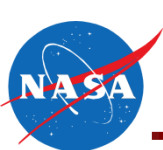




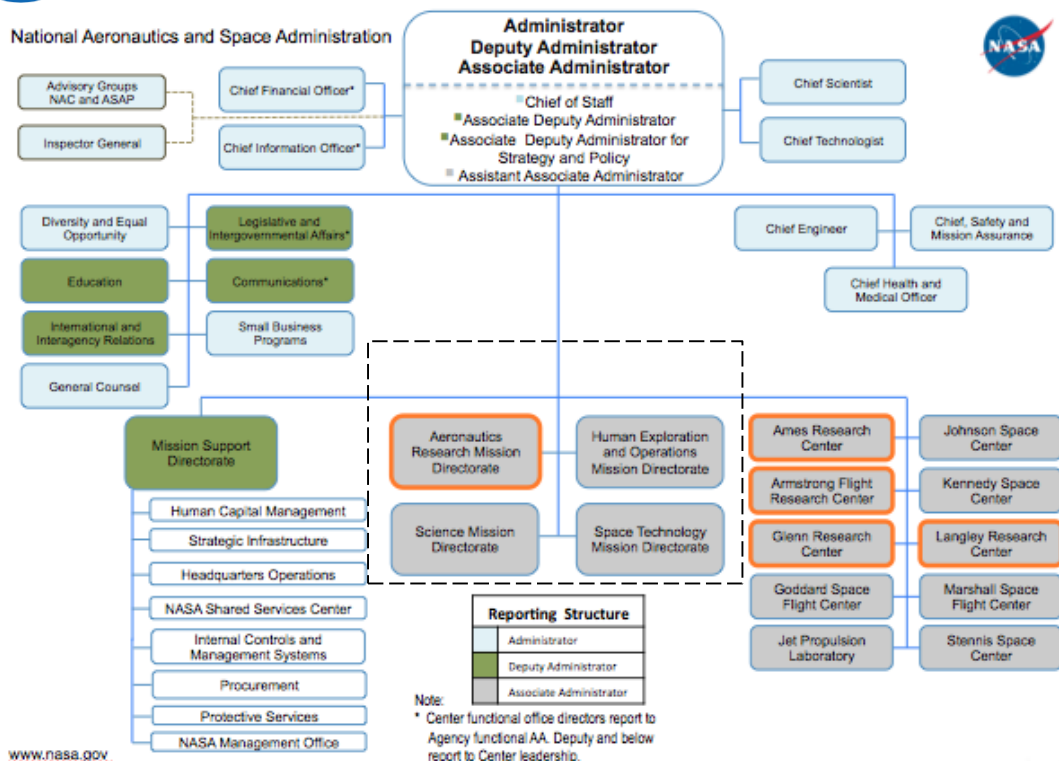
# Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project

TAAC 2016





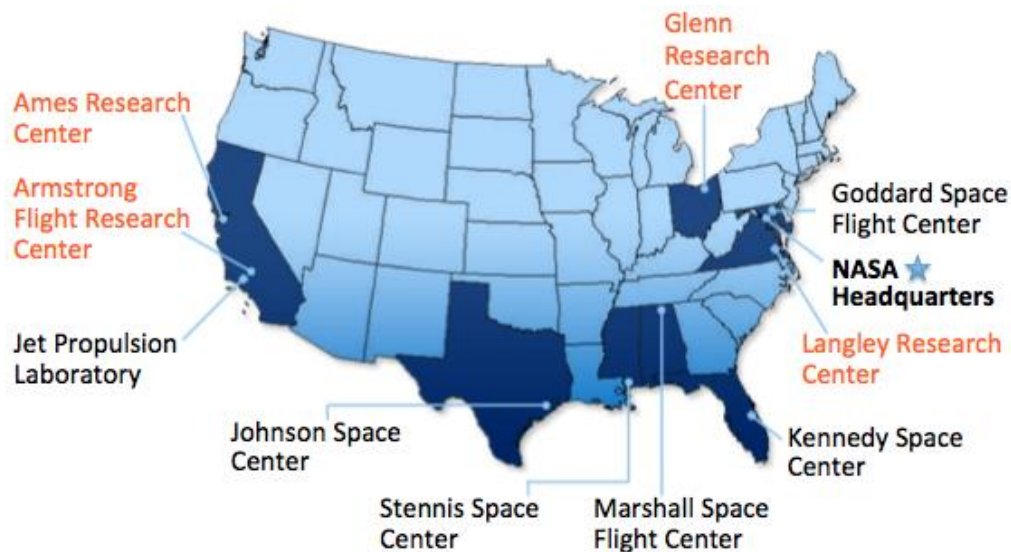
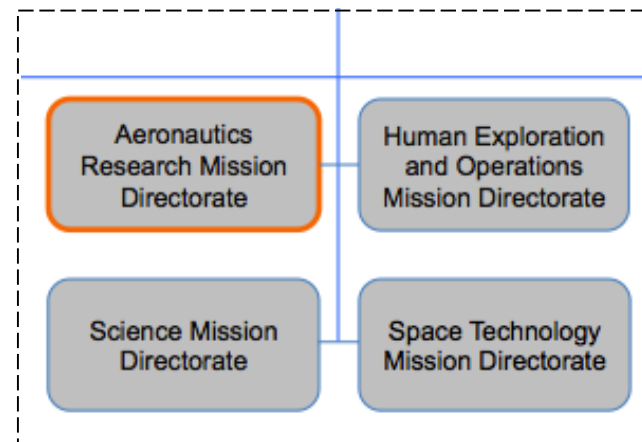
# NASA Organizational Structure

