National Aeronautics and Space Administration

UAS Integration in the NAS Project
UAS Commercialization Industry Conference

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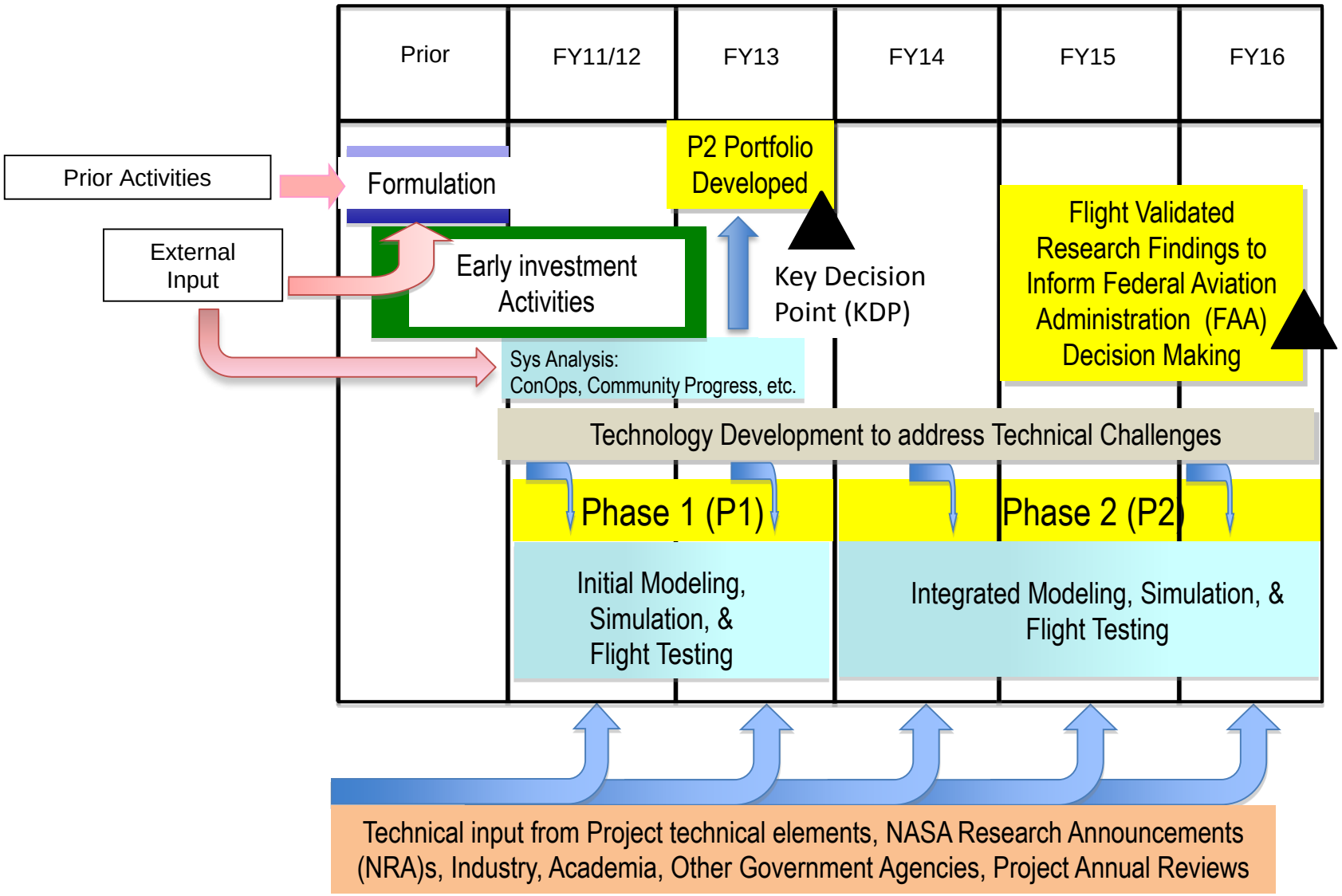
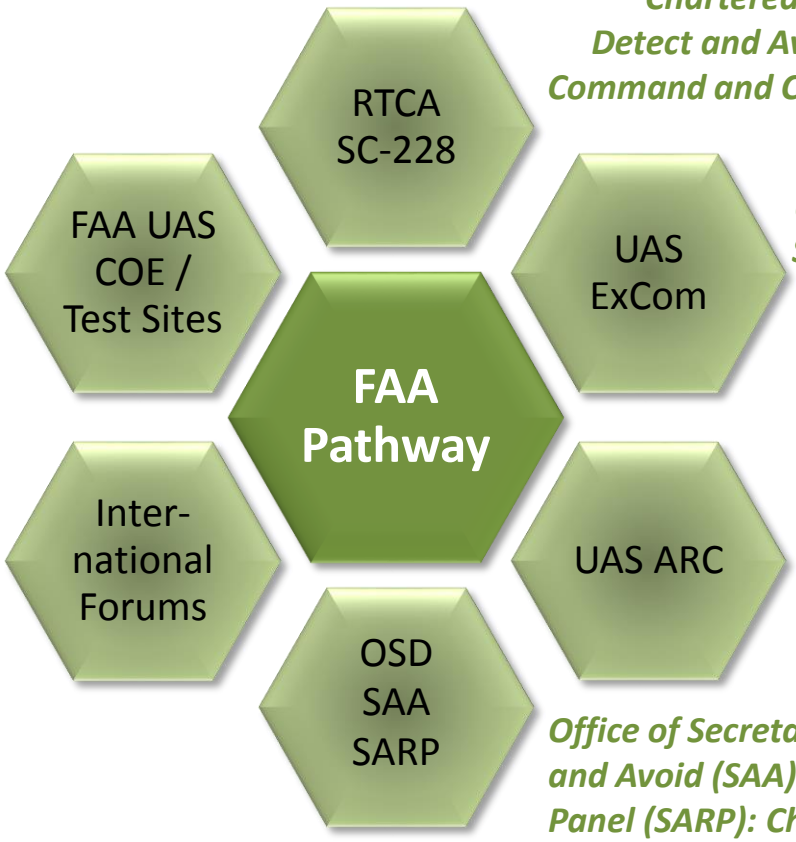
UAS-NAS Project Lifecycle



