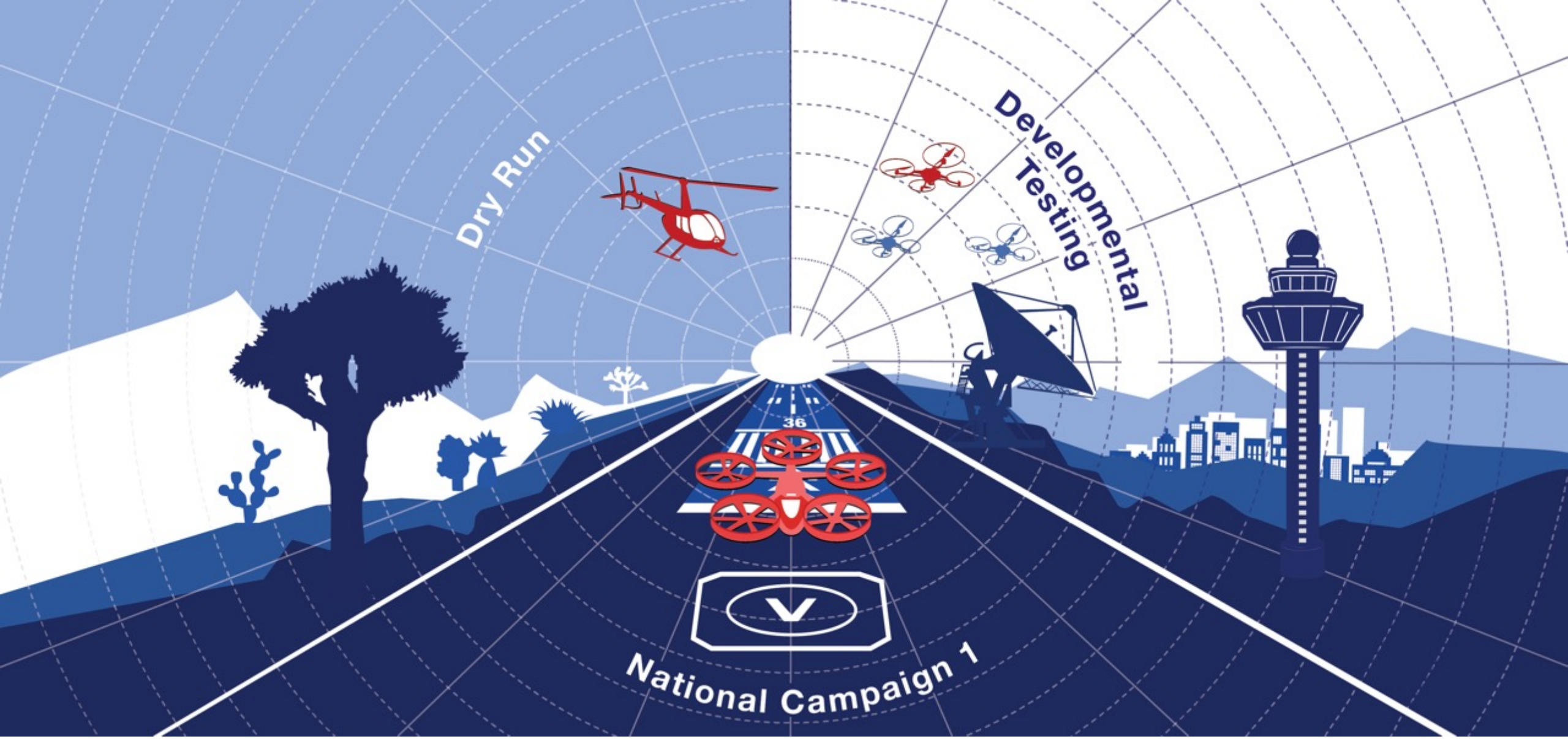




National Campaign Developmental Test - ARTR

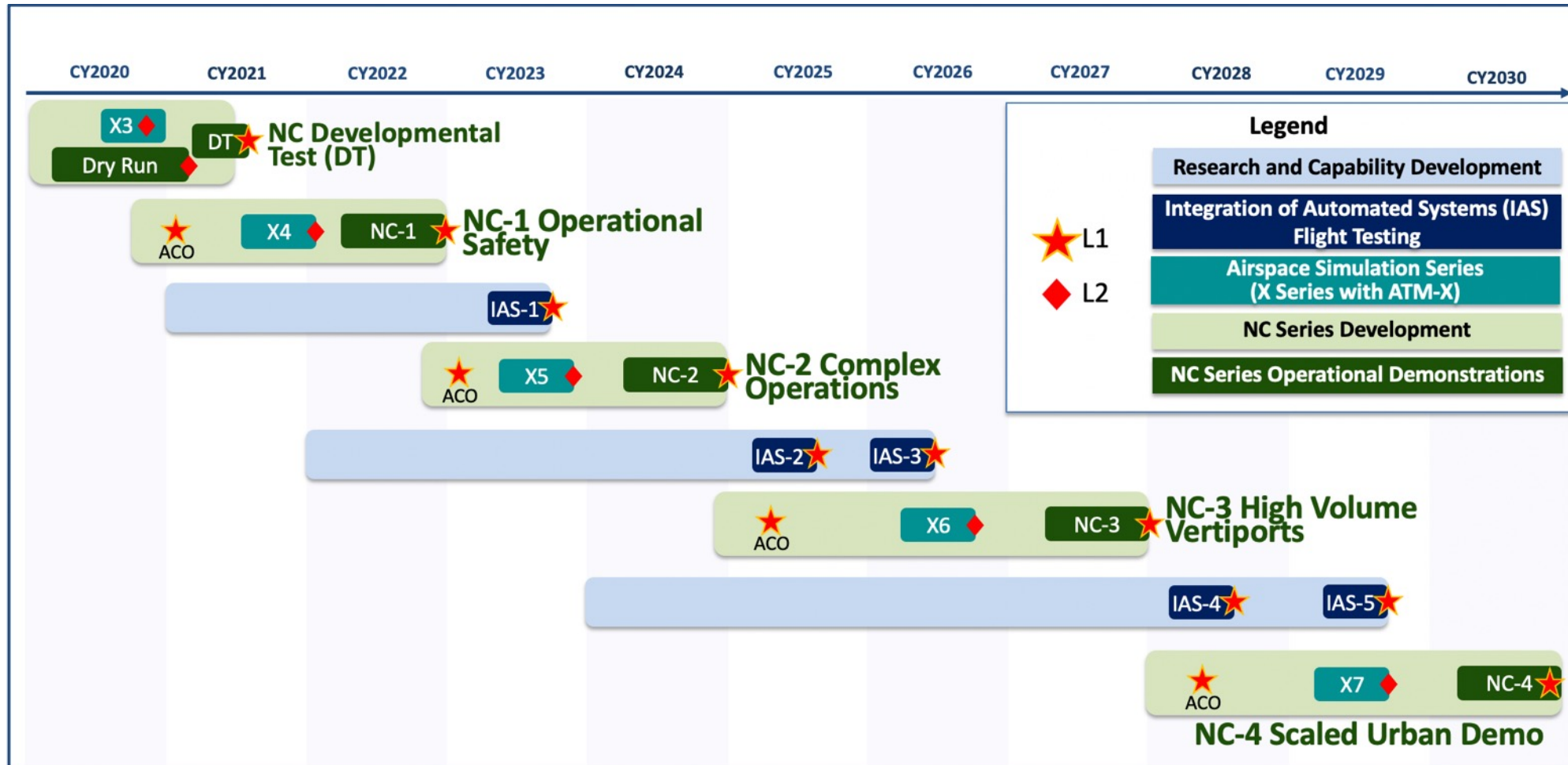
May 20, 2021





AAM Project Partnership Support of the Industry Timeline

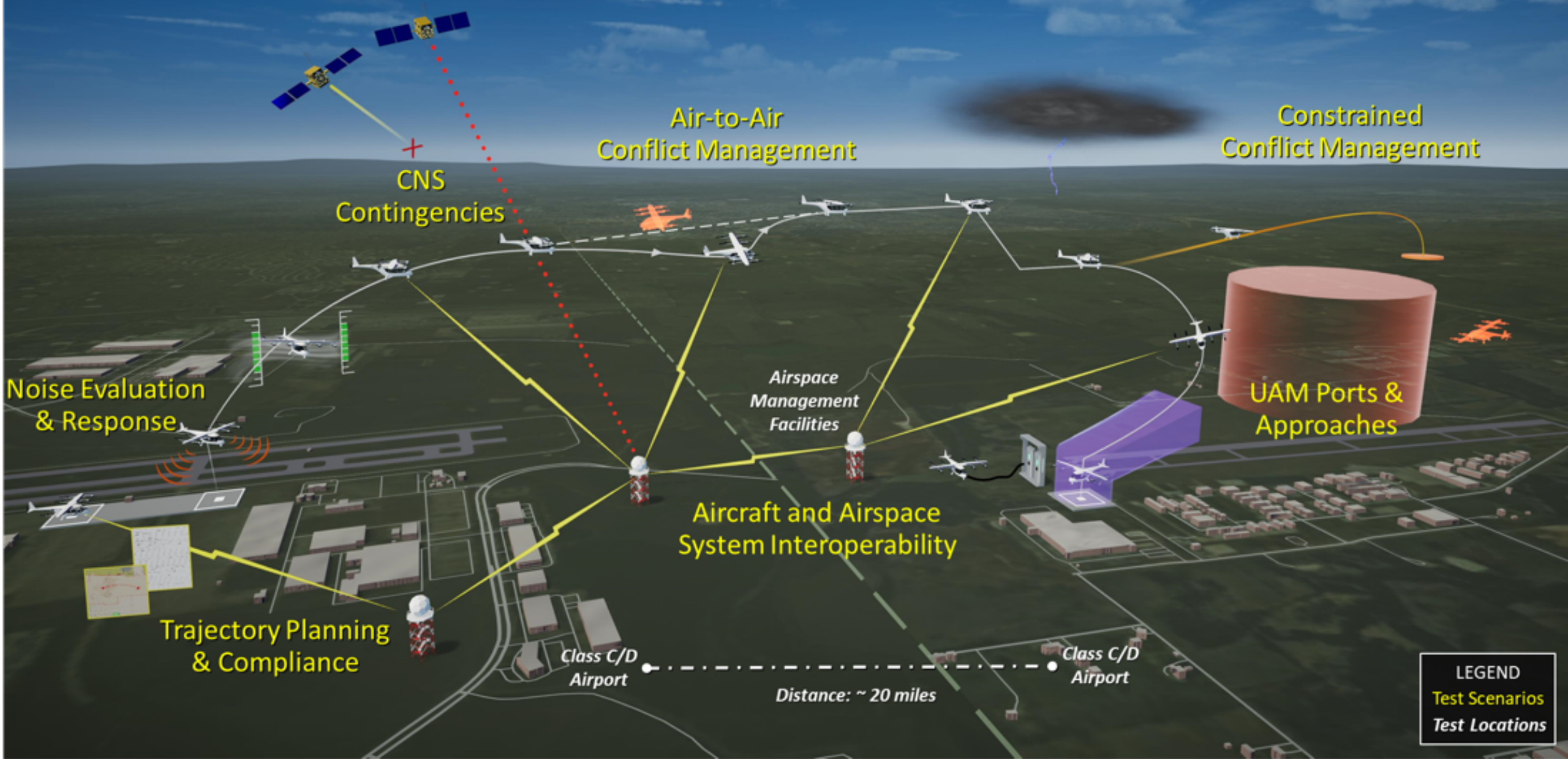
- NC Series Operational Demonstrations – Focus on AAM partnerships with NASA as facilitator
- X-Series Simulations – NC / ATM-X lead preparing airspace partners to support NC flight activities
- R&D Flight Tests -- Build-up and research flights with partners bringing key technologies/vehicles
 - Includes AFCM and HDV technologies and partners with IAS research and demonstration flights