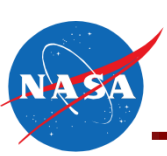


[www.nasa.gov](http://www.nasa.gov)

**Aeronautics Research Centers**

## Mission Directorates





# ARMD Organizational Structure, Programs Overview

MISSION PROGRAMS

Airspace Operations and Safety Program

➔ **AOSP**

- Safe, Efficient Growth in Global Operations**
- Real-Time System-Wide Safety Assurance**
- Assured Autonomy for Aviation Transformation**

Advanced Air Vehicles Program

➔ **AAVP**

- Ultra-Efficient Commercial Vehicles**
- Innovation in Commercial Supersonic Aircraft**
- Transition to Low-Carbon Propulsion**
- Assured Autonomy for Aviation Transformation**

Integrated Aviation Systems Program

➔ **IASP**

- Flight research-oriented, integrated, system-level R&T that supports all six thrusts**
- X-planes/ test environment**

## IASP Projects

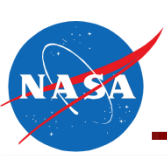
- UAS-NAS
- Environmentally Responsible Aviation (ERA)
- Flight Demonstrations & Capabilities (FDC)

SEEDLING PROGRAM

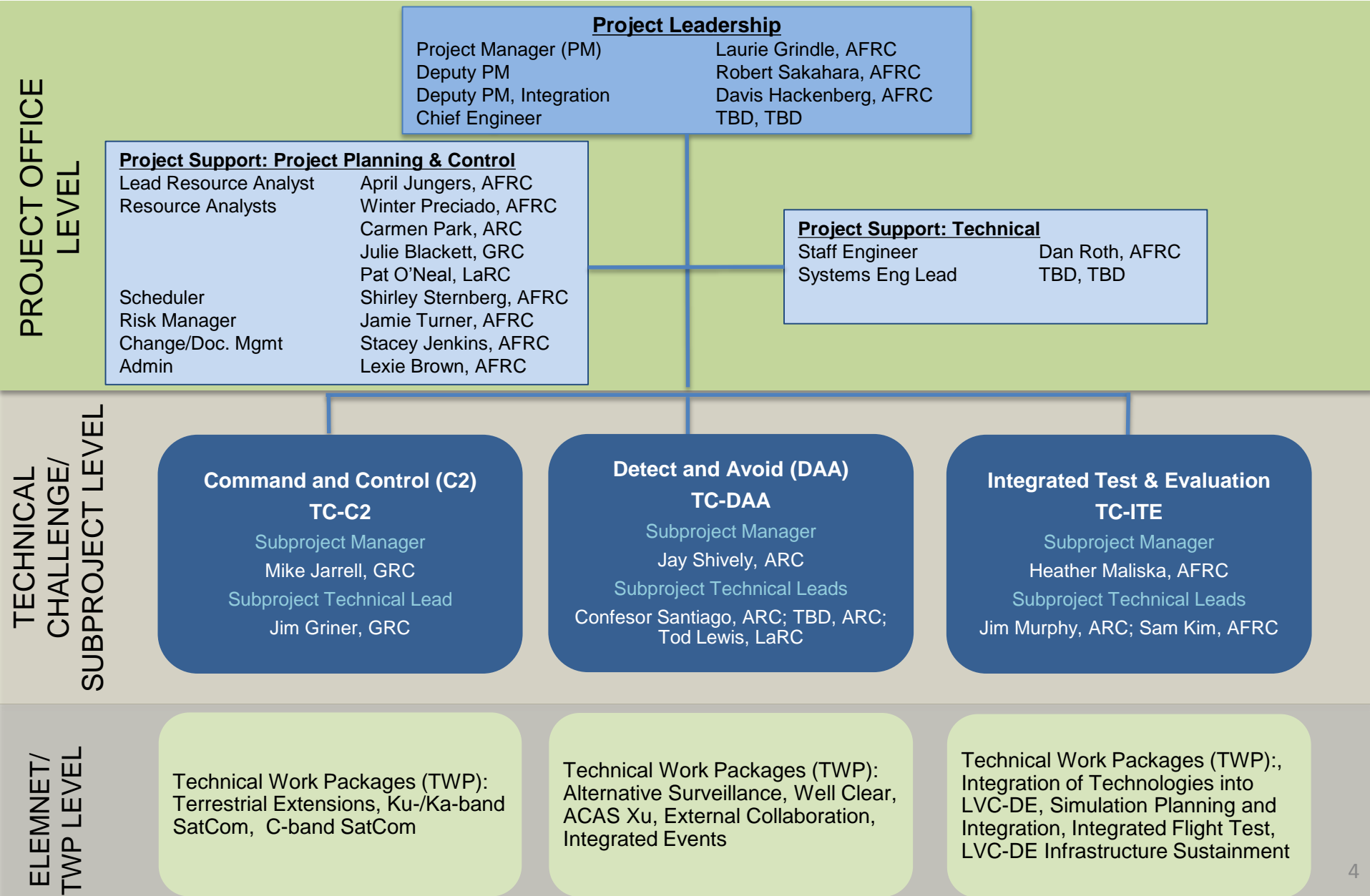
Transformative Aeronautics Concepts Program