FAA Pathway to UAS Access

- The FAA uses several domestic and international forums to lay out the pathway for their priorities and investments.



Chartered to develop Detect and Avoid (DAA) and Command and Control (C2) MOPS

FAA UAS Center of Excellence performs strategic research to guide the FAA, while the test sites contribute essential inputs through UAS testing

UAS Executive Committee (ExCom): Senior gov't steering group focused on streamlining public UAS access

World Radio Conference (WRC), International Civil Aviation Organization (ICAO) UAS RPAS Panel, and the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) are addressing UAS access from an international perspective

UAS Aviation Rulemaking Committee (ARC) Developed civil UAS Implementation Plan based on the FAA's UAS Concept of Operations (CONOPs) & Roadmap

Office of Secretary of Defense (OSD) Sense and Avoid (SAA) Science and Research Panel (SARP): Chartered by OSD to identify SAA Research Gaps

NASA has a leadership role within many domestic forums and participates in the international forums

ARMD Strategic Plan Flow Down to UAS-NAS Project

AERONAUTICS STRATEGIC THRUST

Thrust 6: Assured Autonomy for Aviation Transformation

AERONAUTICS OUTCOME

Outcome (2015 – 2025): Initial Autonomy Applications with Integration of UAS into the NAS

UAS-NAS *Project Goal*

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

UAS-NAS *Research Themes*

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

UAS-NAS *Technical Challenges*

TC-SAA:
Sense and Avoid Performance Standards

TC-C2:
Command & Control Performance Standards

TC-HSI:
Human Systems Integration

TC-ITE:
Integrated Test & Evaluation

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: Sense and Avoid (SAA) Performance Standards

