National Aeronautics and Space Administration

NASA UAS Integration in the NAS Project

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UAS Integration in the NAS Project
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ICAP UAS Subcommittee
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Briefing Outline

- NASA ARMD Research
- NASA Project Organizational Chart
- Project Overview
- Project Technical Challenges and Technical Work Packages
- Capabilities Overview
- Integrated Test Overview

Aeronautics Mega-Drivers and R&T Thrusts

Mega-Drivers

Strategic Research & Technology Thrusts

Safe, Efficient Growth in Global Operations
- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
- Achieve a low-boom standard

Ultra-Efficient Commercial Transports
- Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

Real-Time System-Wide Safety Assurance
- Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
- Develop high impact aviation autonomy applications

NASA Aeronautics Portfolio in FY2013

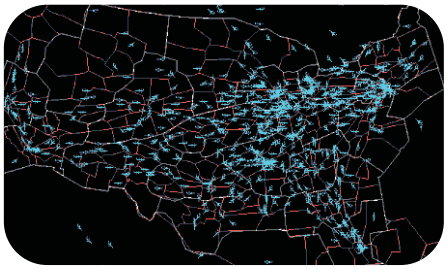


Fundamental Aeronautics Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Integrated Systems Research Program

Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment

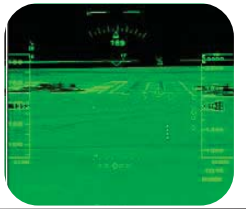



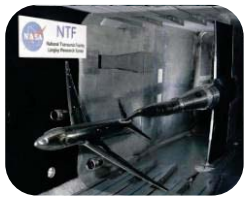
Airspace Systems Program

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.


Aviation Safety Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.