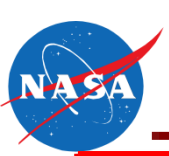
➔ **TACP**

- High-risk, leap-frog ideas that support all six thrusts**
- Critical cross-cutting tool development**

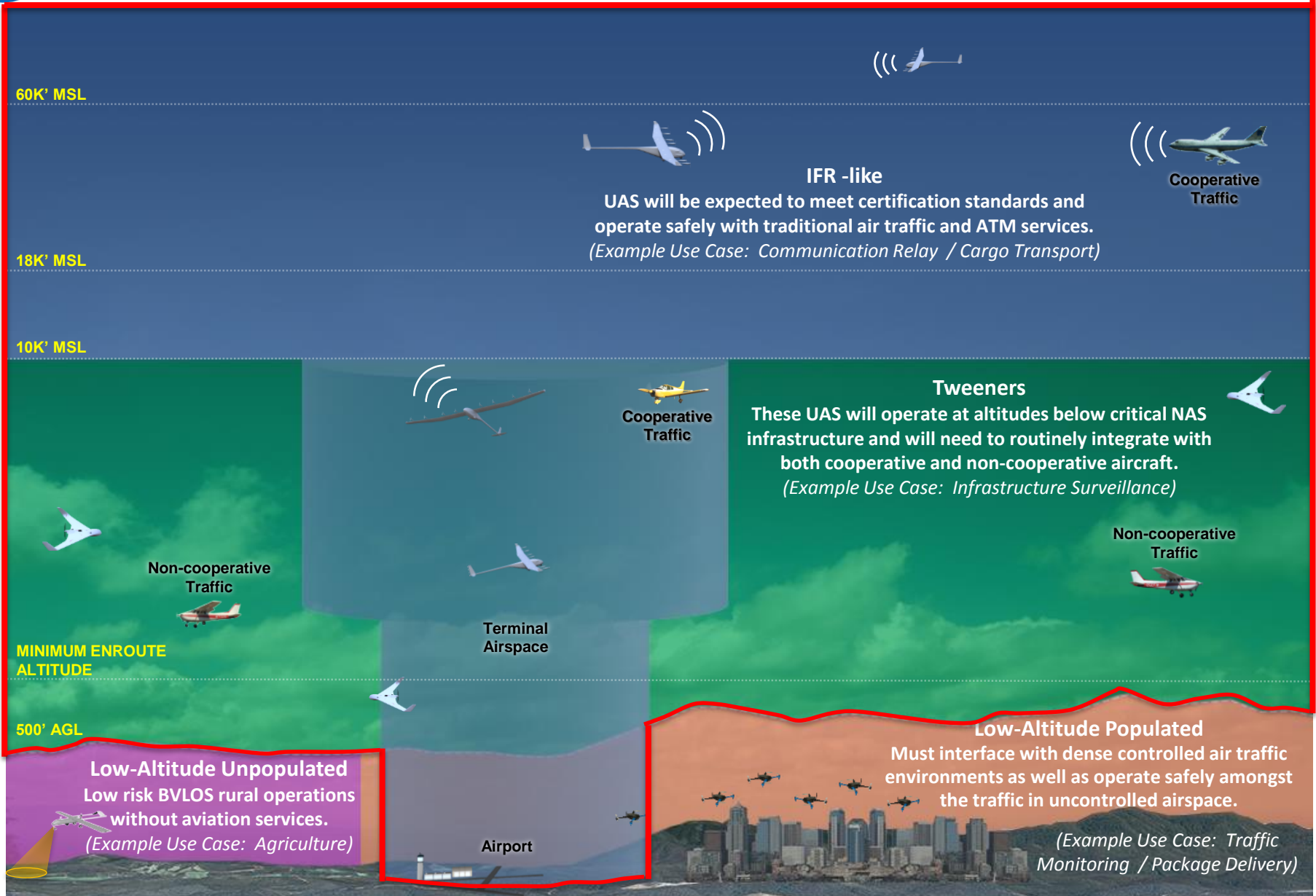


# UAS-NAS Phase 2 Project Organization Structure





# Emerging Commercial UAS Operational Environments (OE)





# Command and Control (C2) Performance Standard Operational Environments (OE)

**Legend**  
Current Research Areas (FY14- FY16)  
Proposed Research Areas (FY17 – FY20)

60K' MSL

**SATCOM  
C2 Data Link**

18K' MSL

