National Aeronautics and Space Administration

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

Certification Subproject

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UAS Integration in the NAS

Need Statement

The Unmanned Aircraft Systems (UAS) Community needs routine access to global airspace for all classes of UAS

Project Goal

Utilize integrated system level tests in a relevant environment to eliminate or reduce technical barriers related to the safety and operational challenges of integrating UAS into the NAS

Technology Development Areas

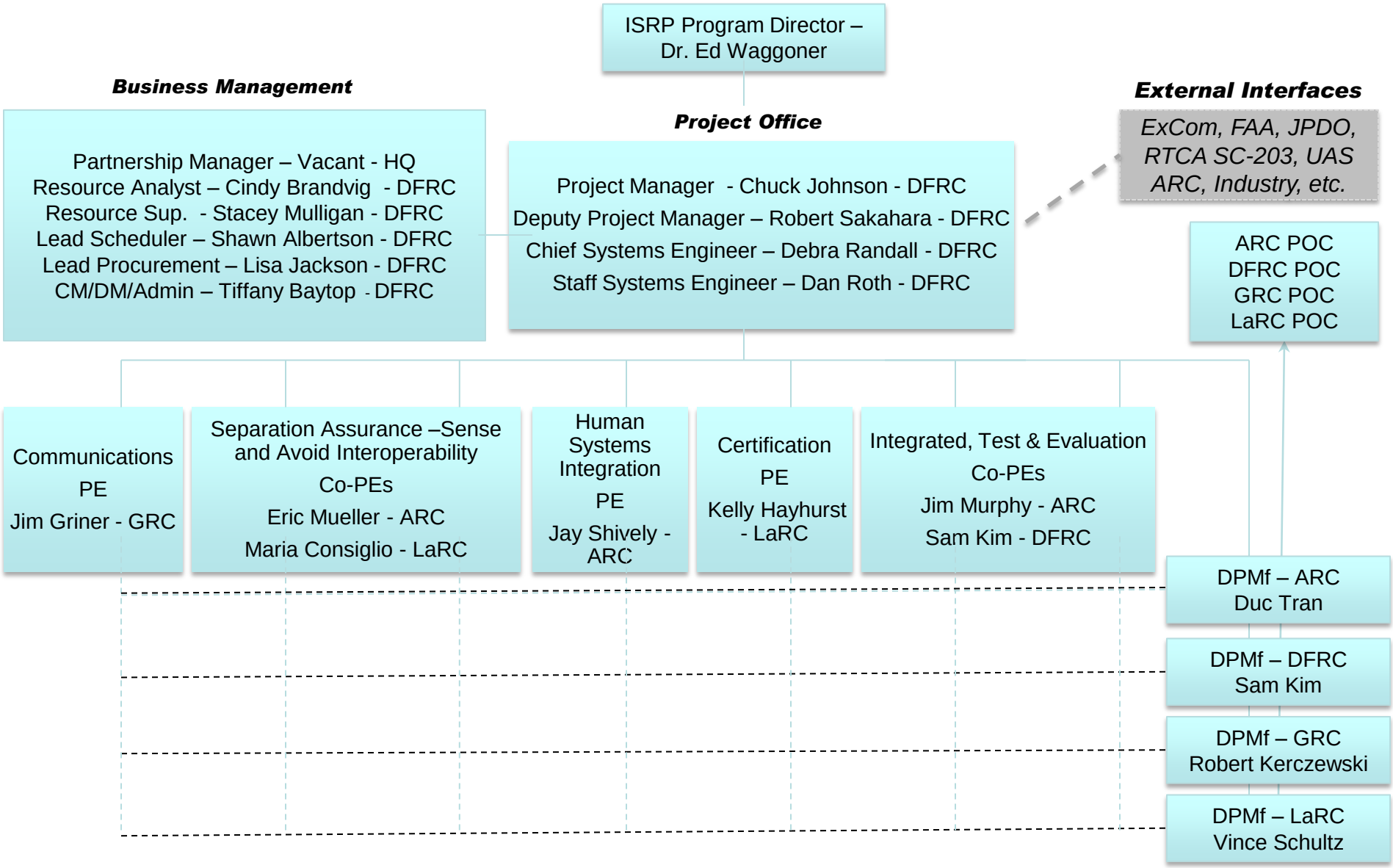
Separation Assurance-Sense and Avoid Interoperability (SSI), Human Systems Integration (HSI), Communications, Certification, Integrated Test & Evaluation