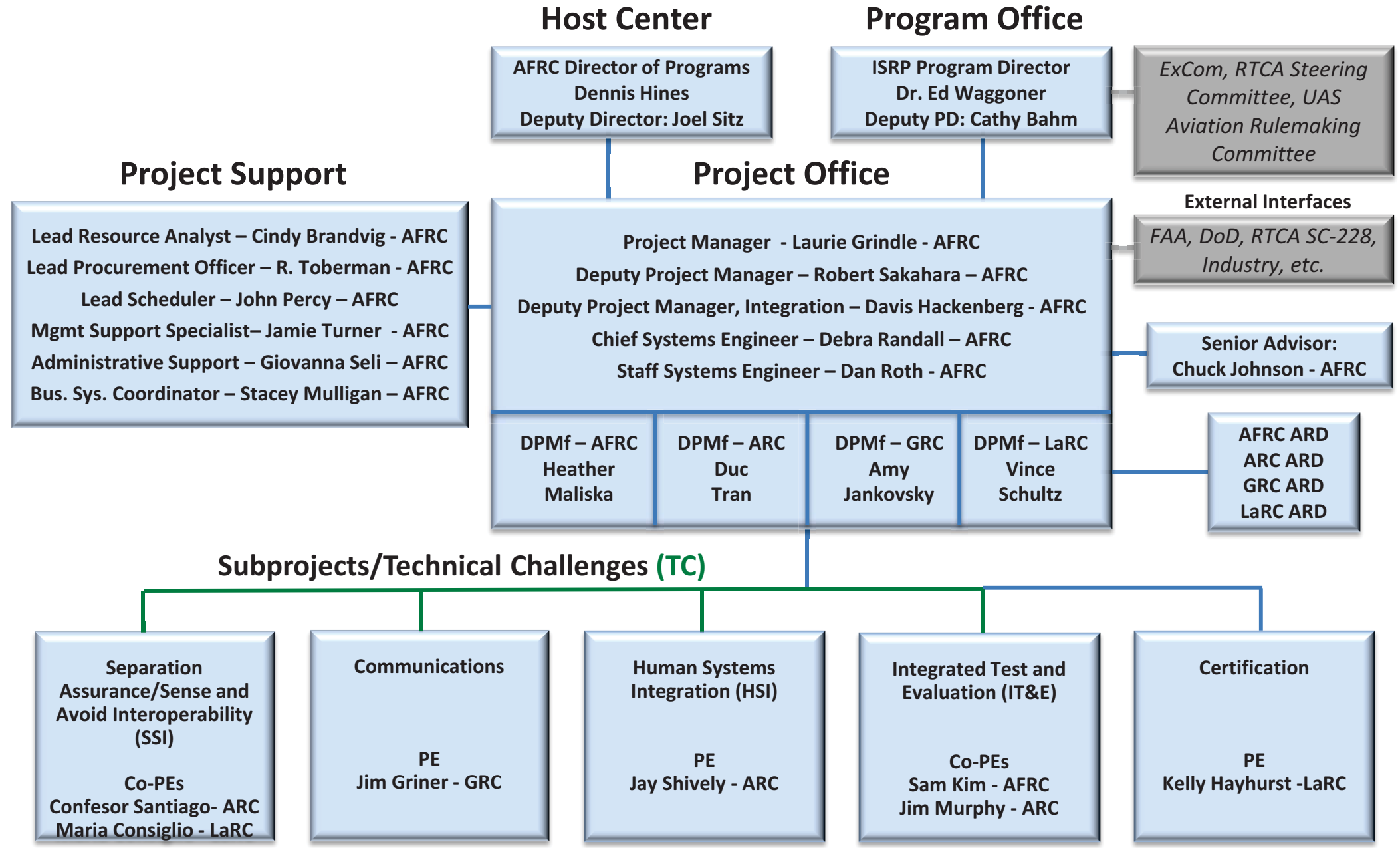



Aeronautics Test Program

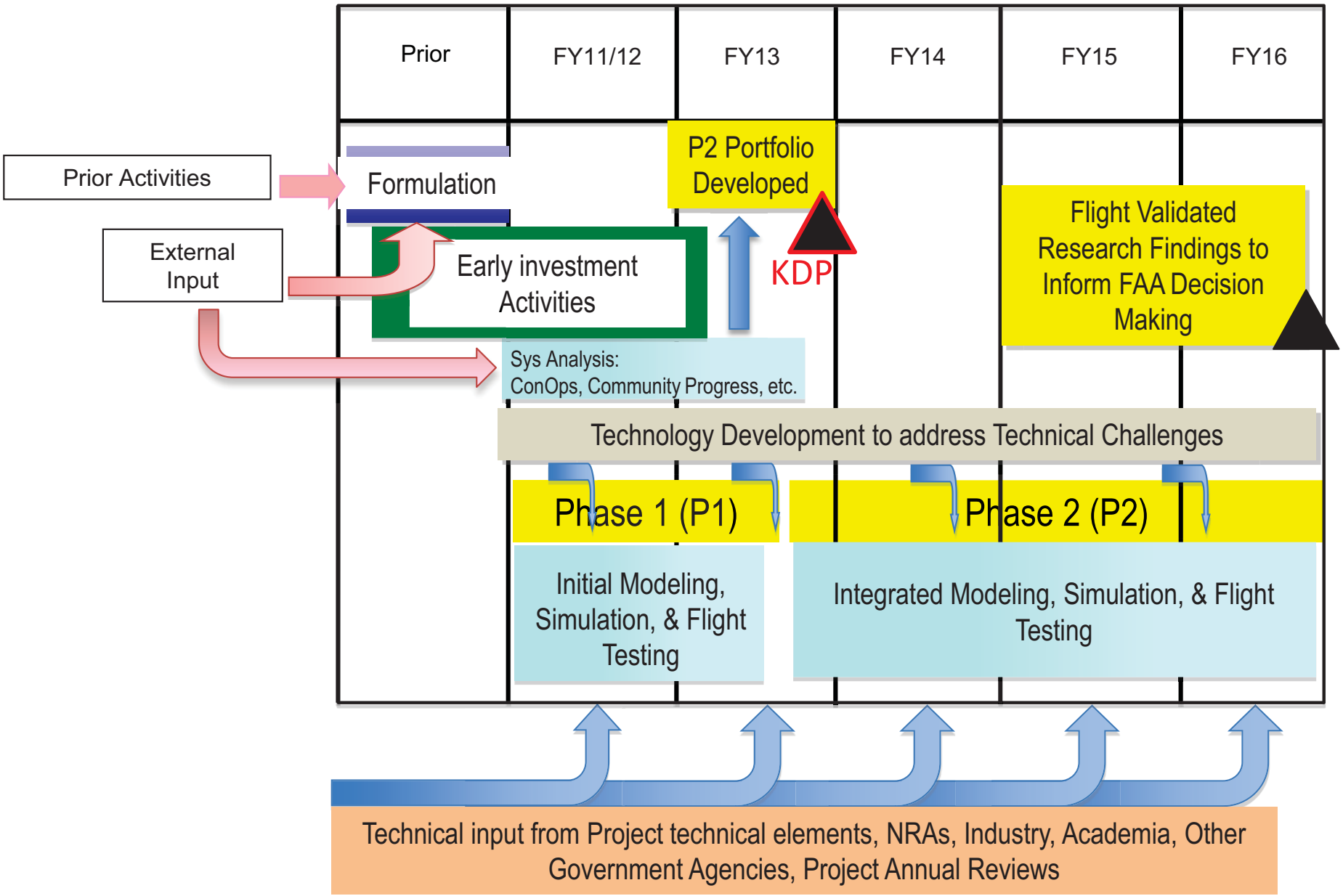
Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.

UAS Integration in the NAS Organizational Structure



PE: Project Engineer, DPMf: Deputy Project Manager for

KDP (Phase 1/Phase 2 Transition)