10K' MSL

500' AGL

**Terrestrial  
C2 Data Link**

**Terrestrial  
C2 Data Link  
Network**

CNPC  
Ground  
Stations

CNPC  
Network

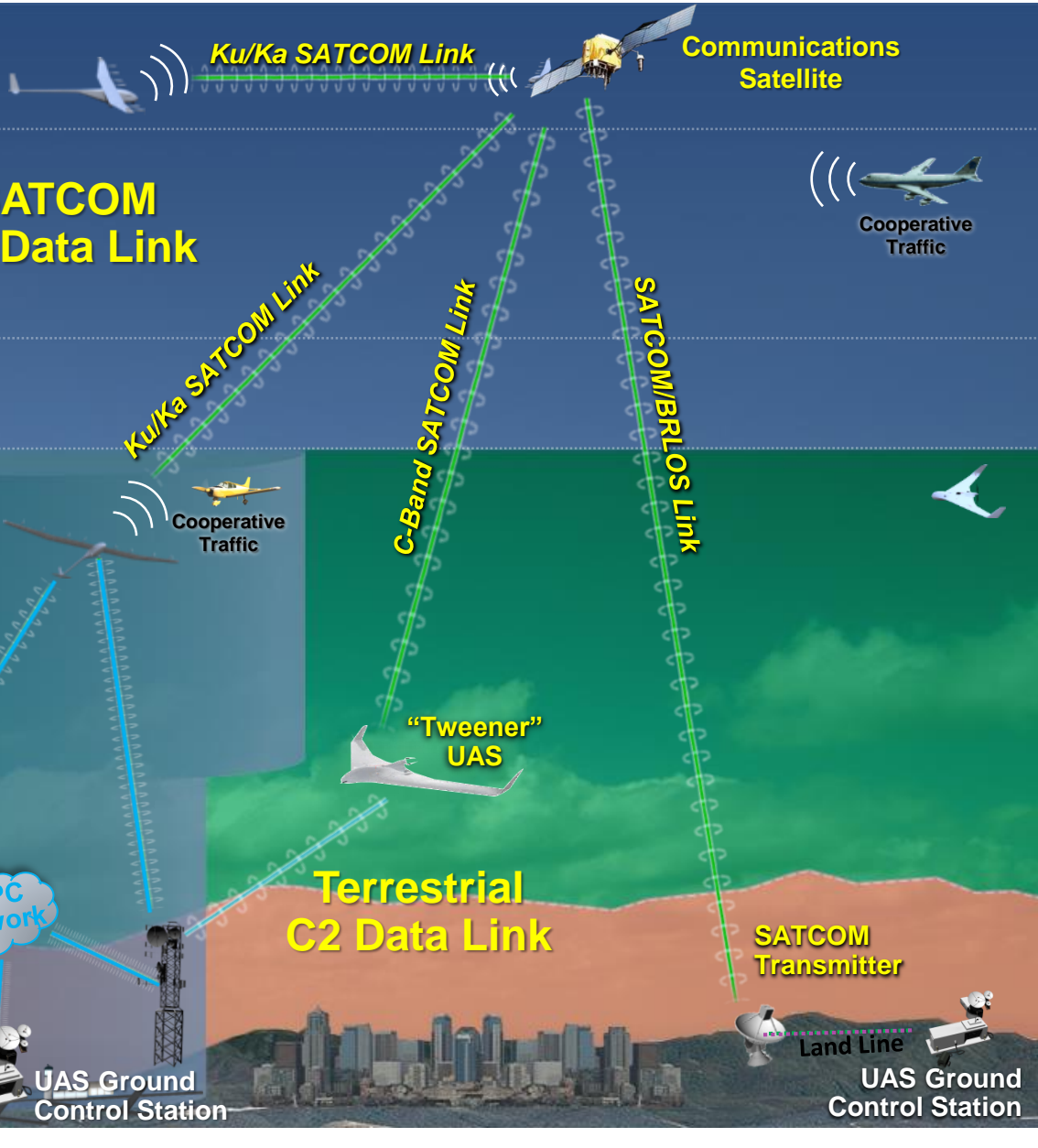
UAS Ground  
Control Station

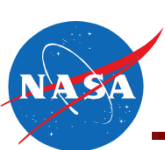
**Terrestrial  
C2 Data Link**

SATCOM  
Transmitter

Land Line

UAS Ground  
Control Station



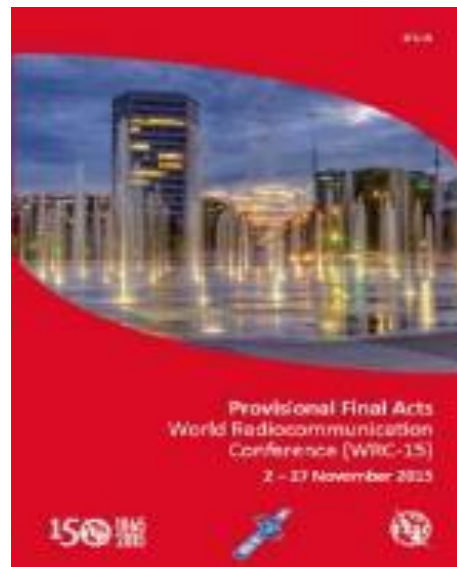


# Recent Accomplishments: C2 Phase 1 MOPS

## Spectrum Compatibility Analysis

Objective: Develop data and rationale to obtain appropriate frequency spectrum allocations to enable the safe and efficient operation of UAS in the NAS