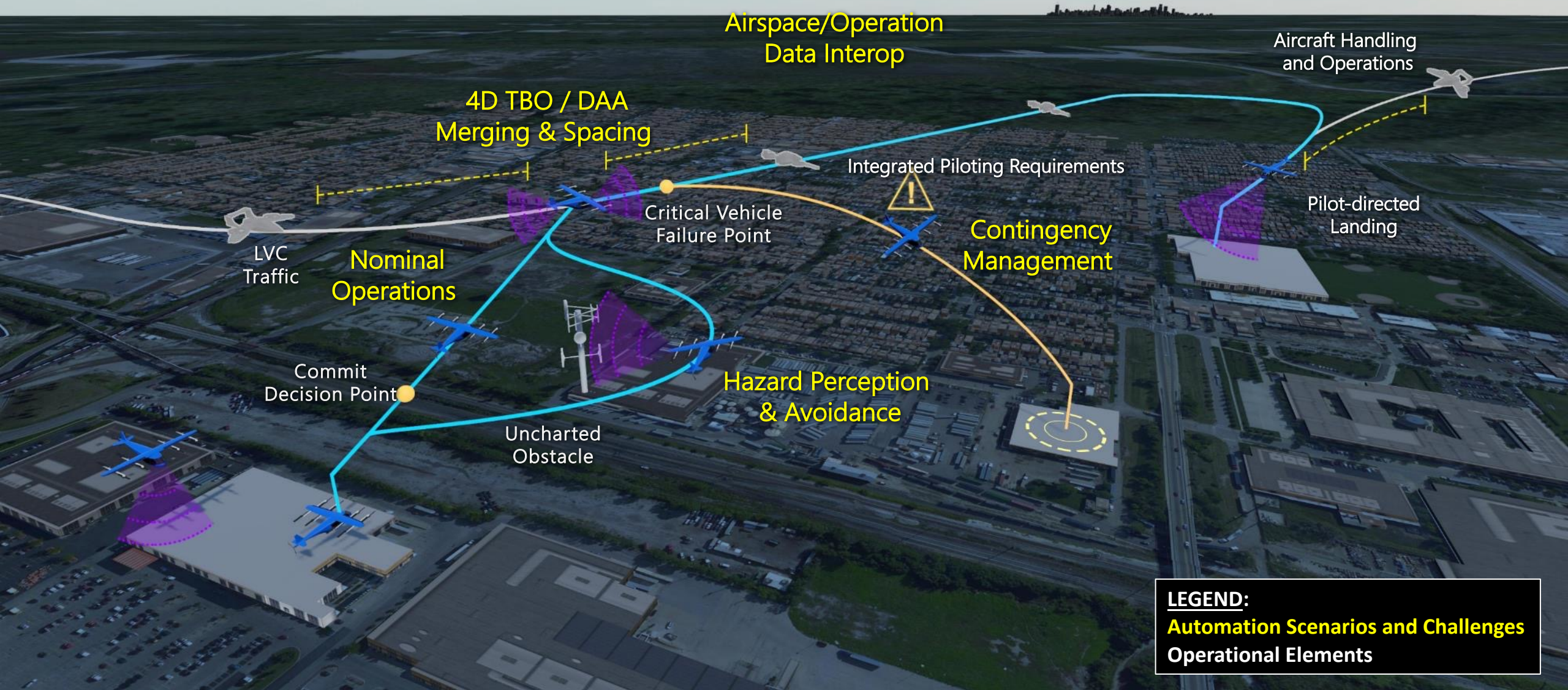


National Aeronautics and
Space Administration

NASA National Campaign OV-1



Research Focus for NASA IAS-1/NC-2 Complex Operations



LEGEND:
Automation Scenarios and Challenges
Operational Elements



NC-1 Objectives and FAA Pillars Alignment (UML 1-UML 2)

Accelerate Certification and Approval: *Develop and assess an integrated approach to vehicle certification, pilot licensing, and operational approval.*

Aircraft

Operations

Infrastructure

Develop Flight Procedure Guidelines: *Develop preliminary guidelines for flight procedures and related airspace design criteria.*

Aircraft

Airspace

Infrastructure

Operations

Evaluate the Communication, Navigation, and Surveillance (CNS) Trade Space: *Explore and evaluate CNS requirements, options, and trade-offs.*

Aircraft

Operations

Infrastructure

Demonstrate an Airspace Management Architecture: *Demonstrate and document an airspace system architecture capable of safely managing scalable AAM operations without burdening the current air traffic management system.*