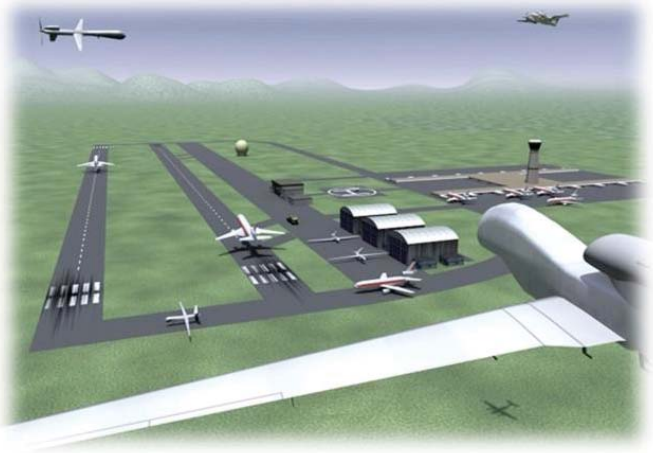


UAS-NAS Project Formulation

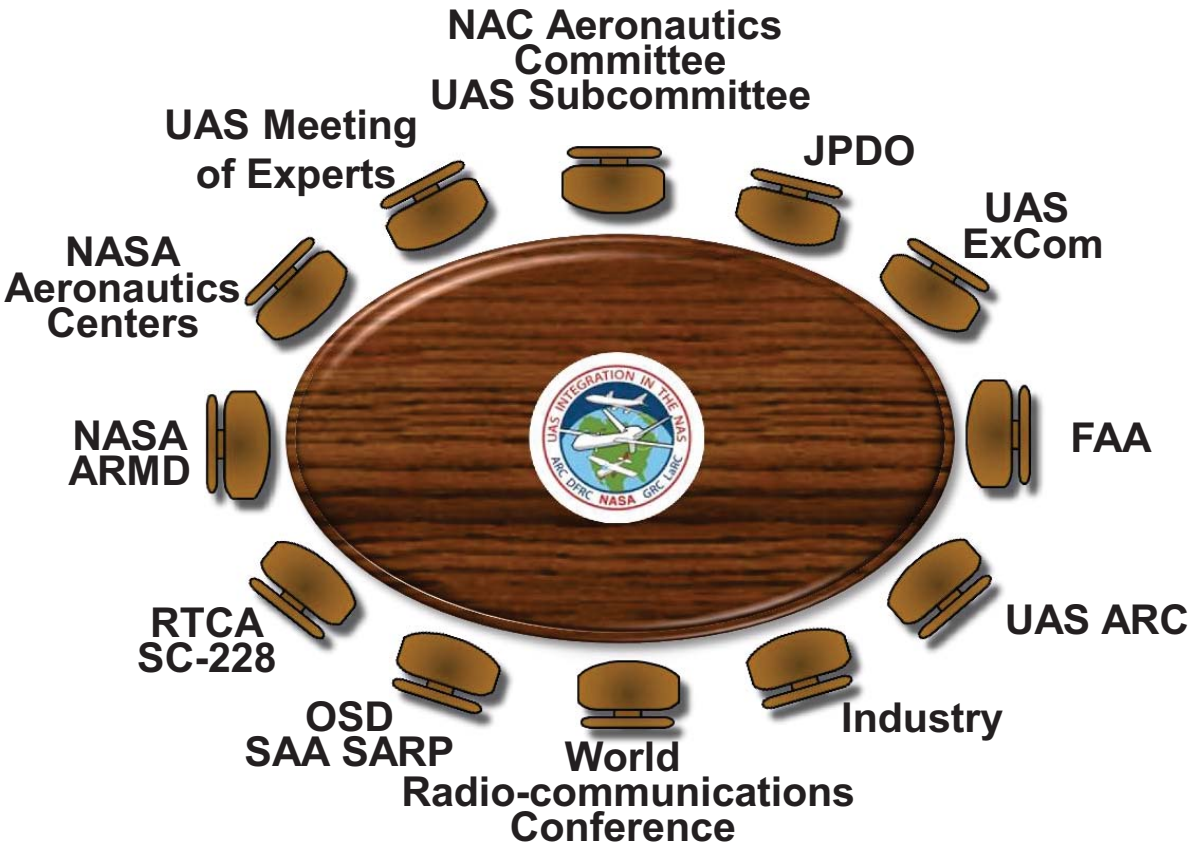
Key Stakeholders and Influencing Factors

Project Focus:

Unencumbered NAS Access for Civil / Commercial UAS



Key Stakeholders & Influencing Factors



The NASA UAS-NAS Project is influenced by several key stakeholders within the UAS Community which helped guide it's formulation

Project Characteristics

Phase 2 of the UAS-NAS Project has some fundamental characteristics of note

- The Technology Development outputs are primarily research findings (validated data, algorithms, and recommendations) which contribute to an outcome of the elimination or reduction of barriers to NAS access
  - Project timeframe for impact is 2015 - 2025

- The UAS-NAS Project is operating in an ever-changing environment and must remain agile and adapt as the customer/community needs change
  - While the base of what the Project is planning to deliver doesn't change, the specifics of the final products may change to better meet the community need

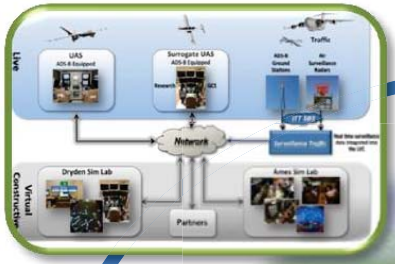
Project Goal, Research Themes, & Technical Challenges

Goal: Provide research findings to reduce technical barriers associated with integrating Unmanned Aircraft Systems into the National Airspace System utilizing integrated system level tests in a relevant environment

Research Theme 1: UAS Integration - Airspace integration procedures and performance standards to enable UAS integration in the air transportation system

Research Theme 2: Test Infrastructure - Test infrastructure to enable development and validation of airspace integration procedures and performance standards