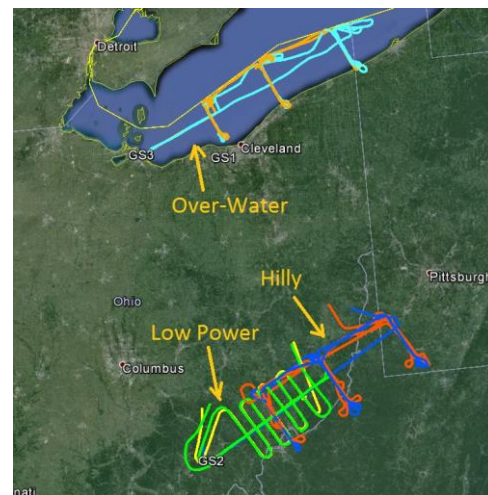
Accomplishment: NASA conducted sharing study results delivered at the 2015 World Radiocommunication Conference (WRC-15) to support Ku & Ka Band frequency Allocations

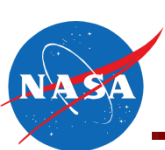


## Verify and Validate C2 MOPS Requirements

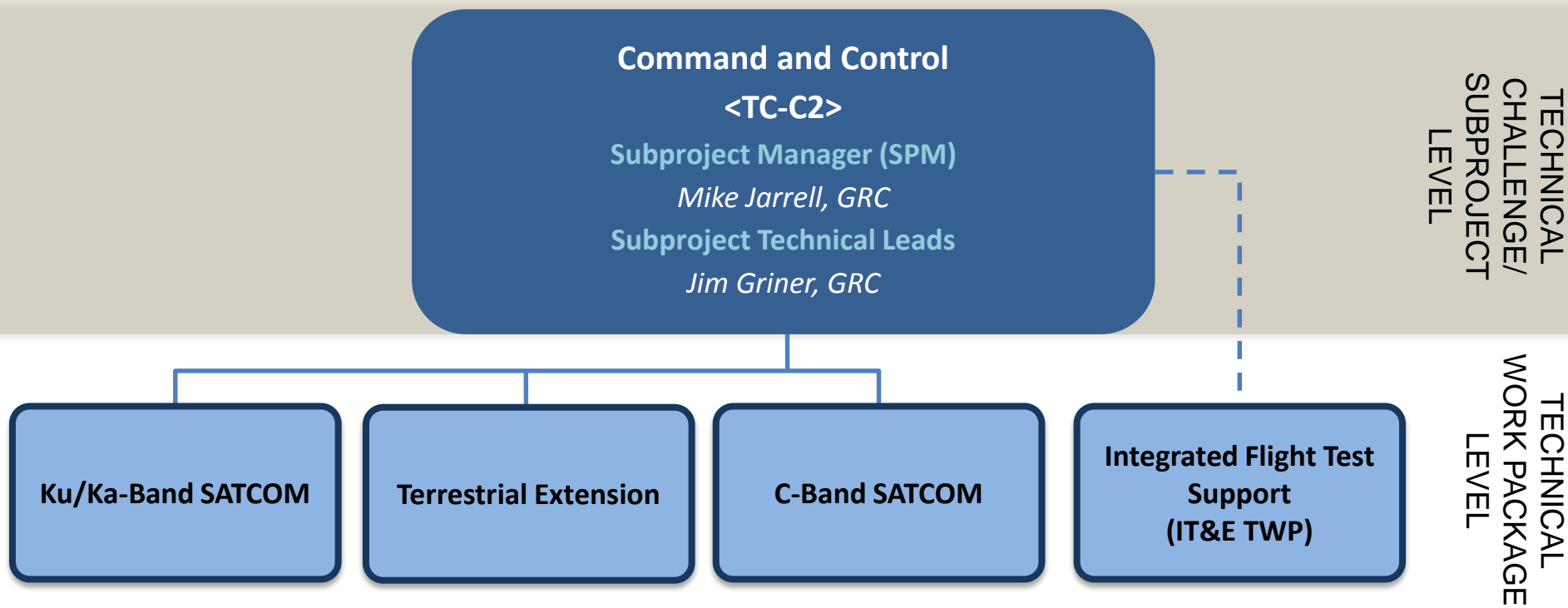
Objective: Analyze the performance of fifth generation Control and Non-Payload Communication System (CNPC) prototypes