Airspace

Operations

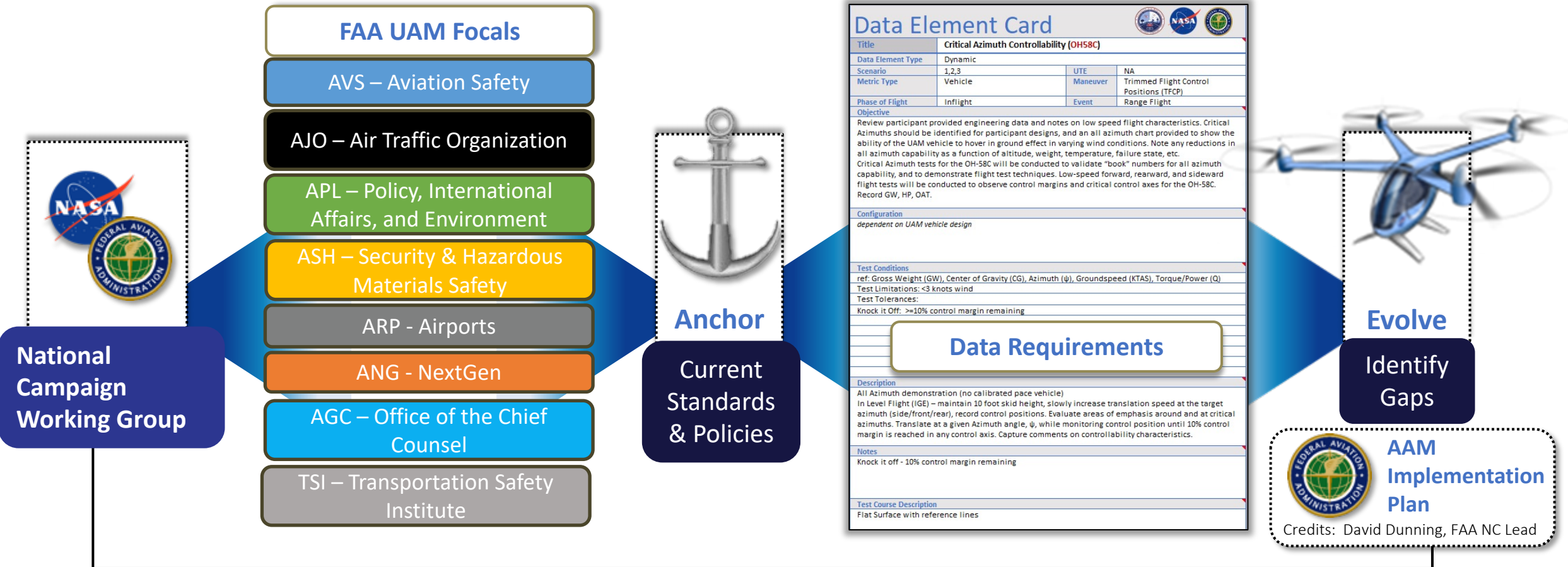
Identify Community Integration Needs: *Conduct initial characterization of the community noise of AAM vehicles through measurements of vehicle ground noise.*

