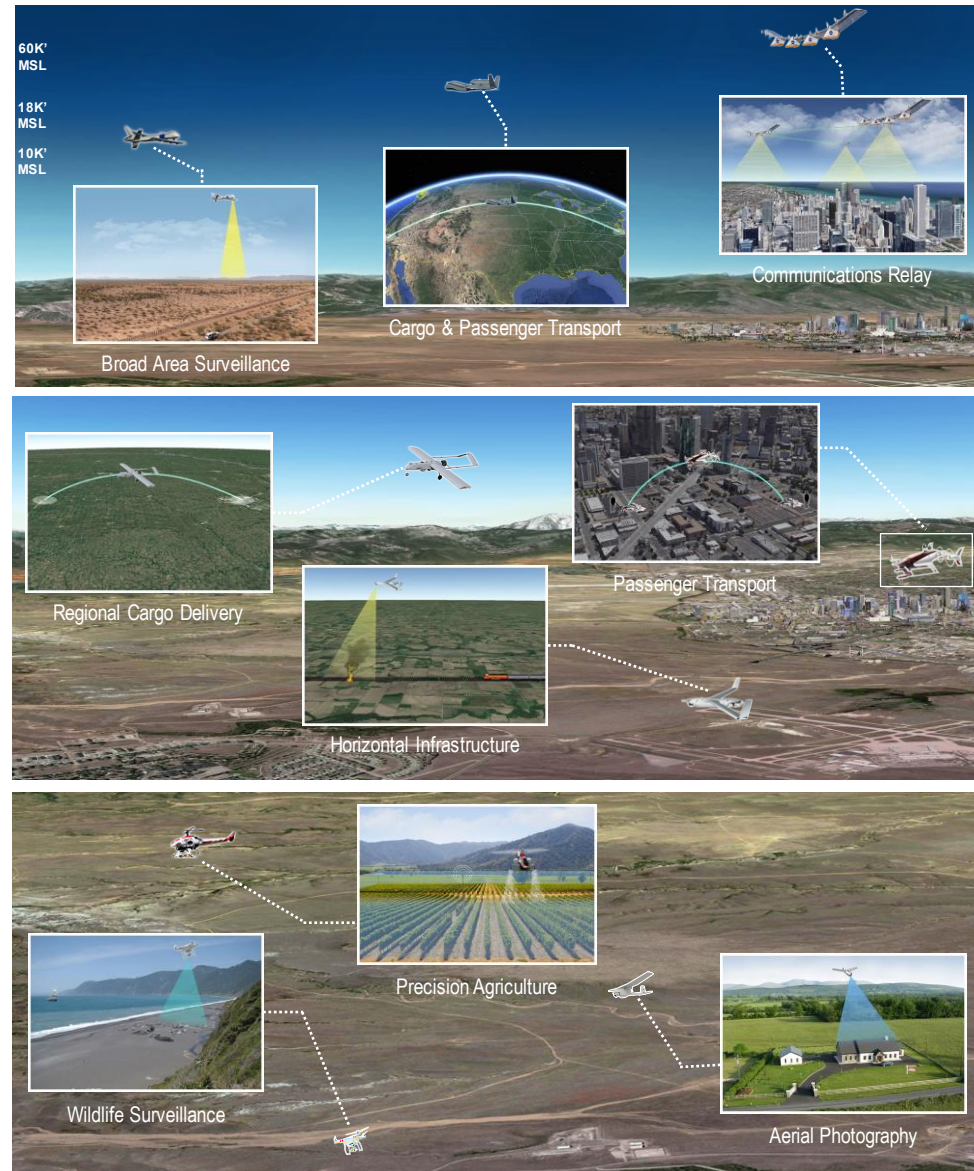


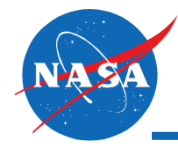




# Potential SIO Missions

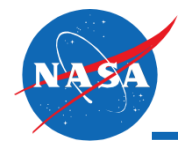
- SIO will demonstrate missions with high commercialization potential
  - HALE (above FL600)
  - IFR-like
  - VFR-like
- Missions must include operations over 500 feet above ground level
- May select multiple partners for a portfolio of commercial ConOps
  - Restricted by funding and resources





