Urban Air Mobility: Grand Challenge

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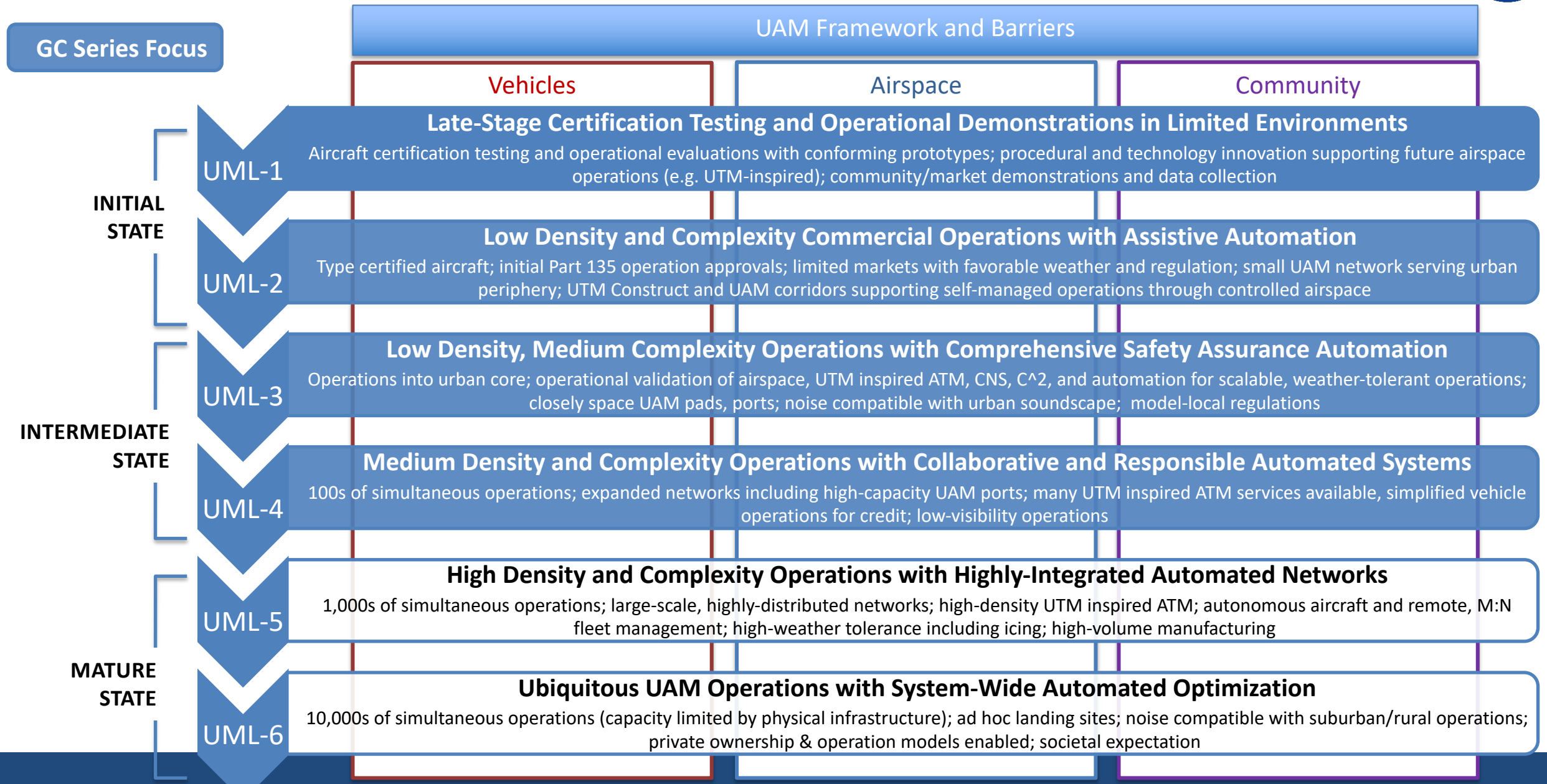
NEW AIRSPACE ENTRANTS

Challenges to Enabling New Airspace Entrants

- Integrated Infrastructure
- Demand/Capacity Imbalances
- Integration in the NAS
- Vehicle Certification
- Safe and Secure Ops

UAM Maturity Levels (UML)



NASA UAM Ecosystem Partnership Approach

NASA intends to establish partnerships with government, industry, and academia to collaborate on the critical enabling technologies and vital research relevant to UAM.