Aircraft

Community

Data Products & Processes with FAA

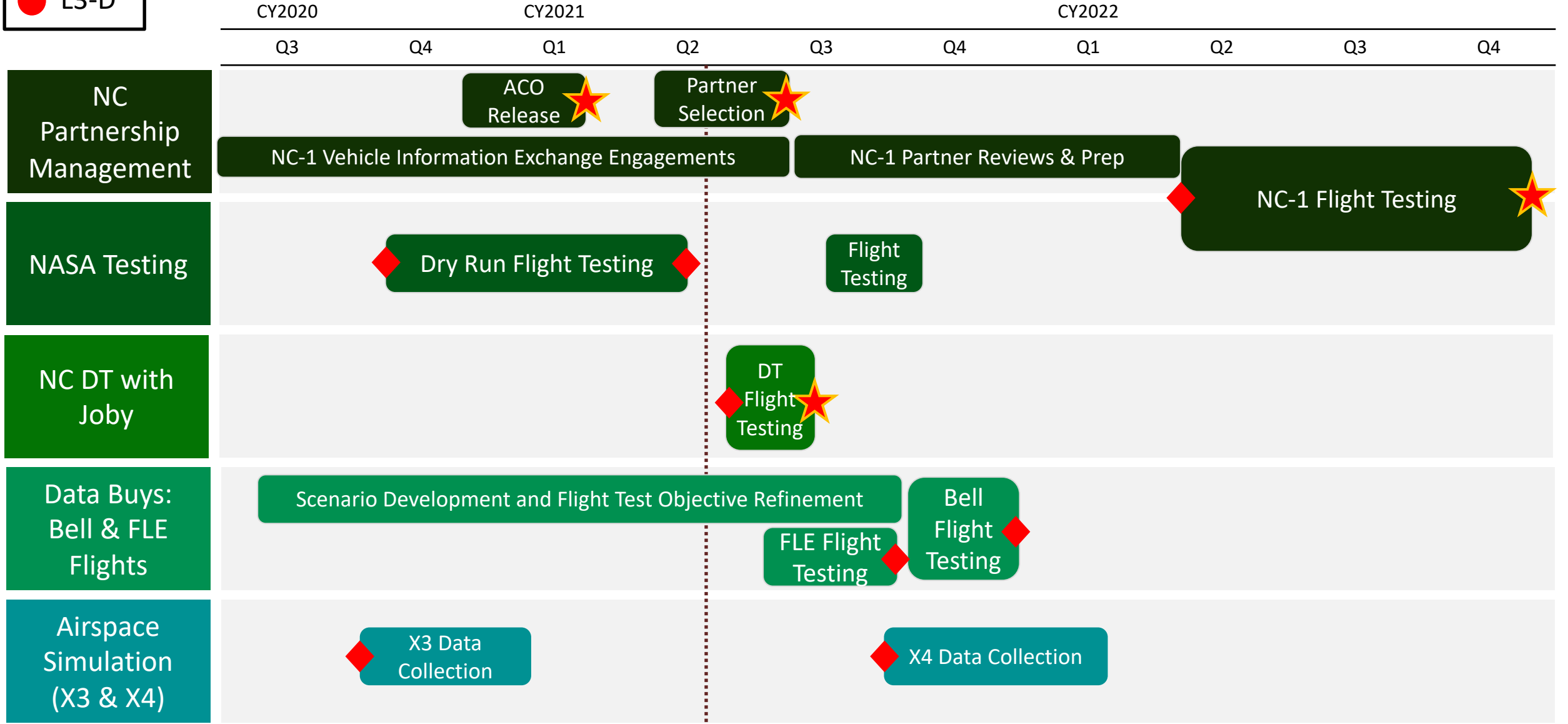
NASA | FAA Collaboration



Performing collaborative gap analysis for existing standards and policies across all lines of business in the FAA to enable UAM operations

 L1
  L2
  L3-D

NC Execution in FY21 – NC Developmental Test





NC Developmental Test Objectives

NC-DT Goal: Ensure that NASA is fully prepared to execute NC-1 event in a manner maximizing benefits to the AAM community

DTO-1: Assess Maturity and Robustness of NASA Proving Ground

Full Success: Collect data to support analysis of the flight test and simulation infrastructure for Scenarios 1-4.

DTO-2: Assess Effectiveness of NC Testing Processes, Logistics, and Data Collection

Full Success: Guide one partner organization through technology readiness, test readiness, flight and simulation execution, and data collection processes.

DTO-3: Preliminary Assessment of Partner Capabilities and Systems Performance

Full Success: Conduct flight test and simulation for at least one partner aircraft/airspace system to collect vehicle, airspace, and connectivity/communication performance data against the requirements for Scenarios 1-4.

DTO-4: Assess the Suitability of NC-1 Scenarios

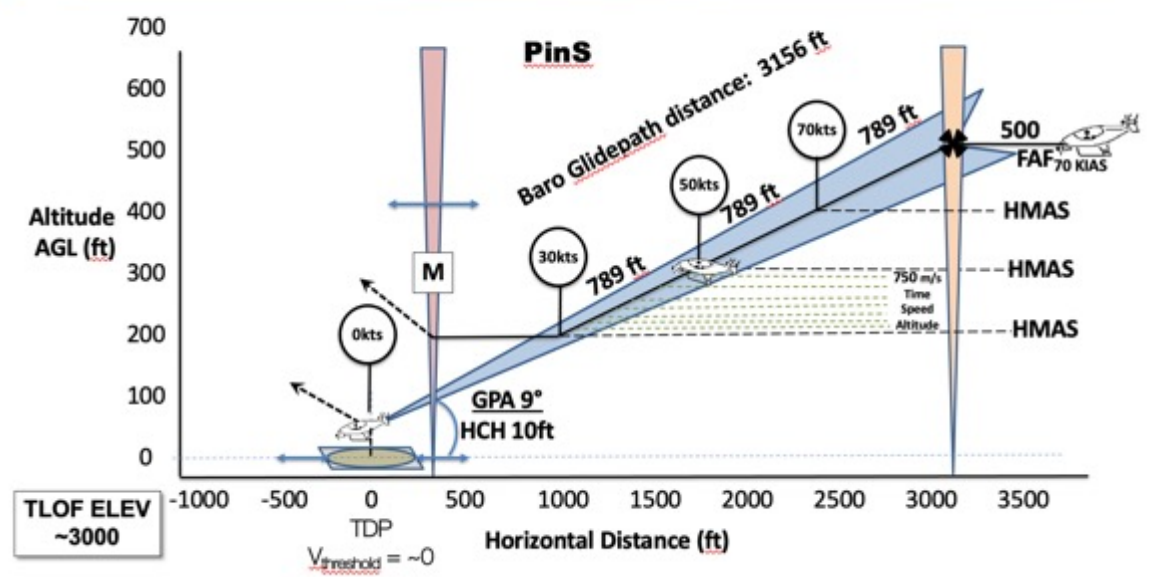
Full Success: Assess the applicability of the scenarios through the execution of at least three of the NC-1 scenarios with at least one vehicle and one airspace partner.



DTO-1: Assess Maturity and Robustness of NASA Proving Ground



Quad Zero Approach



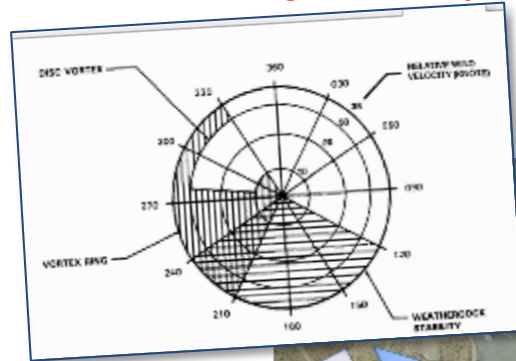


DTO-1: Assess Maturity and Robustness of NASA Proving Ground

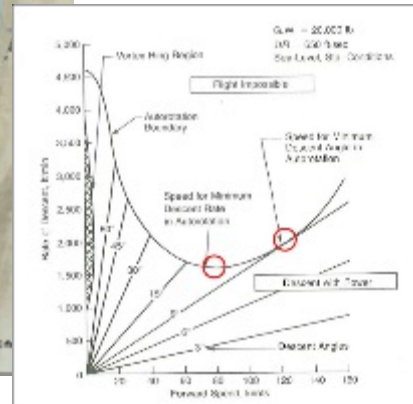
Minimum Flight Characteristics required for Urban Operations