# Notional SIO Responsibilities

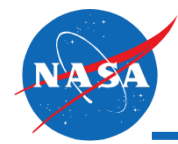
Partnership Considerations	Description of Considerations
General Responsibilities	<p>Partner(s) – Provide a UAS with integrated DAA &amp; C2, on the pathway to certification</p> <p>NASA – Lead collaborative community wide effort, provide subject matter expertise, interface with the FAA</p>
Conops	<p>Partner(s) – Define commercial opportunity and ConOps that will be demonstrated</p> <p>NASA – Lead collaborative community wide effort, provide subject matter expertise, interface with the FAA</p>
Safety and Certification	<p>Partner(s) – Safety case, data to substantiate safety, and aggressively pursue type certification</p> <p>NASA – Leverage partners to develop safety &amp; certification documentation applicable to entire community, significant coordination with FAA, provide subject matter expertise</p>
Command and Control / Detect and Avoid	<p>Partner(s) – DAA &amp; C2 technologies integrated on a UAS with a pathway to certification, coordination with standards bodies</p> <p>NASA – Provide industry with consultation, leveraging UAS-NAS core competencies and subject matter expertise</p>
UAS Technologies	<p>Partner(s) – Define minimum equipment lists, and V&amp;V essential technologies necessary for UAS commercial mission (i.e. surface ops, contingency management, power systems, etc.)</p> <p>NASA – Leverage broad internal NASA expertise per industry needs and available resources</p>
SIO Demo and Airworthiness	<p>Partner(s) – Define and execute a demonstration that emulates a commercial conops at a relevant test location and collect airworthiness data and documentation to meet NASA’s airworthiness process and obtain approval to operate in the NAS</p> <p>NASA – Subject matter expertise, Responsible for airworthiness approval</p>



# Procurement and Resources

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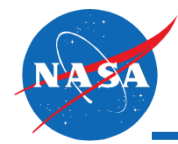
- SIO will use a Cooperative Agreement to formalize the relationship between NASA and Industry
  - At least 50% cost match required from industry
  - Greater cost match encouraged
- Resource philosophy
  - NASA will provide baseline resources for subject matter expertise and consultation
  - Industry will provide vehicle development, integration, and operations
  - Industry partners expected to request any additional resources required beyond the baseline resources



# Planned NASA In-kind Support

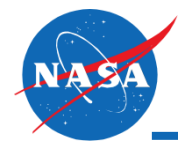
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- Anticipated baseline NASA in-kind support
  - 2.0 work year equivalent for DAA consultation and support in FY2019 and FY2020
  - 1.5 work year equivalent for C2 consultation and support in FY2019 and FY2020
  - 2.0 work year equivalent for airworthiness consultation and support in FY2019 and FY2020
  - 1.5 work year equivalent for Live Virtual Constructive (LVC) test environment support in FY2019 and FY2020 (note that additional resources will be required for new LVC connections)
  - 2.5 work year equivalent in FY2019 and FY2020 for certification consultation and support, and for generating broadly applicable certification documentation
  - 1.0 work year equivalent in FY2019 and FY2020 for management of the Cooperative Agreement(s)
- If additional support is desired in a particular area, the additional resources should be included in the proposal
  - Any requests for additional consultation support in a particular area
  - Any requests for lab/facility support should be coordinated with the lab/facility prior to submission of the proposal
- Additional funding is available, which can be applied to:
  - The creation of deliverables
  - Collection of airworthiness data
  - Creation of certification artifacts
  - The FY2020 demonstration in the NAS
- SIO is limited to the resources identified above



# Planned Deliverables

- Deliverables designed to facilitate communication between NASA and the Industry partners
- Most deliverables align with standard systems engineering documents and/or documents required for airworthiness approval and certification
- Planned deliverables
  - General
    - Kick-off meeting presentation
    - Monthly status reports
    - Graphics for public relations use
    - Final brief and contributions toward final report
  - Airworthiness and Certification
    - Mission ConOps document
    - Risk-based Safety Assessment document
    - Flight Demonstration Plan and other documentation needed for NASA's airworthiness process
    - UAS Operating Manual
    - Project Specific Certification Plan
    - Any issue papers, special type certificates, and any other certification artifacts produced
  - Systems Engineering
    - System test and acceptance plan
    - System Design document