Accomplishment: Utilized Gen-5 radios at three CNPC ground stations and onboard GRC S-3B aircraft in order to collect data for performance in two relevant environments

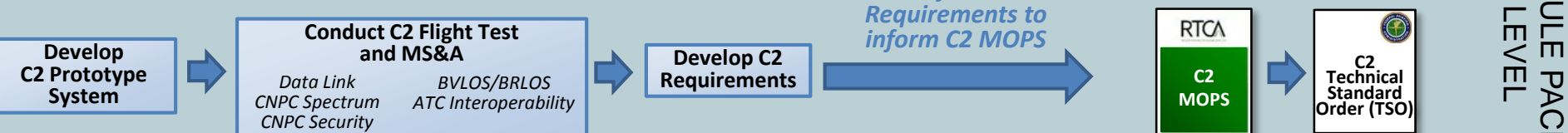




# C2 Subproject Structure for Project Phase 2



## C2 Performance Standards

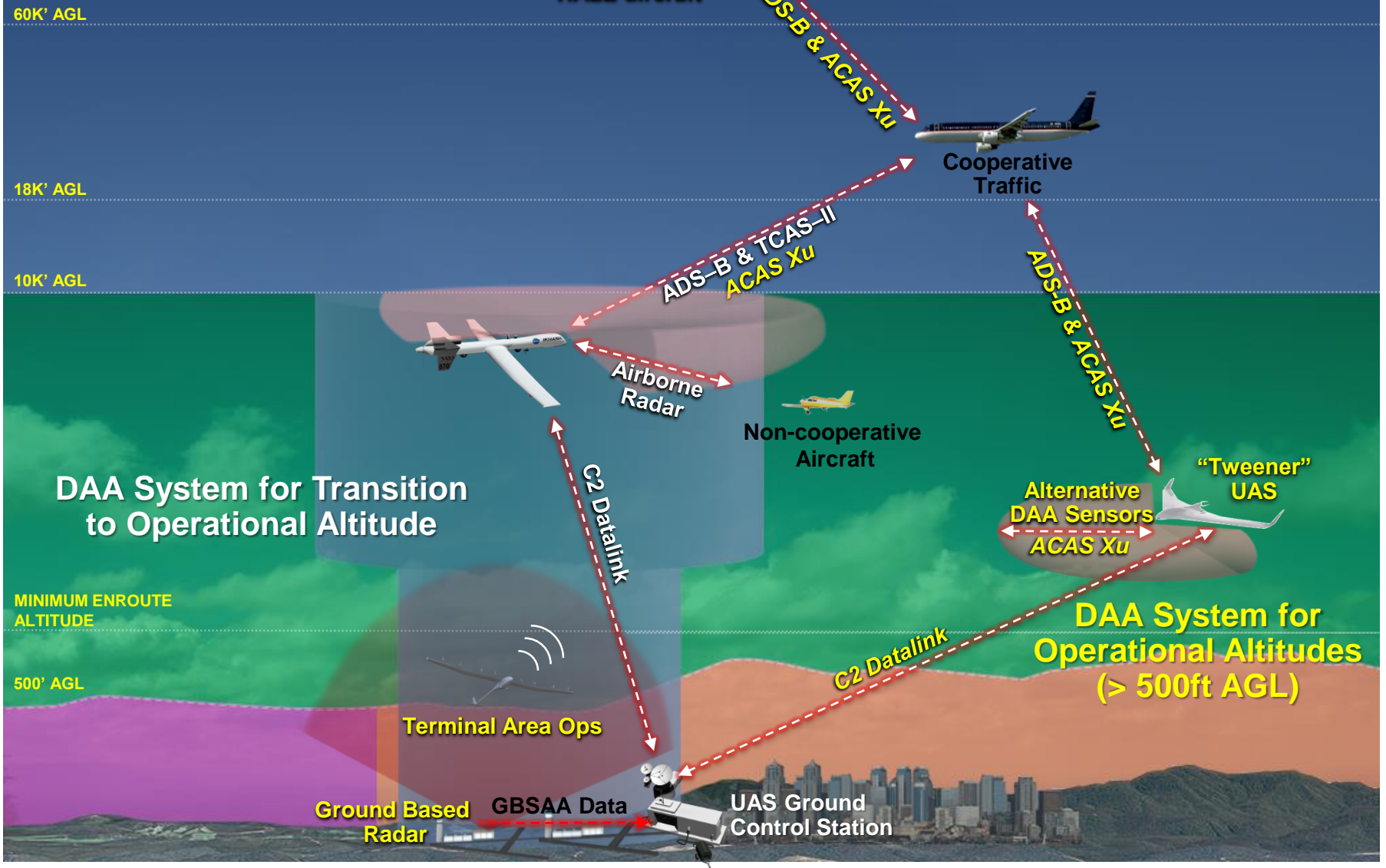


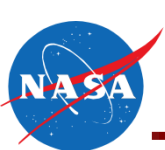




# Detect and Avoid (DAA) Performance Standard Operational Environments (OE)

**Legend**  
 Current Research Areas (FY14- FY16)  
 Proposed Research Areas (FY17 – FY20)



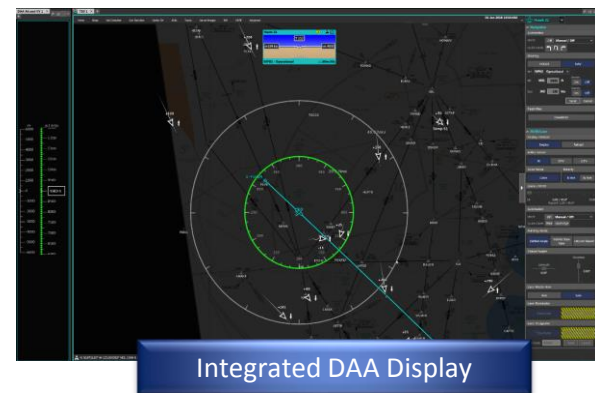


# Recent Accomplishments: DAA Phase 1 MOPS

## Human Systems Integration “Part Task 6”

Objective: Conduct final V&V activity in support of the SC-228 DAA human machine interface requirements for displays, alerting, and guidance

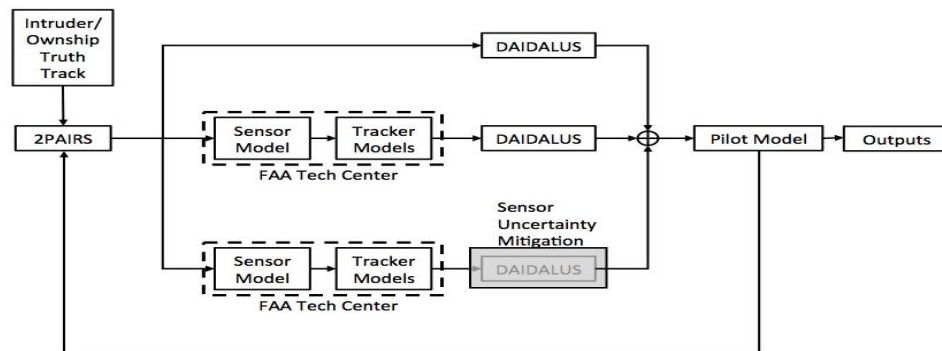
Accomplishment: Verified pilot performance against minimum requirements, re-evaluated performance differences between a standalone and integrated DAA displays

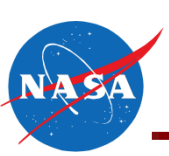


## DAA End to End V&V

Objective: Verify and Validate (V&V) a MOPS-representative Detect and Avoid (DAA) system in an End-to-End simulation environment representative of the MOPS

Accomplishment: Final closed-loop, pilot (model)-in-the-loop, end-to-end simulation evaluation of MOPS leveraging encounter sets from MOPS test cases & MIT/LL NAS encounter model





# Recent Accomplishments: DAA Phase 1 MOPS

## Integrated Test and Evaluation FT4

Objective:

- Conduct Flight Test Series 4 integrating the latest SSI algorithms, HSI displays, and active test aircraft sensors using the Live, Virtual, Constructive test environment
- Document the performance of the test infrastructure in meeting the flight test requirements

Accomplishment: FT4 successfully completed on 6/30/2016

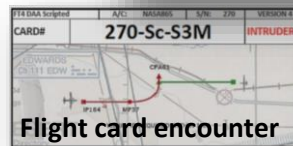
- 2 system checkout and 19 data collection flight tests
- 11 weeks (April 12 - June 30)
- 321 air-to-air encounters