- All Azimuth Capability
- Windward/Leeward effects on controllability
- Tailored UAM civil certification HQ tasks

VEHICLE minimum requirements



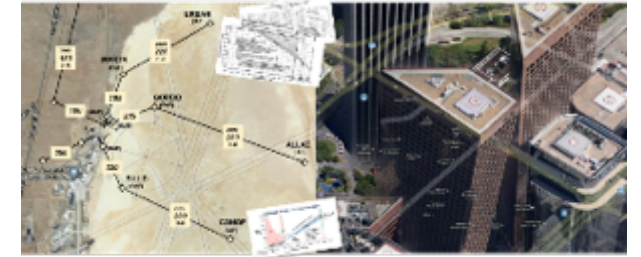
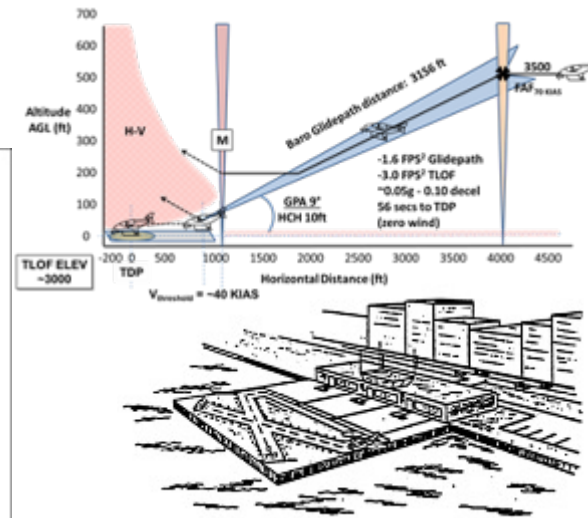
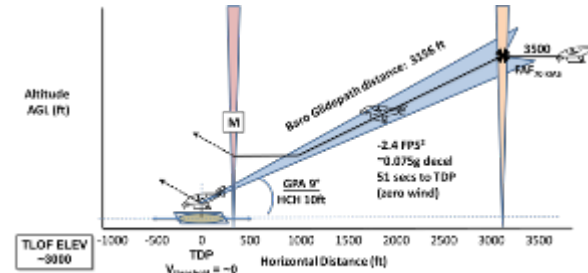
Prevailing winds