TC-ITE: Integrated Test & Evaluation



TC-SAA: SAA Performance Standards

TC-HSI: Human Systems Integration

TC-C2: C2 Performance Standards

UAS Integration in the NAS Project

Value Proposition Flow Diagram

NASA UAS-NAS Project Activities

TC1 SAA Performance Standards

- Develop SAA Performance Testbed
- Develop SAA Interoperability Testbed
- Conduct SAA Flight Test and MS&A
  - *Perf. Trade-offs*
  - *Interoperability*
  - *Self Separation*
  - *CONOPs*
  - *Well Clear*
  - *Coll. Avoid.*
- Develop SAA Performance & Interoperability Requirements

TC2 C2 Performance Standards

- Develop C2 Prototype System
- Conduct C2 Flight Test and MS&A
  - *Data Link*
  - *CNPC Spectrum*
  - *CNPC Security*
  - *LOS*
  - *BLOS*
  - *ATC Interop.*
- Develop C2 Requirements

TC3 Human Systems Integration

- Develop Prototype GCS
- Conduct Human Factors (HF) Flight Test and MS&A
  - *Conting. Mngmt*
  - *Pilot Response*
  - *Autonomy*
  - *SAA*
  - *C2*
  - *Displays*
- Develop HF Guidelines for SAA, C2 & GCS

TC6 Integrated Test & Evaluation

- Develop LVC Test Infrastructure
- Conduct IHITL Testing
- Conduct FT3 Test Scenarios
- Conduct FT4 Test Scenarios & Mission Based Flight Activity

Certification & Safety

- Analyze Classification Factors for UAS
- Conduct Restricted Category Study
- Analyze Case Study Results

Key Products

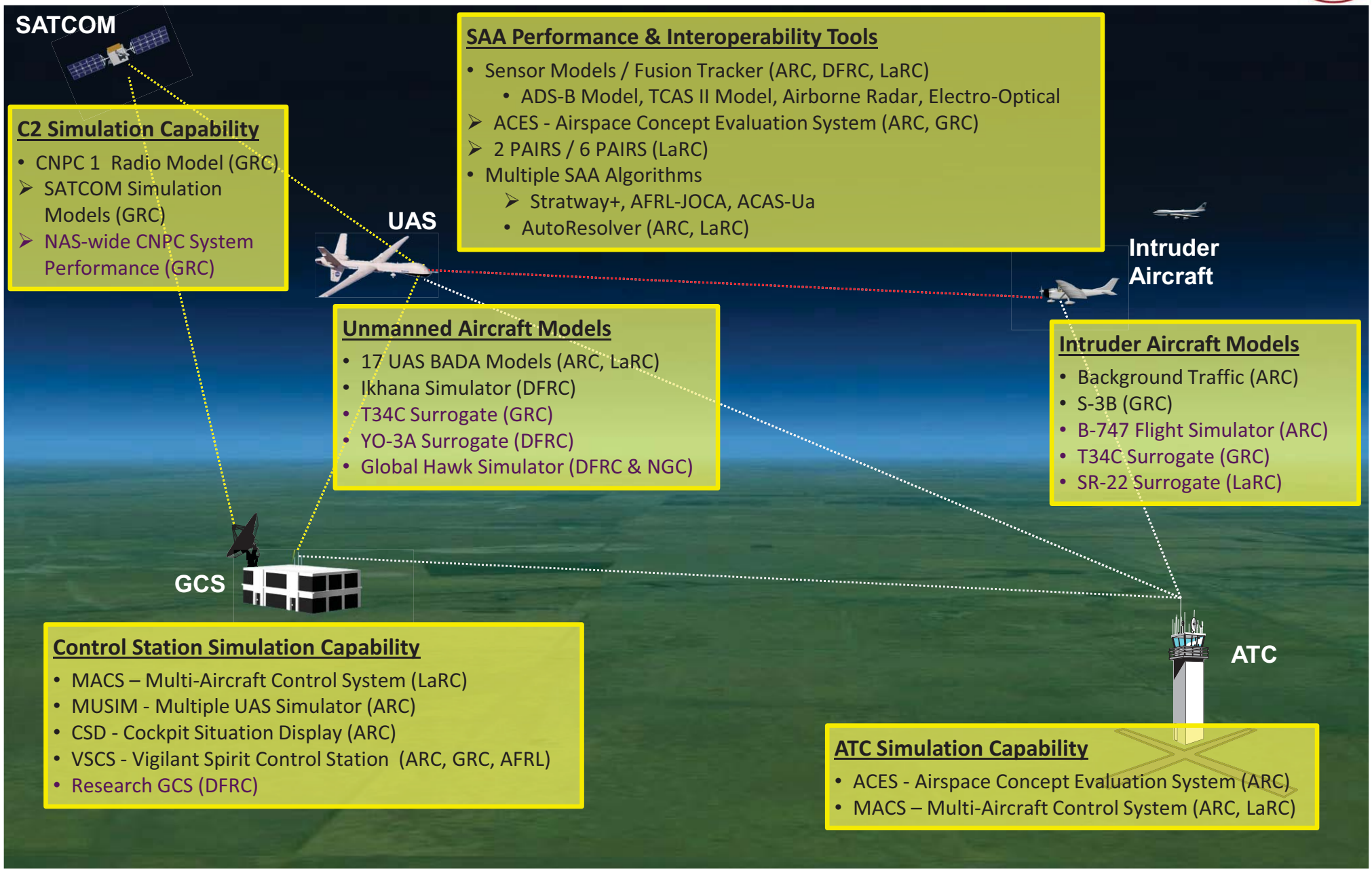
- *SAA Performance Requirements to inform DAA MOPS*
- *C2 Performance Requirements to inform C2 MOPS*
- *SC-228 GCS & HF Whitepapers*
- *Re-usable Test Infrastructure*
- *Test Data to support SAA & C2 Standards Devlpmt*
- *Safety Substantiation Final Report & Safety Metrics Data*