LVC



FT4 Flight Assets

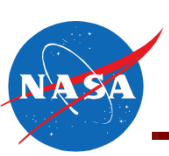


Scripted Encounters



Flight Test Execution

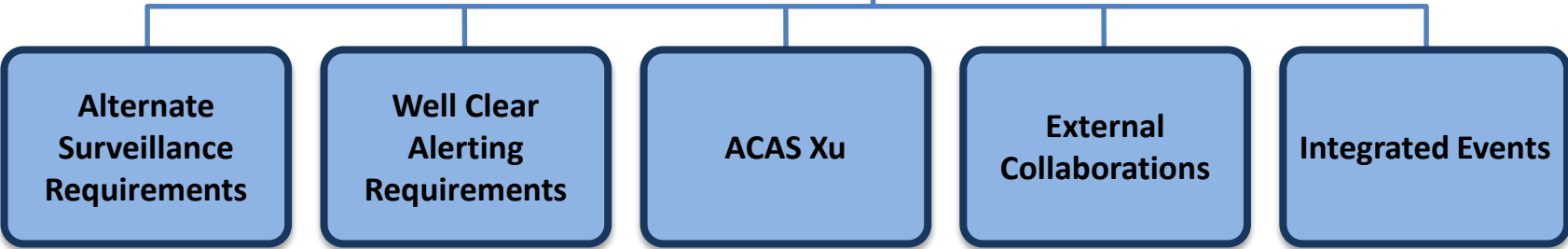
Final DAA MOPS scheduled to be released through RTCA in December 2016



# DAA Subproject Structure for Project Phase 2

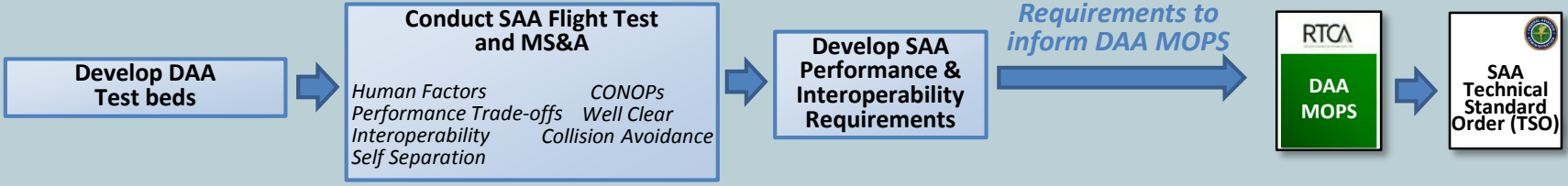
**Detect and Avoid**  
**<TC-DAA>**  
Subproject Manager (SPM)  
*Jay Shively, ARC*  
Subproject Technical Leads  
*Confesor Santiago, ARC, Tod Lewis, LaRC, TBD, ARC*

TECHNICAL CHALLENGE/  
SUBPROJECT LEVEL

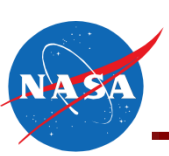


TECHNICAL WORK PACKAGE LEVEL

## SAA Performance Standards



SCHEDULE PACKAGE LEVEL



# IT&E Subproject Structure for Project Phase 2

TECHNICAL CHALLENGE/  
SUBPROJECT LEVEL

**Integrated Test & Evaluation**  
 <TC-ITE>  
 Subproject Manager (SPM)  
*Heather Maliska, AFRC*  
 Subproject Technical Leads  
*Sam Kim, AFRC, Jim Murphy, ARC*

**Integration of Technologies into LVC-DE**

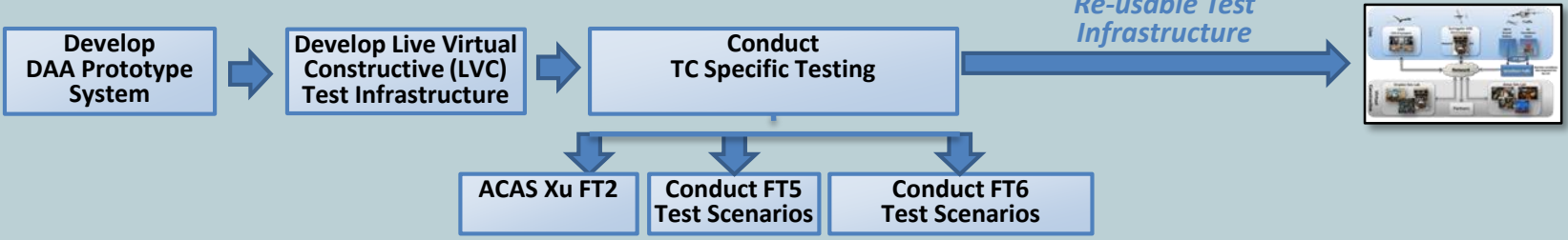
**Simulation Planning & Integration**

**LVC-DE Infrastructure Sustainment**

**Integrated Flight Test**

TECHNICAL WORK PACKAGE LEVEL

## Integrated Test & Evaluation



SCHEDULE PACKAGE LEVEL