TC-HSI: Human Systems Integration

TC-C2: Command & Control (C2) Performance Standards

Non-TC: UAS Restricted Use Certification

Non-TC: Small UAS Mission Support Technologies

TC = Technical Challenge

UAS Integration in the NAS Project

Technical Challenge Value Proposition

NASA UAS-NAS TC Project Activities

Key Products

Resultant Outcomes

TC SAA — SAA Performance Standards

- Develop SAA Performance Testbed
- Develop SAA Interoperability Testbed
- Conduct SAA Flight Test and MS&A
  - *Performance Trade-offs*
  - *Interoperability*
  - *Self Separation*
  - *CONOPs*
  - *Well Clear*
  - *Collision Avoidance*
- Develop SAA Performance & Interoperability Requirements

TC C2 — C2 Performance Standards

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

TC HSI — Human Systems Integration

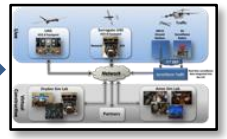
- Develop Prototype GCS
- Conduct Human Factors (HF) Flight Test and MS&A
  - *Contingency Management*
  - *Pilot Response*
  - *Autonomy*
  - *SAA*
  - *C2*
  - *Displays*
- Develop HF Guidelines for SAA, C2 & GCS

TC ITE — Integrated Test & Evaluation

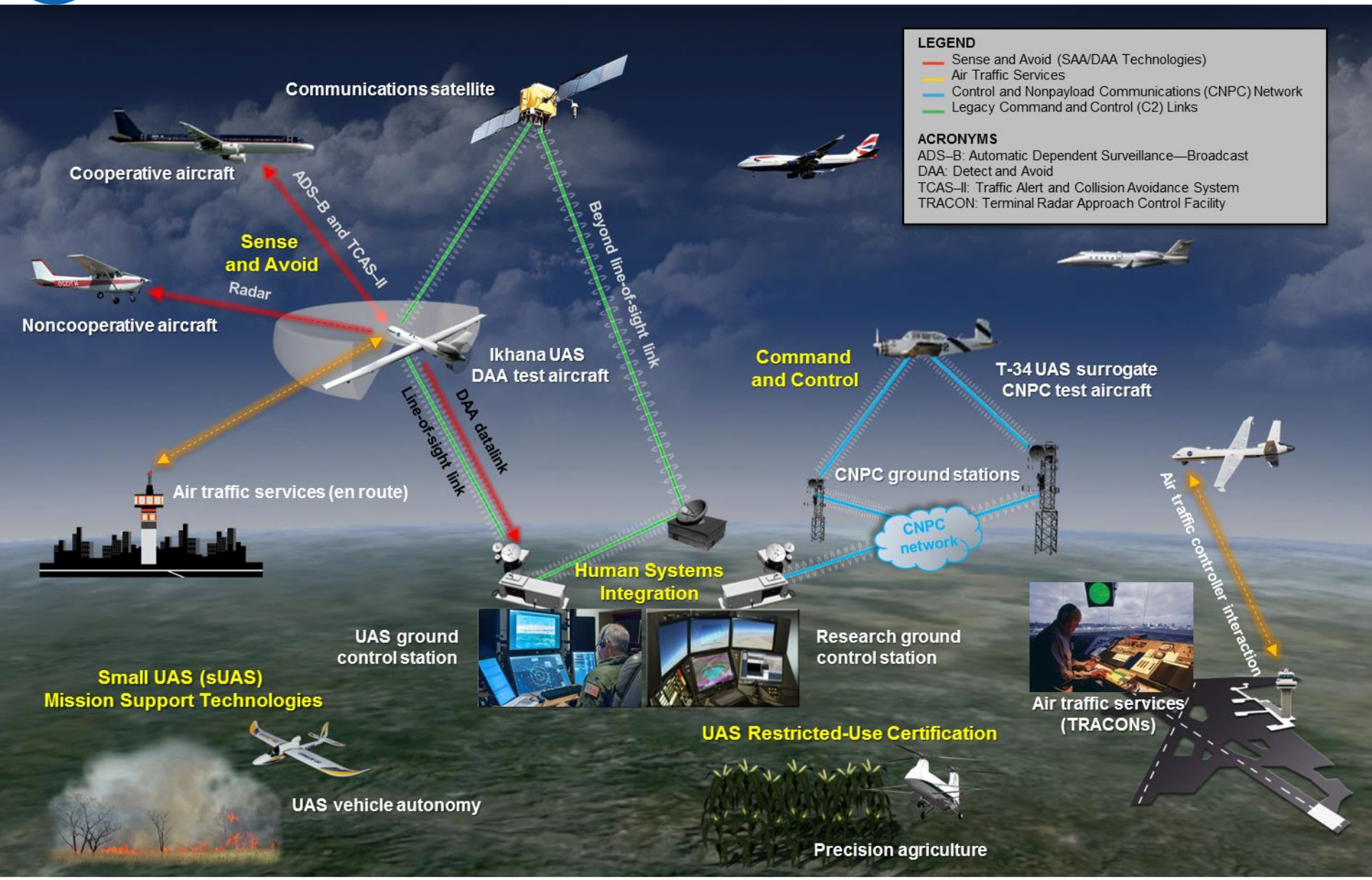
- Develop LVC Test Infrastructure
- Conduct TC Specific Testing
  - Conduct IHITL
  - Conduct SAA Initial Flight Test Scenarios
  - Conduct FT3 Test Scenarios
  - Conduct FT4 Test Scenarios & Capstone