Resultant Outcomes

- RTCA DAA MOPS → SAA Technical Standard Order (TSO)
- RTCA C2 MOPS → C2 Technical Standard Order (TSO)
- RTCA DAA MOPS, RTCA C2 MOPS → SAA Technical Standard Order (TSO), C2 Technical Standard Order (TSO)

- RTCA DAA MOPS, RTCA C2 MOPS → SAA Technical Standard Order (TSO), C2 Technical Standard Order (TSO)

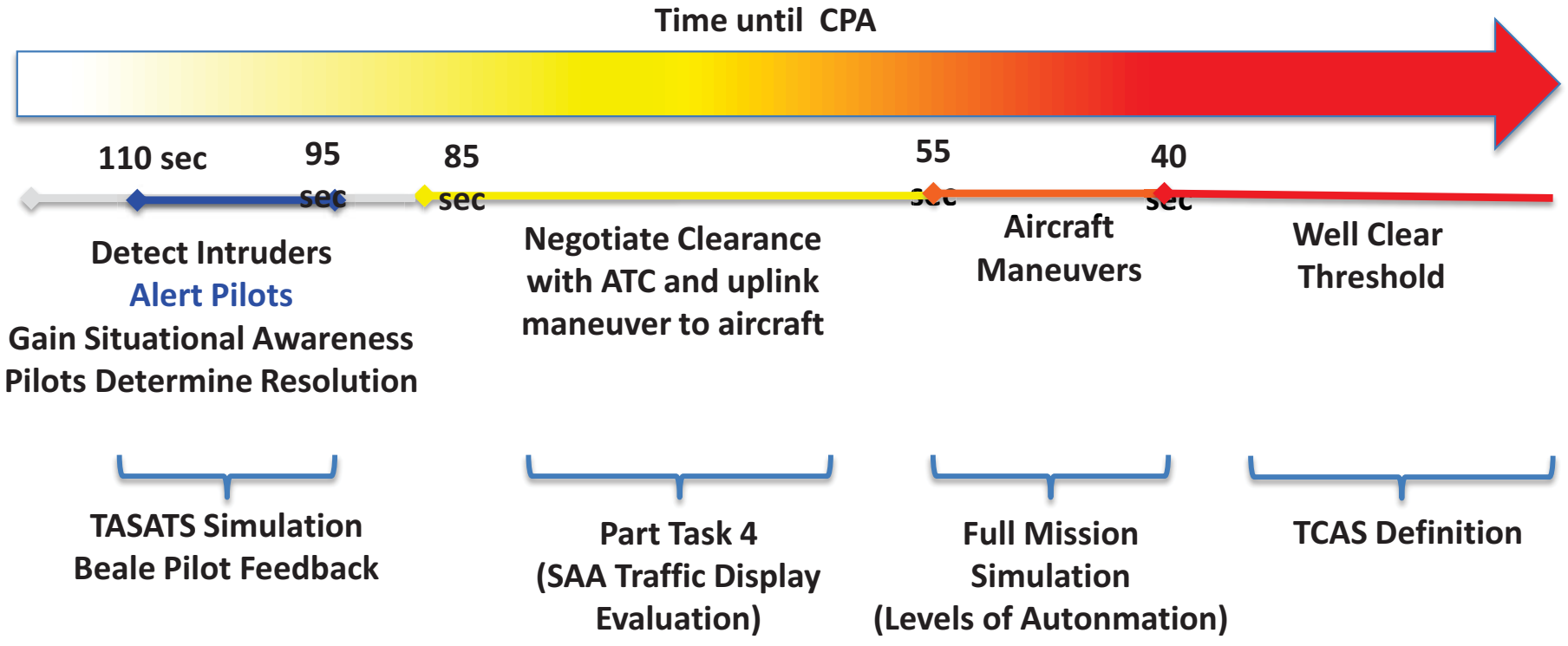
UAS-NAS Modeling & Simulation Tools and Capabilities Phase 2