NASA/FAA Executive Board ("Research Transition Team")

Project Research Partnerships

Vehicle Partners

Airspace Partners

Academia

Grand Challenge Series

A major enabler to inform the UAM Ecosystem

Scaled Urban Demo

Community Outcome
UML-4 Book of Requirements

Ecosystem-wide partnerships are required to enable UML-4

UAM Community Integration Partnerships

AIAA Vertical Flight Society

RTCA

AUVSI

ASTM International

Professional Associations and Standards

Other Gov't Agencies

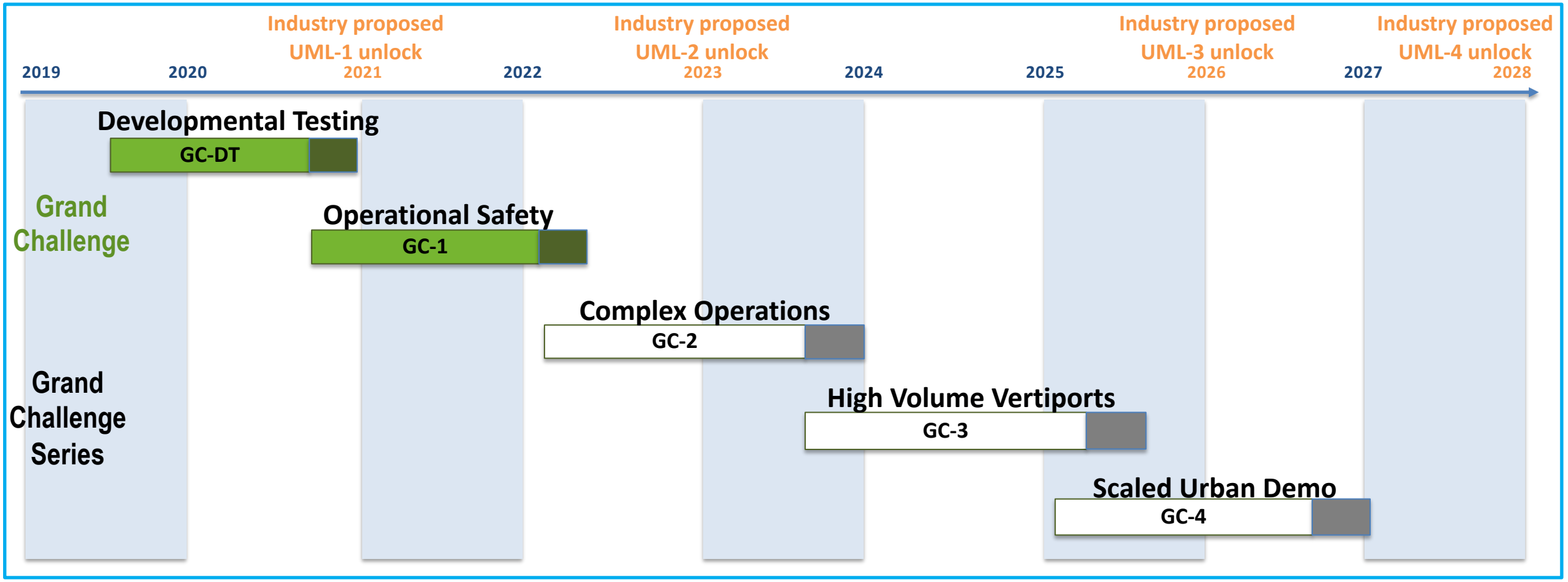
State / Local

International

NASA plans to partner with Federal/State/Local authorities as well as international & professional associations to develop the policies, regulations, and standards necessary to enable the UAM market.

UAM GC Series support of Industry Proposed timeline

Based on a range of publicly available industry projections; not a consensus view



- GC-DT and GC-1 are designed to accelerate safe operational integration concepts for UAM
- GC Series progression defined, but intended to remain flexible/agile:
  - GC focused on achieving UML-4
  - Each GC can be an "off-ramp" to relevant UML unlocks, but GC progression is dependent on industry readiness and commitments