Condensed UAM Approaches/Airspace

- Viable UAM IMC approaches
- Heliport and Vertiport operations

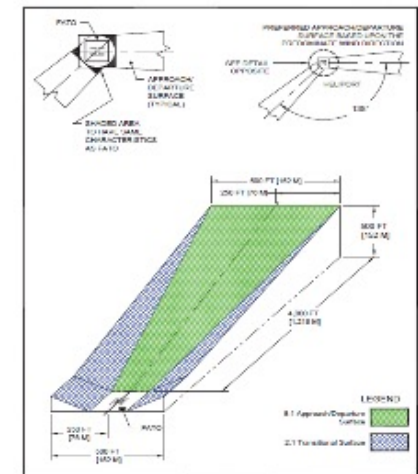
AIRSPACE constraints



Required evolutions to existing standards to enable UAM

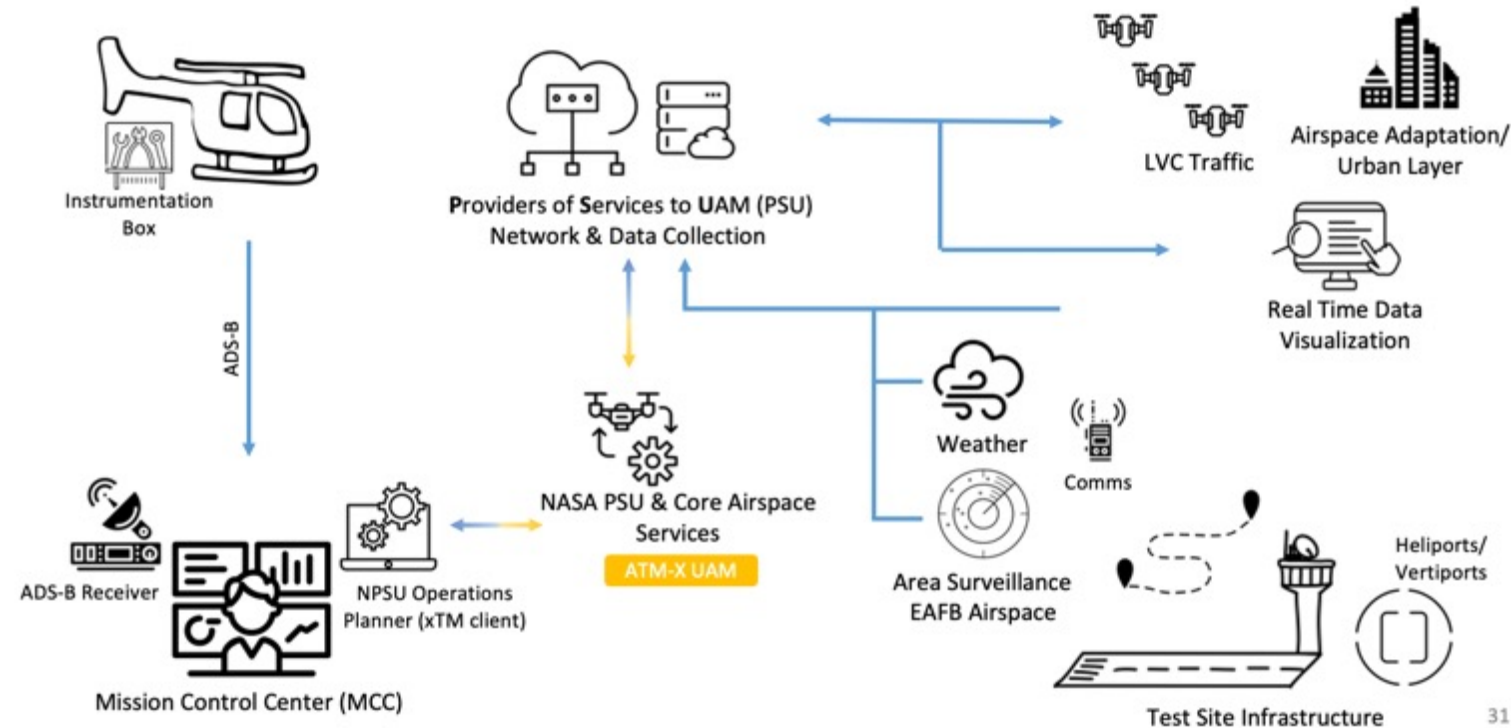
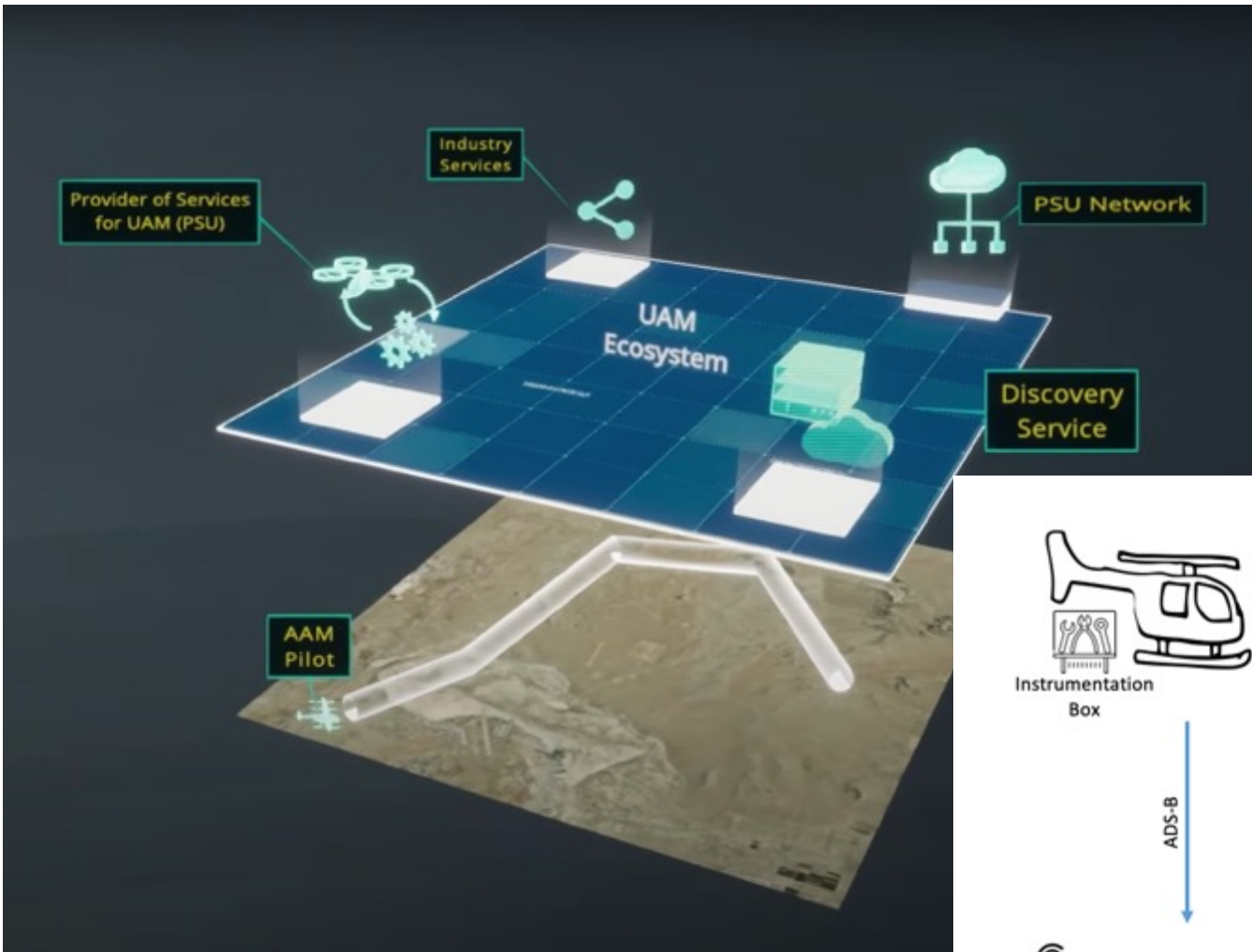
- Terminal/Instrument Procedures (TERPS)
- Urban Planning

INFRASTRUCTURE needs





DTO-1&2: Assess Effectiveness of NC Processes, Logistics, and Data Collection





DTO-3&4: Preliminary Assessment of Partner Capabilities and Systems Performance

Collect flight characterization data, such as, accel/decel, climb/descend, bank angles, approach angles, departure angles leveraging, missed approach, balked landing