Key Stakeholders

UAS ExCom, FAA, JPDO/NextGen, DoD, SC-203 and other Standards/Regulatory Organizations

Time-frame for Impact 2015 to 2025

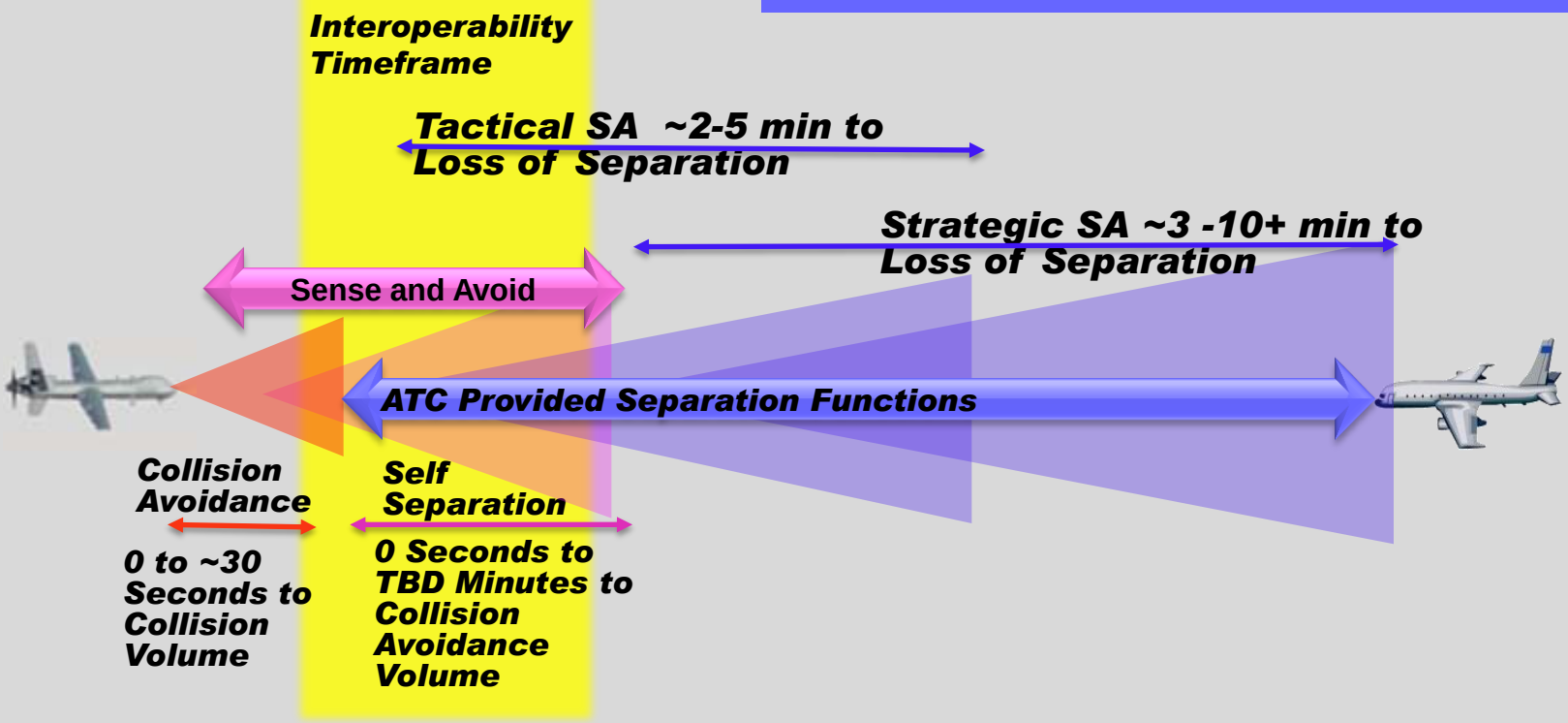
Organizational Chart



SAA/SA Interoperability

Collision Avoidance – SAA action to prevent an intruder from penetrating the collision volume when all other modes of separation fail.