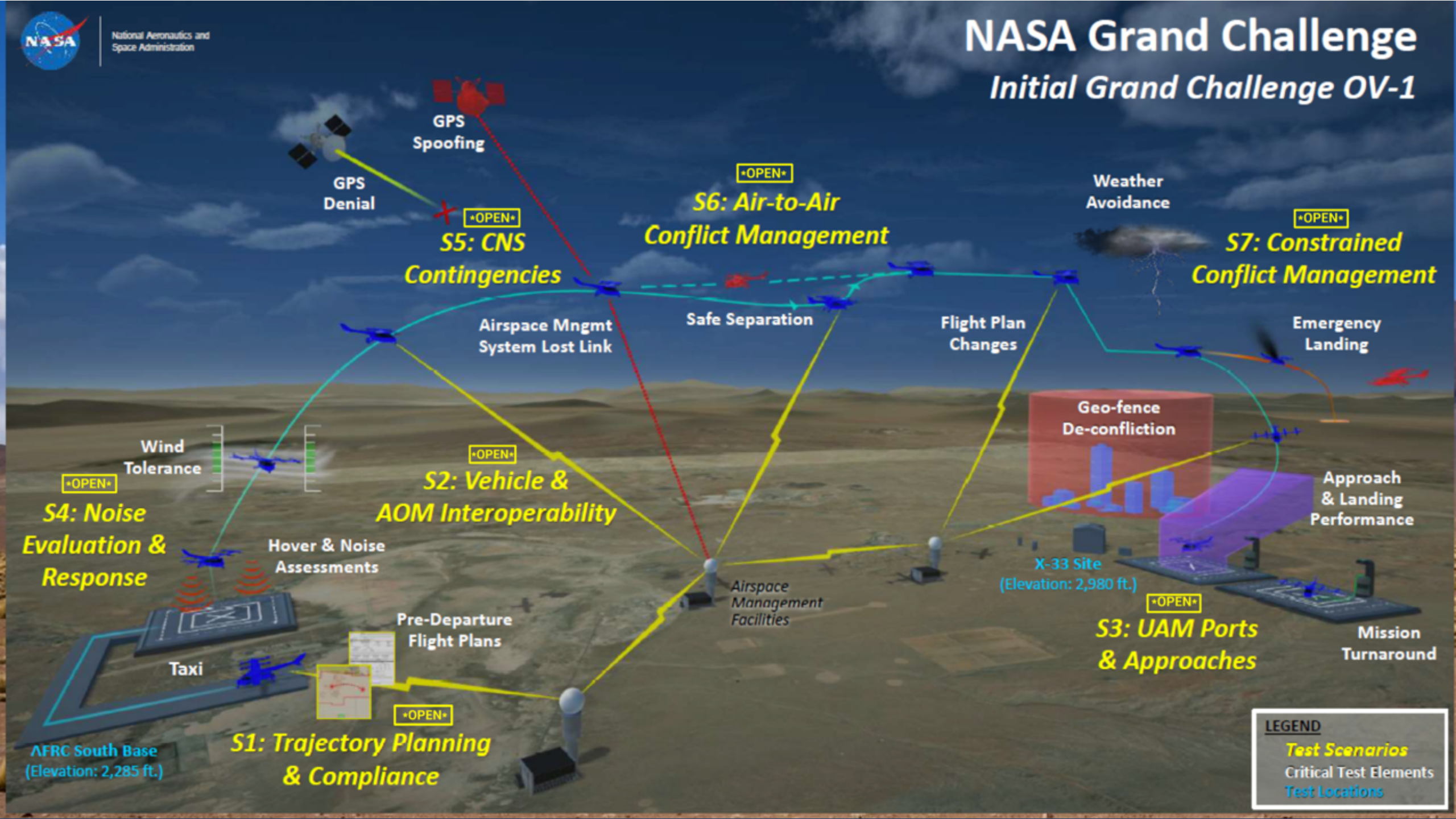
Grand Challenge 1 Goals & Objectives

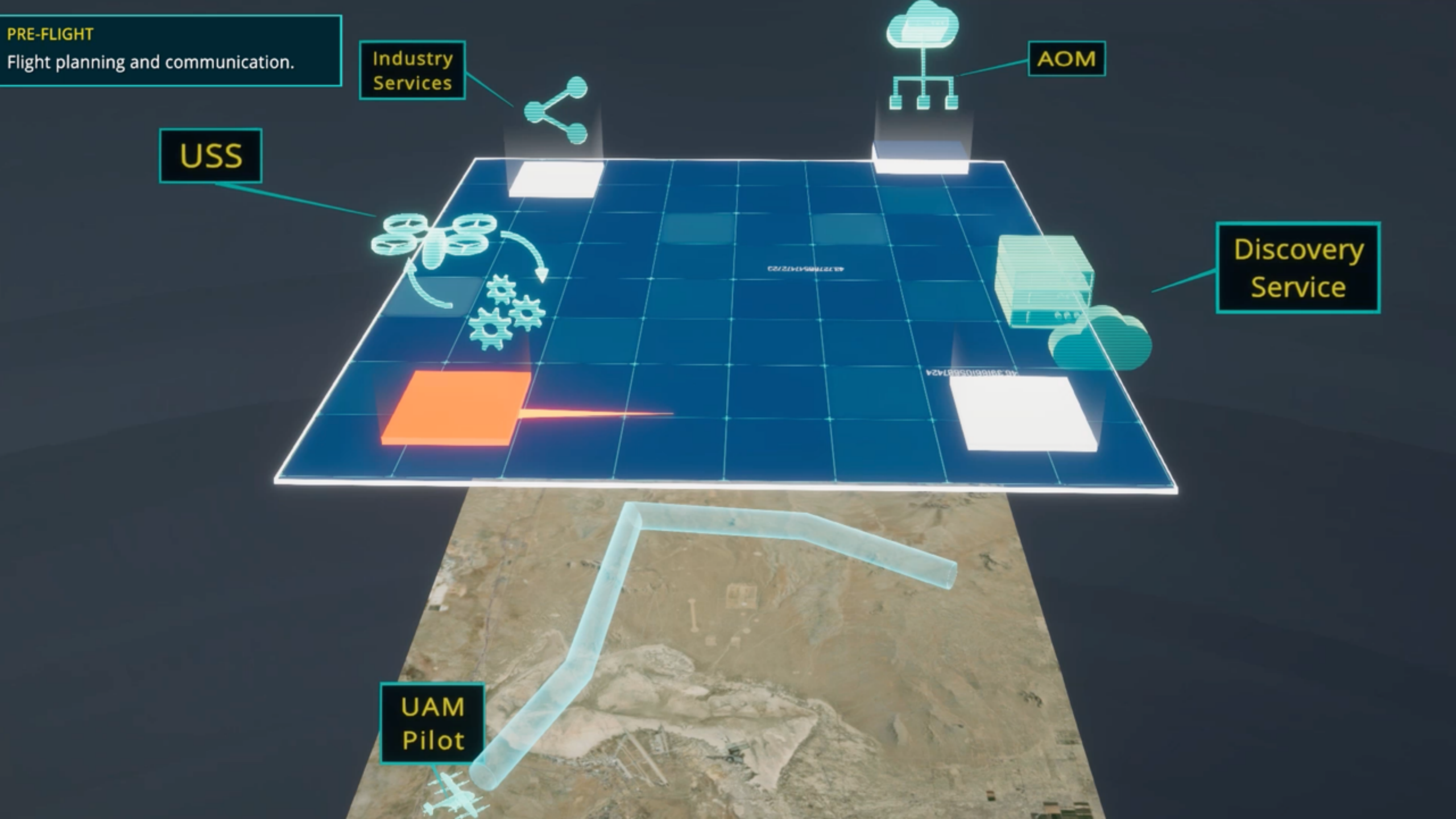
Goal

Improve UAM safety and accelerate scalability through integrated demonstrations of candidate operational concepts provided by industry participants and scenarios representative of nominal and expected off-nominal situations

Objectives

- **Accelerate Certification and Approval.** Develop and assess an integrated approach to vehicle certification and operational approval
- **Develop Flight Procedure Guidelines.** Develop preliminary guidelines for flight procedures and related airspace design criteria
- **Evaluate the CNS Trade-Space.** Explore and evaluate communication, navigation, and surveillance requirements, options, and trade-offs
- **Demonstrate an Airspace Management Architecture.** Demonstrate and document an airspace system architecture capable of safely managing scalable UAM operations without burdening the current air traffic management system