# Evaluation Goals

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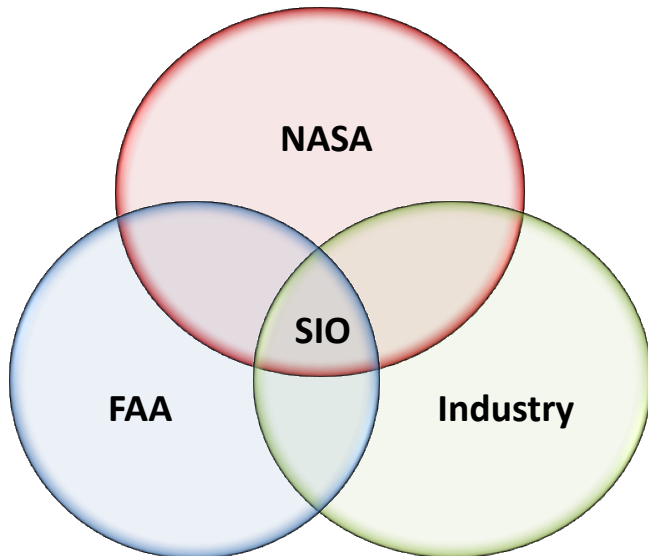
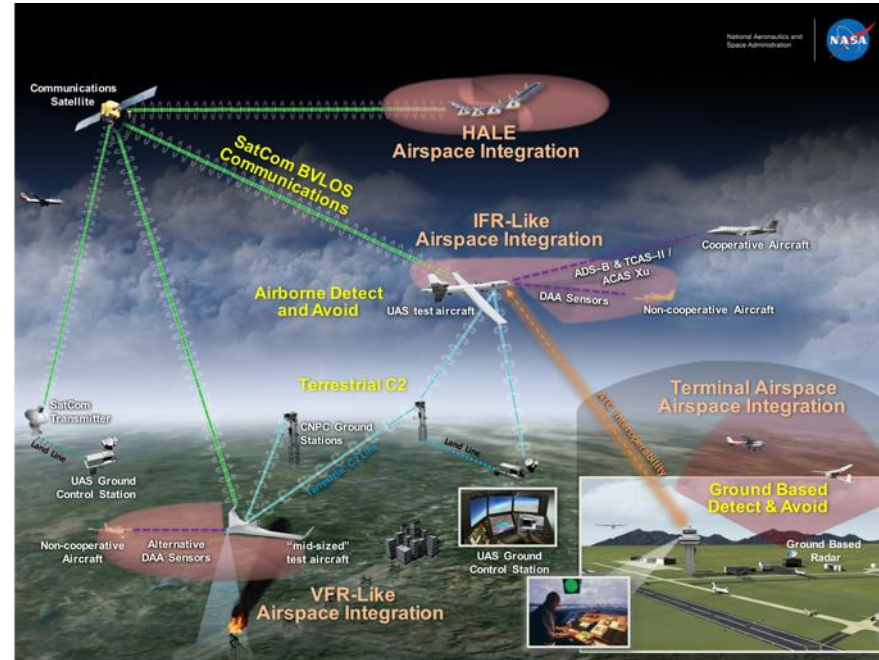
- Subset of evaluation goals
  - Selection of one or more industry partners that are interested in commercializing and certifying their UAS
  - Strong technical quality
    - Feasible DAA system with a clear pathway to certification
    - Feasible C2 system with a clear pathway to certification
  - Able to support a demonstration in the NAS in FY2020
    - Obtain airworthiness approvals to operate in the NAS
- Planned evaluation areas
  - Commercialization potential
  - Technical merit and feasibility
    - Detect and Avoid (DAA)
    - Command and Control (C2)
    - UAS technologies, architecture, and integration
    - Certification
    - Airworthiness
  - Cost realism and industry contributions
  - Prior experience, personnel and facilities

**Goal:** Accelerate routine commercial UAS operations in the National airspace System (NAS)

- Demonstrate commercial UAS mission in the NAS
- Obtain approval to operate in the NAS
- Work toward certification

**Method:** Partnership with industry

- Industry provides UAS development, integration, testing, operations, and begin certification process
- NASA provides subject matter expertise in DAA, C2, airworthiness, and certification
- NASA will keep the FAA informed of certification efforts via the Research Transition Team (RTT)



## Procurement Mechanism:

- Cooperative Agreement
- NASA expects to provide baseline resources for subject matter expertise and consultation
- Industry is expected to provide vehicle development, integration, and operations

## Possible operating environments:

- High altitude operations (above FL600)
- Medium altitude operations (10,000 ft to FL600)
- VFR-like low altitude operations (500 to 10,000 ft)