Self Separation – SAA maneuver by the UAS pilot within a sufficient timeframe to prevent activation of CA while conforming to accepted air traffic separation standards.



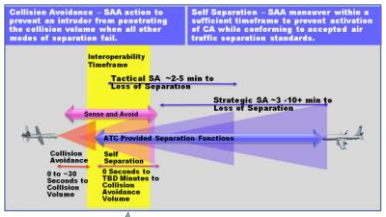
Notional depiction of overlapping detection look-ahead times for different SA and SAA functions (not to scale).
Look-ahead times vary with different algorithms.

HSI Subproject

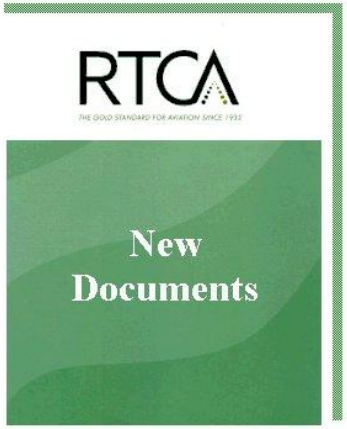
Coordinate with ATC - respond w/o increase to ATC workload

Efficiently manage contingency operations w/o disruption of the NAS

Seamlessly interact with SSI

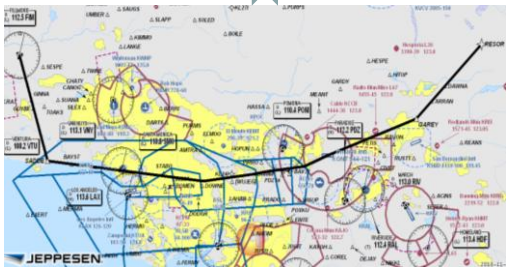


Research test-bed and database to provide data and proof of concept for GCS operations in the NAS