Collect acoustic data to inform eVTOL noise evaluation database

Vehicle State Data

- Aircraft true airspeed
- Ground speed
- Flight path angle
- Barometric/Geo altitude
- Pressure altitude
- Vertical velocity (v_z)
- Vertical speed
- Magnetic heading
- True heading
- Latitude/Longitude
- Lat/Lon acceleration
- Pitch, roll, yaw rate & angle
- GPS/UTC time sync data

Energy Data

- Battery Charge State
- Battery Temperature
- Consumption Rate
- Health indicator

Rotor Data

- RPM (5 bladed rotors)
- Blade angle (for all)
- Rotor geometry

Inceptor Data

- Inceptor force
- Inceptor position
- Inceptor modes/speeds

Transition Data

- Transition schedule
- TX-Transition
- Transition test block
- Transition performance

Motor Data

- Temperature (all 6)
- Controller temperature
- Motor RPM
- Power cell storage state

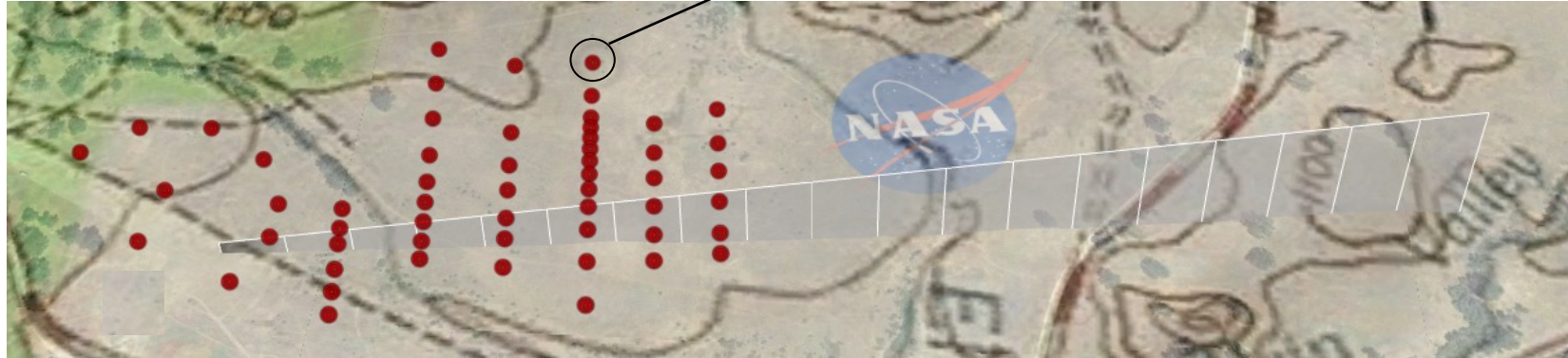
Pilot Interfaces

- Control requests
- Right hand inceptor
- Left hand inceptor
- Rudder Pedals



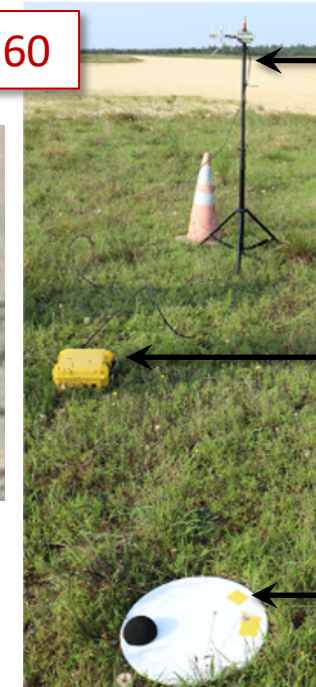
O-4: Assess the Suitability of NC-1 Scenarios

Scenario 4 Acoustic Testing



Microphone station

x 60

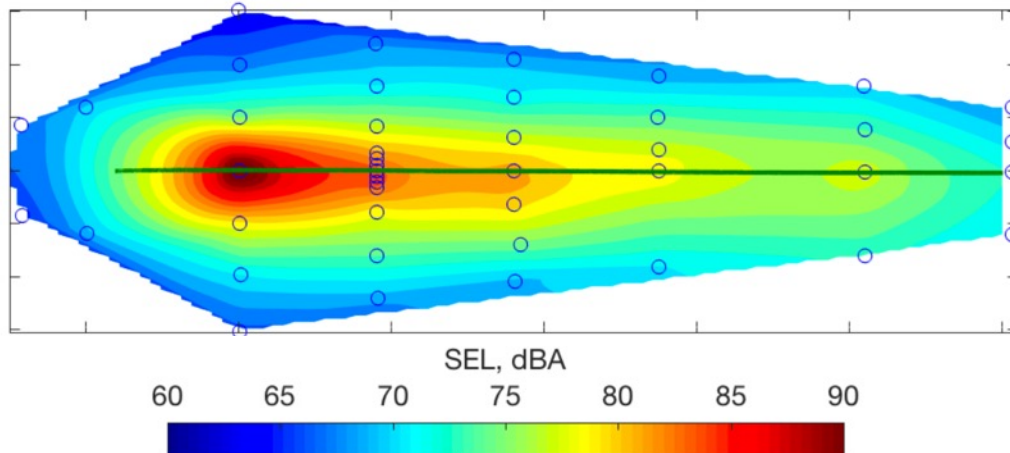


Antenna for wireless control

DAQ

High quality microphone

Processed result (Example from previous helicopter test)



National Campaign will provide

- Microphone array to process ground noise contours for each flyover; UTC timestamped data for synchronization with aircraft tracking data
- Will enable initial assessment of the noise impact for various phases of flight, including near vertiport operations and en route