- **Characterize Community Considerations.** Conduct initial characterization of passenger and community considerations through measurements of vehicle ground noise


National Aeronautics and Space Administration
NASA Grand Challenge
Initial Grand Challenge OV-1
GPS Spoofing
GPS Denial
•OPEN•
S5: CNS Contingencies
•OPEN•
S6: Air-to-Air Conflict Management
Weather Avoidance
•OPEN•
S7: Constrained Conflict Management
Airspace Mngmt System Lost Link
Safe Separation
Flight Plan Changes
Emergency Landing
Geo-fence De-confliction
Wind Tolerance
•OPEN•
S4: Noise Evaluation & Response
•OPEN•
S2: Vehicle & AOM Interoperability
Approach & Landing Performance
Hover & Noise Assessments
Airspace Management Facilities
X-33 Site (Elevation: 2,980 ft.)
•OPEN•
S3: UAM Ports & Approaches
Pre-Departure Flight Plans
Taxi
Mission Turnaround
•OPEN•
S1: Trajectory Planning & Compliance
AFRC South Base (Elevation: 2,285 ft.)
LEGEND
Test Scenarios
Critical Test Elements
Test Locations


PRE-FLIGHT
Flight planning and communication.
Industry Services
AOM
USS
Discovery Service
UAM Pilot