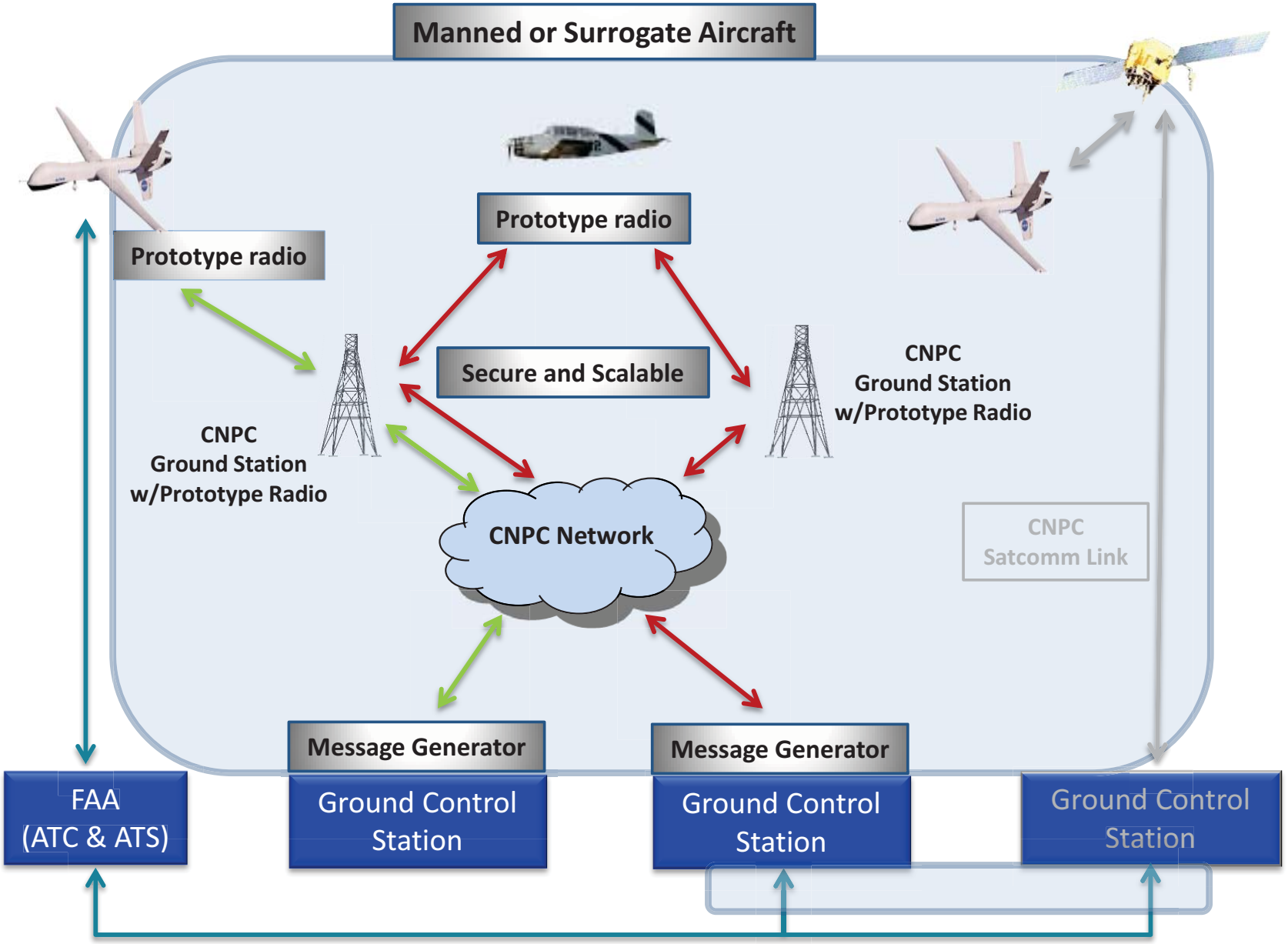
Legend: Also Used in Phase 1 = Black text, New for Phase 2 = Purple text ➢ Tools/Capabilities not integrated into LVC