Human factors guidelines for GCS operation in the NAS

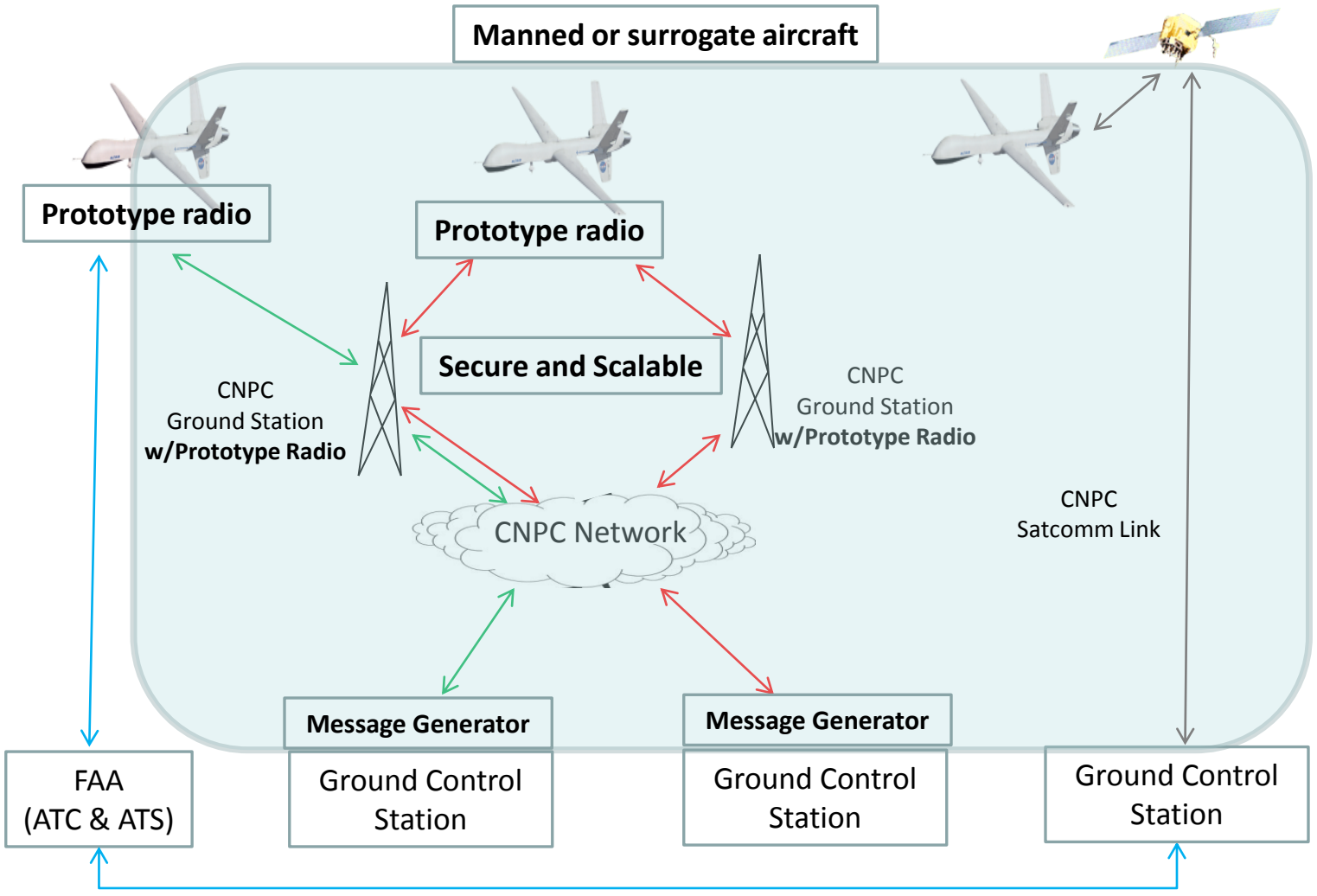
Ensure operator knowledge of complex airspace and rules



Standard aeronautical database for compatibility

Traffic information for situation awareness and separation (NextGen)