Key Products → Resultant Outcomes

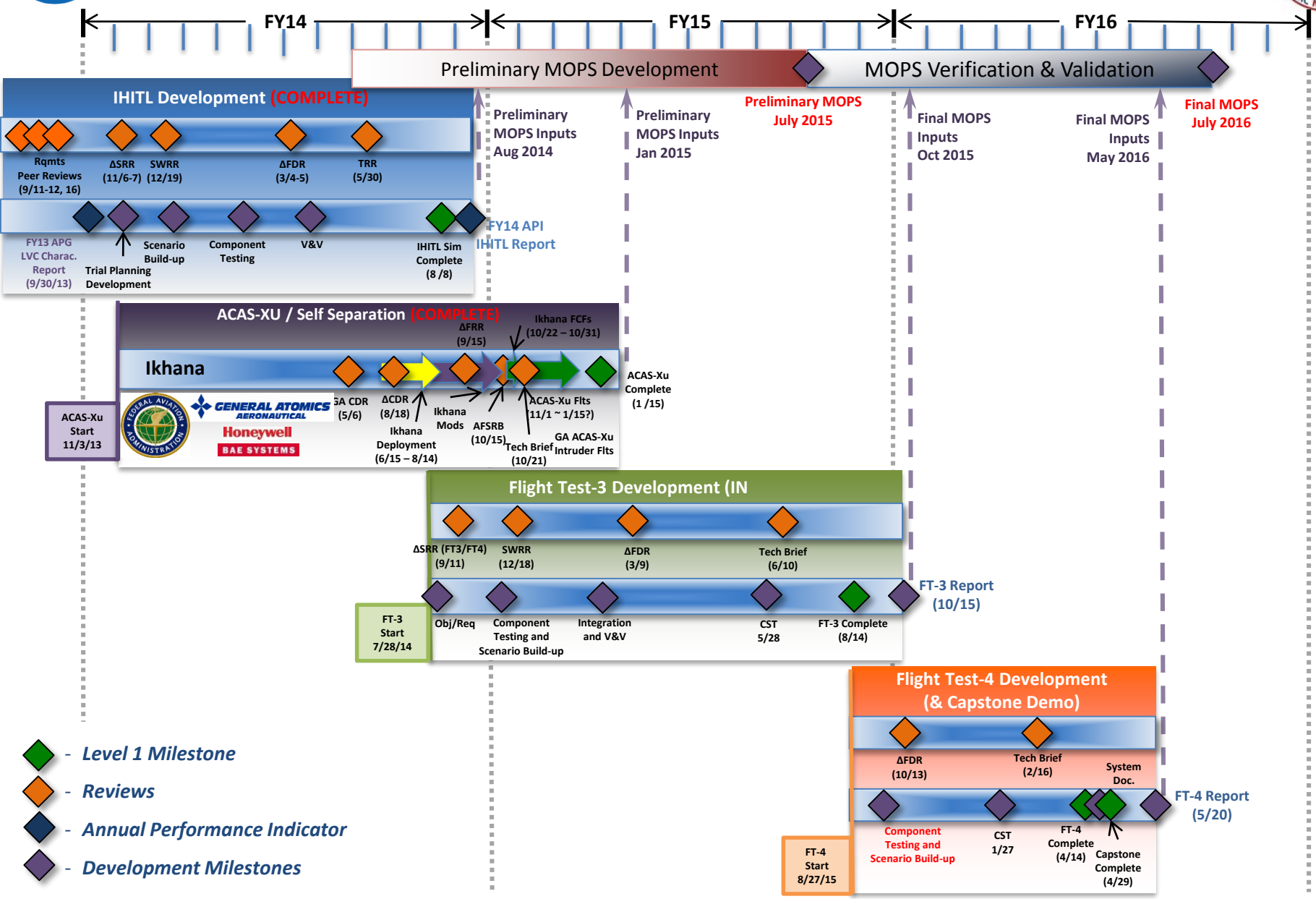
- *SAA Performance Requirements to inform DAA MOPS* → RTCA DAA MOPS → DAA Technical Standard Order (TSO)
- *C2 Performance Requirements to inform C2 MOPS* → RTCA C2 MOPS → C2 Technical Standard Order (TSO)
- *HF Performance Requirements to inform DAA & C2 MOPs, HF Guidelines* → RTCA DAA MOPS, RTCA C2 MOPS → DAA Technical Standard Order (TSO), C2 Technical Standard Order (TSO)
- *Re-usable Test Infrastructure*



UAS-NAS Project OV-1



Integrated Test Flow and MOPS Development



Timeline Not To Scale

Other NASA UAS Access Efforts

Phase 2 MOPS ~FY17-20

- DAA MOPS for aircraft interoperating in Classes E and D Airspace
  - May require a suite of options including GBSAA, EO, cell technology, etc
- SATCOM MOPS for C2
- Necessary human systems integration guidelines

Early Implementation Program (through UAS ARC) ~FY17-20

- Research findings to enable routine operations above FL180 with required equipage

UAS Traffic Management (UTM) ~FY16-26

- Low altitude volume of airspace (e.g. 400 AGL and below)
- Enable operations including goods delivery, infrastructure surveillance, agricultural support, and medical services delivery
- Upcoming UTM Convention July 28-30 at NASA Ames Research Center

NASA will continue to pursue efforts to enable UAS access over the next decade

Benefits to the Commercial Industry

Overall NASA goal - Open airspace in safe/efficient manner for civil/commercial activities

UAS-NAS Project:

- **Enable flights to/from Class A Airspace through Classes E and D Airspace**

EIP:

- **Enable routine operations above FL180 (Classes A and Upper E)**

Phase 2 MOPS:

- **Enable routine operations in Classes E and D Airspace**

UTM

- **Enable routine operations in low altitude volume of airspace**

NASA efforts, in collaboration with the entire UAS Community of Interest, will maximize commercialization opportunities