Note: All acronyms are defined in the Notes Page

Self-Separation Timeline



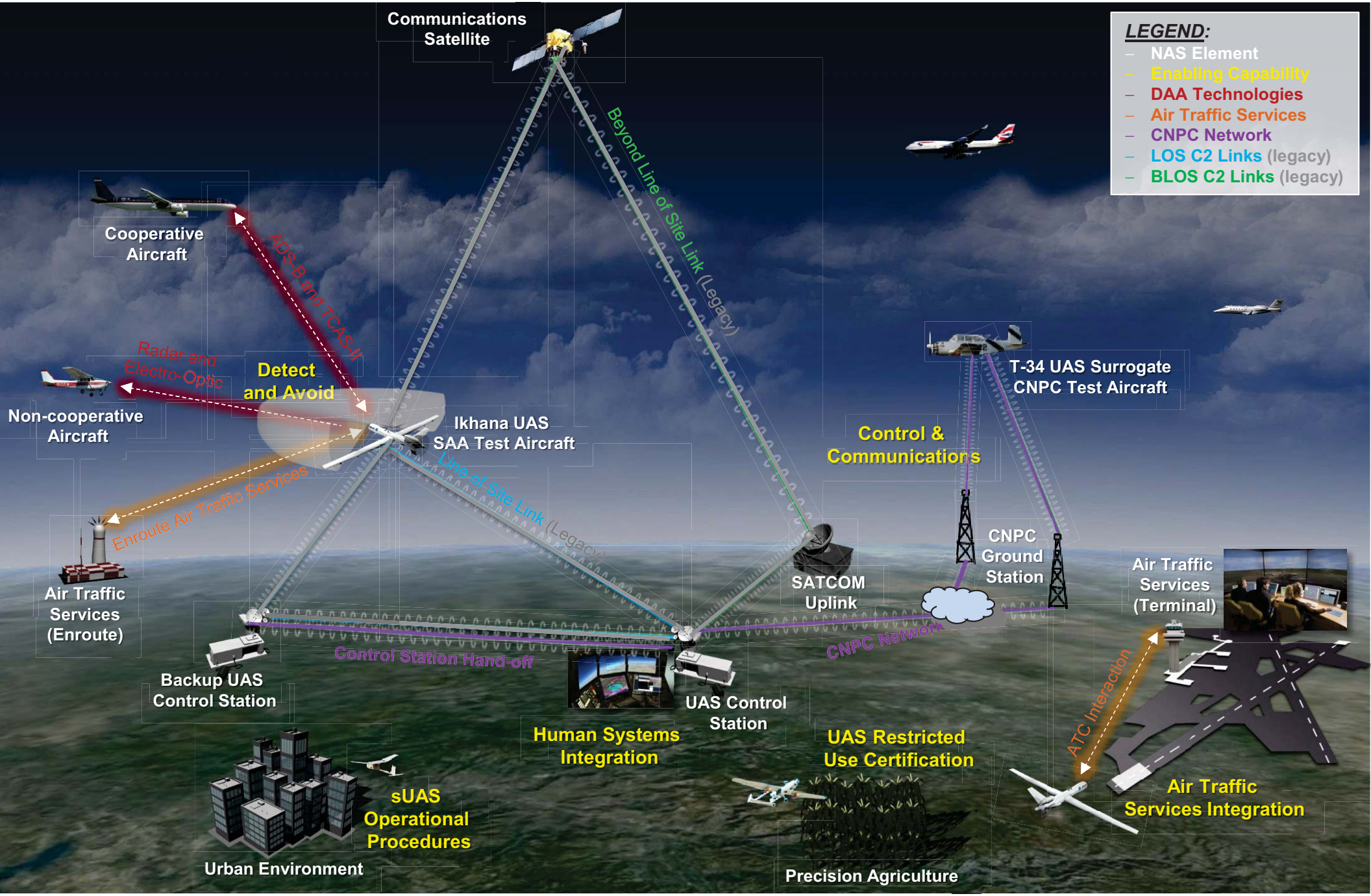
Communication Subproject Focus



Possible Future ATC and ATS Ground Connectivity

NASA UAS NAS Project OV-1

Validated through Integrated Test



2015, 2016 Flight Test (i.e. FT3, FT4)

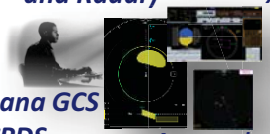
Live Ownship

DFRC Ikhana

OR

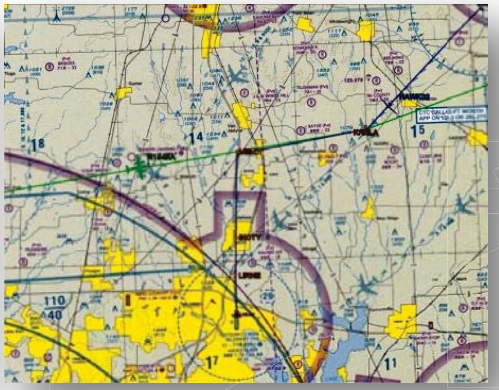
GRC S-3B

Ikhana Data Link
- *C2*
- *Voice*
- *Health & Status*
- *Video*
- *Traffic (ADS-B and Radar)*



Ikhana GCS
- *CPDS*
- *Stratway+*
- *Autoresolver*

CNPC Data Link
- *C2*
- *Voice*
- *Health & Status*
- *Video*
- *Traffic (ADS-B and Radar)*



Need Common Airspace

Virtual/Constructive Intruders

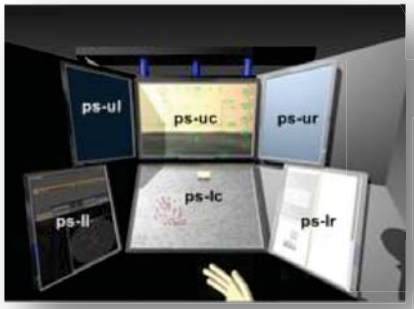
Honeywell King Air
- *ADS-B*
- *TCAS II Instm*
- *High speed*

ADS-B Out

GRC T-34C
- *ADS-B*
- *2nd CNPC*
- *SAA*

CNPC Data Link
- *C2*
- *Voice*
- *Health & Status*
- *Video*
- *Traffic (ADS-B)*

UAS Pilot as Subject



Research GCS

Stratway+

Autoresolver

Displays of Proximal Traffic SAA/DAA Algorithms

VPN

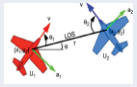
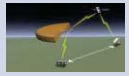
Distributed Environment/Connectivity