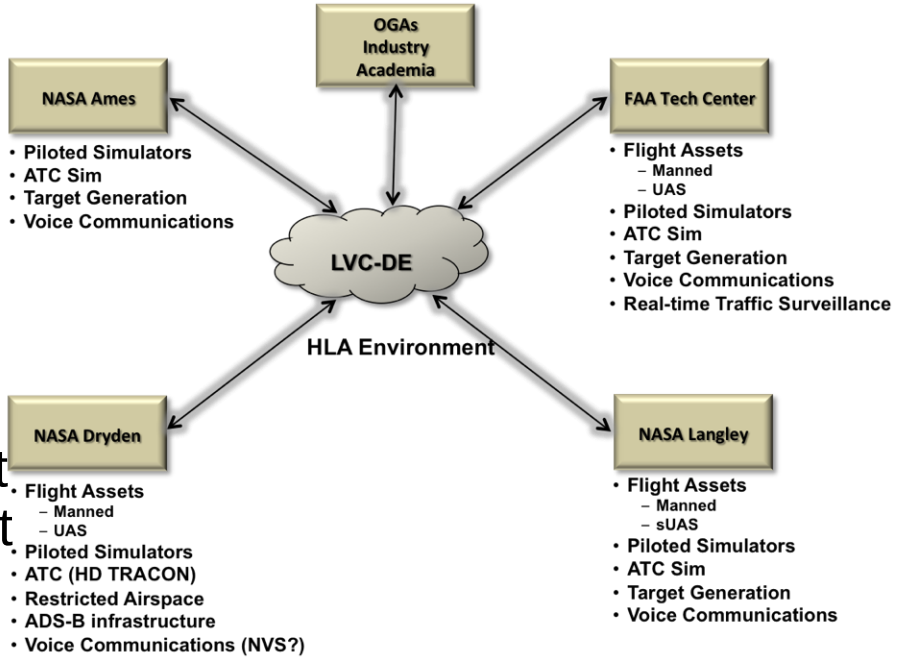
Communication Subproject Focus



Possible Future ATS and ATC Ground Connectivity

Notional Live Virtual Constructive Distributed Environment

- Core connectivity between Dryden and Ames
- Distributed environment provides the opportunity to utilize unique assets from geographically dispersed facilities
- Virtual simulations inject human interactions into a central role by exercising the decision making process and communications
- Virtual traffic generated to present complex conflict scenarios without imposing collision risks to “live” aircraft
- Complex airspace can be evaluated while the “live” aircraft fly in “safe” restricted airspace



Certification

Technical Challenge

Provide data and analysis to support a *sound technical basis* for determining appropriate airworthiness requirements for UAS, especially for their avionics

- what factors are most important consider with respect to safety?
  - ➢ especially reliability and design assurance requirements

Technical Approach

- **Assess options/factors for classifying UAS for the purpose of specifying reliability and design assurance requirements**
- **Identify, collect, and analyze UAS hazard and risk-related data to support development of policy and standards**
- **(maybe) Conduct a case study to determine a type certification basis for a UAS**

Context & Scope

- **Context is processes, standards, and regulations**
  - not a specific technology
  - not any particular type or size of UAS
- **Focus is on *airworthiness***
  - particularly interested in systems/avionics (xx.1309)
    - on-board, in the ground control station, in the communication links
- **Not looking at regulation of**
  - people
  - operations
    - except as may impact airworthiness
  - production capabilities

Objectives-Relationships

Objective 2: Hazard/Risk-related Data

Collect hazard and risk-related data to support understanding of UAS safety issues & regulation development

Objective 1: <u>Theoretical</u> assessment of requirements

Provide a method/factors for UAS classification with respect to airworthiness requirements/standards, especially avionics

Tentative Objective 3: <u>Empirical</u> assessment of requirements

Conduct a case study to propose a type certification basis for a UAS

Understanding factors important to regulating UAS airworthiness

Broad look at the problem

Point solution to the problem

Tasking for Objective 1 (Classification)

- **Task 1: Identify and assess existing approaches for UAS classification**
  - extensive literature search and consultation with subject matter experts
  - identify factors used in classification, assumptions, rationale, and implications
- **Task 2: Investigate alternate approaches to UAS classification for airworthiness**
  - define different approaches, based on Task 1 results
  - investigate the application of RTCA/DO-264 for a specific UAS mission/service
- **Task 3: Comparative analysis of approaches**
  - elaborate the benefit and limitations of each of the classification schemes from Tasks 1 and 2
- **Task 4: Down-Select best approach for further assessment**
  - share findings from tasks 1-3 with the FAA, with the intent of selecting one of the approaches for further study/validation
- **Task 5: Initial preparation for conducting a case study to validate the candidate methodology**
  - consider how modeling, simulation, and flight test could help validate the results of Tasks 1-4

Tasking for Objective 2 (Data)

- **Task 1: Determine data needed to support development of regulation/policy**
  - consider operational and technical risks associated with UAS to determine specific data that would be valuable to collect
    - e.g., loss of control, loss of separation, performance degradation, component failures, etc.
- **Task 2: Identify existing data sources and evaluate gaps**
  - determine organizations that are currently operating UAS and collecting data
- **Task 3: Investigate data analysis methods needed to support identification of UAS safety issues**
  - evaluate data analysis methods, including those for sparse data sets (which may be likely for various UAS data), for applicability
- **Task 4: Evaluate options for data collection/storage**
  - determine suitability of existing databases or other options for UAS safety data
- **Task 5: Determine hazard and risk-related data generated by other subprojects**
  - determine whether relevant data could be collected as part of the flight testing activities for the other subprojects.
- **Task 6: Document recommendations for hazard and risk-related data collection to support development of regulation.**