ATC as Subject

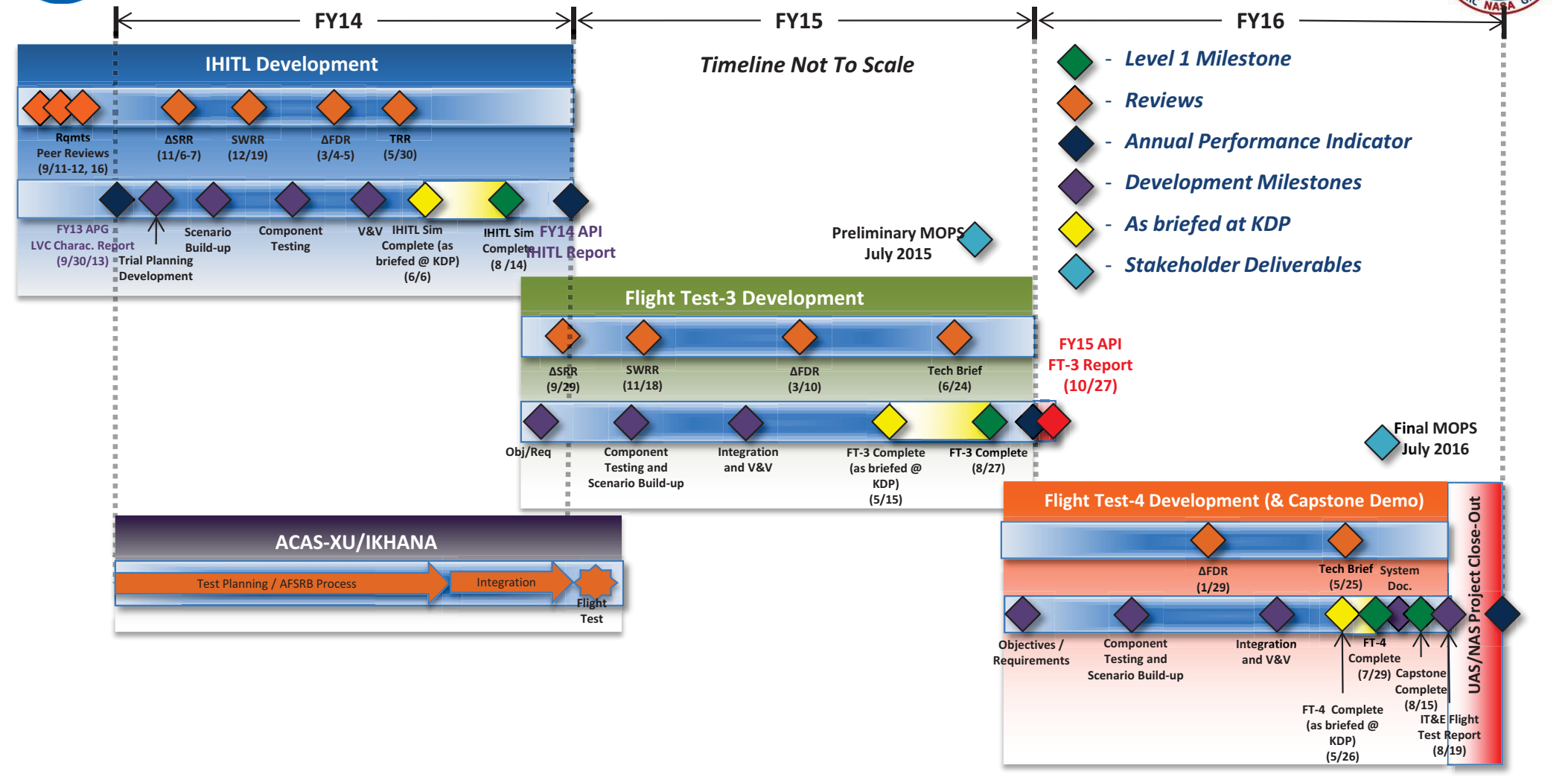
Pseudo Pilots

Multi-Aircraft Control System

Integrated Test Progression

Test Element	IHITL [FY14]	FT3 [FY15]	FT4 [FY16]
GCS 	• Research Ground Control Station (RGCS) with traffic displays and alerting logic	• RGCS with UAS Surrogate (T-34C) Command and Control	• RGCS with UAS Surrogate (T-34C) C2 • Multiple GCSs
SAA Algorithms 	• Self separation, idealized sensor data	• Multiple SAA algorithms • Collision avoidance on UAS and surrogate	• Multiple SAA algorithms • Collision avoidance on UAS and surrogate
UAS 	• Simulated	• UAS Surrogate (T-34C) • SAA equipped UAS	• UAS Surrogate (T-34C) • SAA equipped UAS
Sensor 	• Simulated	• On board SAA	• On board SAA • Possible SAA on surrogate aircraft
Surveillance 	• Modeled mixed ADS-B and radar	• ADS-B/TIS-B, modeled and real	• ADS-B/TIS-B, modeled and real
Traffic 	• Simulated	• UAS/UAS Surrogate • Live Traffic • Simulated Traffic	• UAS/UAS Surrogate • Live Traffic • Simulated Traffic
Command and Control Link 	• Modeled	• Prototype Equipment – single aircraft	• Prototype Equipment – multiple aircraft
Test Scope	Simulation sessions over an 8 week period	Multiple flights over an 8 week period (~30 flight hours)	Multiple flights over an 8 week period (~30 flight hours)

IT&E Project Life Cycle – Phase 2



Flight Test 3 and 4 schedules are being updated. Anticipated dates are:

- Flight Test 3, June-July 2015
- Flight Test 4, January-February 2016