Airworthiness Certification Case Study

Basic idea: NASA will provide a team of subject matter experts to work with a UAS manufacturer to *virtually* go through initial steps of the airworthiness certification process for the manufacturer's UAS

- **Follow the 14 CFR Part 21 guidance for Type Certificates**
- **Draft a Type Certification Basis**
  - specifies applicable regulations, special conditions, exemptions, optional design regulations and environmental (noise) findings
- **Draft a Compliance Checklist**
  - specifies methods of compliance (e.g. flight test, ground test, compliance statement, analysis, inspection, etc.) for each regulation
- **Rationale for everything!**
- **Other documentation as appropriate**

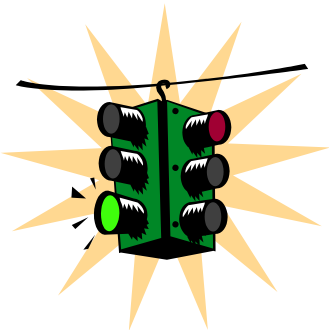
More detail

- **Targeting UAS manufacturers because they would likely be the holders of the type certificate**
  - open to other options, as long as we can mimic the certification process
- **Require access to the UAS design information**
  - unmanned aircraft, communication links, control station, …
- **Targeting UAS that**
  - are > 55lbs
  - fixed wing, rotorcraft, hybrid
  - are representative of a general class of UAS
    - ➢ not novel/unique designs
- **Targeting manufacturers who have a civil/commercial application**
- **Participants must be willing to have open and public distribution of results**

Status and Work Ahead

- **A Request for Information (RFI) was released on February 8th, seeking information from UAS manufacturers who might be interested in participating in a case study**
  - **responses due by March 26th**
  - **http://prod.nais.nasa.gov/cgi-bin/eps/synopsis.cgi?acqid=150093**

- **Decision to go forward with a Request for Proposals has not been made yet**
  - **If yes,**
    - **Review of RFI responses to scope RFP**
    - **Draft/review/release of RFP**
    - **Proposal evaluation and selection/contracting**
    - **Conduct the case study**



Potential Benefits of the Case Study

Learn what regulations apply as is, *for that particular aircraft*	Provide data to FAA to help validate their database on applicability of current 14 CFR to UAS
Learn what regulations apply with interpretation, *for that particular aircraft*	
Learn what regulations clearly don't apply (exemptions), *for that particular aircraft*	
Learn about "special conditions" needed to handle safety issues that are not covered by existing regulation, *for that particular aircraft*	Provide data to FAA to help determine new regulation that might be needed
Learn about acceptable methods of compliance, *for that particular aircraft*	Provide data to FAA on compliance issues
Learn whether the process itself may benefit from modification	Provide data to FAA to help formulate UAS certification process
Provide an example of a UAS going through initial steps of the airworthiness certification process	Aid UAS industry in learning about airworthiness certification

BACKUP CHARTS

Data “Types”

- Electronic/Avionics UAS data
  - Telemetry data
  - GCS data
  - NAS-oriented data
  - Data from on-board data recorder
- Operations and Incident Data
  - Maintenance Logs
  - Incident/accident reports
  - Mission profile and planning data
- UAS Development Data
  - UAS Test and Certification data
    - Software process data (DO178C)
    - Subsystem and structural …
  - UAS Performance Data
  - UAS aerodynamic models and data

Data Analysis

- Statistical methods/Classification
  - Define classes of UAS
  - Define mission/application classes
  - Support risk analysis
- Risk analysis
  - System risk analysis
  - Safety cases
  - Software risk analysis
- Text mining
  - Incident reports, maintenance logs, operator reports
- Correlation analysis
  - Analyze interrelationship of data from different sources
- Statistical methods/Reliability Analysis
  - Calibrate physical and prognostics models
  - Identify system/component reliability issues
  - Provide information for prognostics and Vehicle Health management (health-based maintenance)