Scenario 3:
UAM Ports and Approaches

OPEN

OPEN

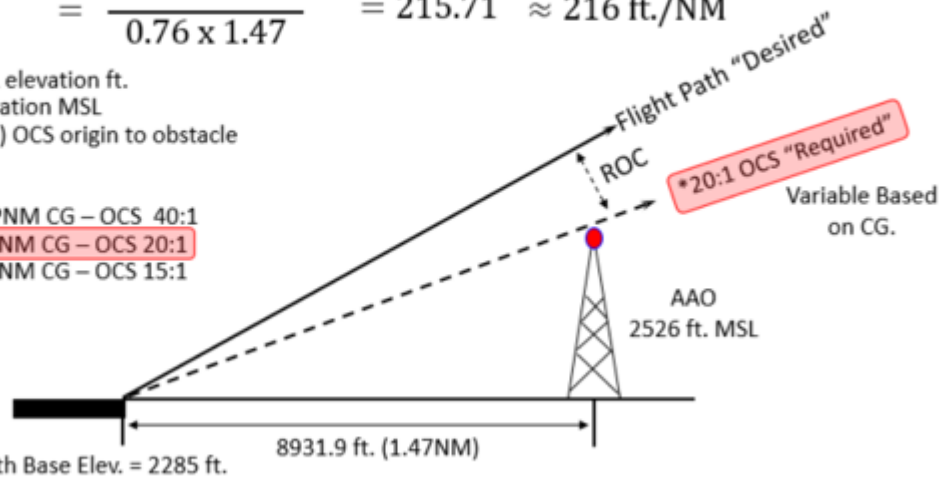
OPEN

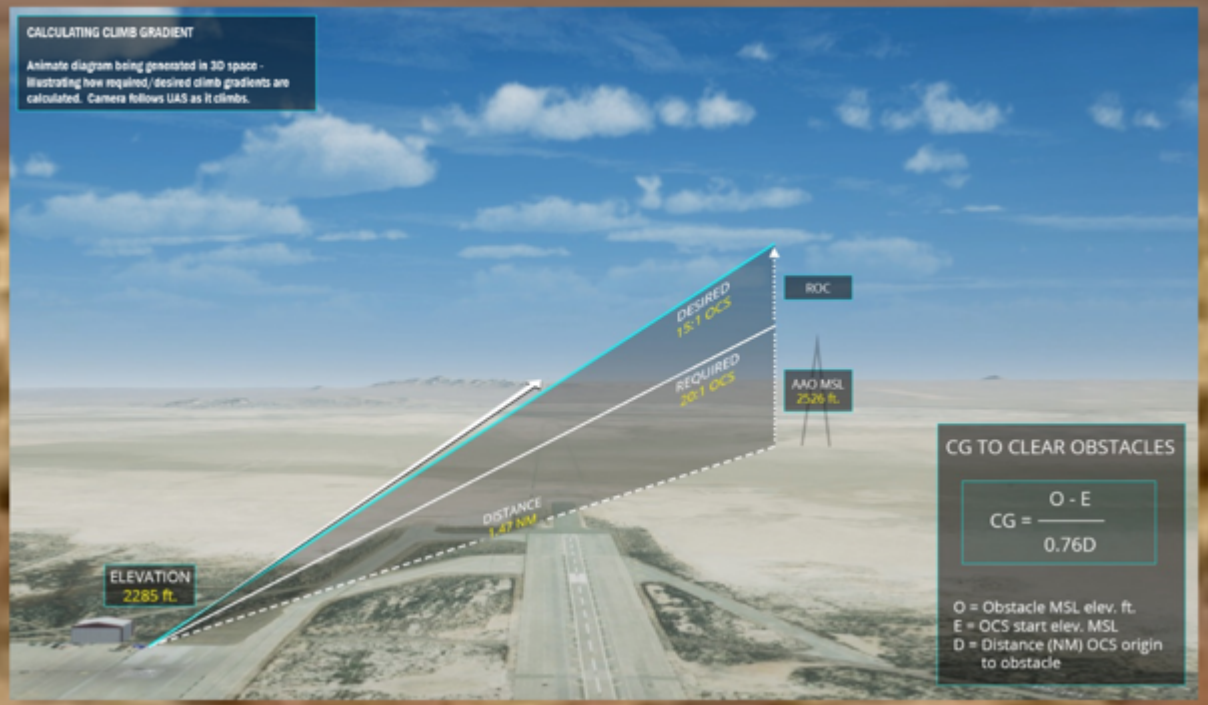
OPEN

$$CG = \frac{O - E}{0.76D} = \frac{2526 - 2285}{0.76 \times 1.47} = 215.71 \approx 216 \text{ ft./NM}$$

O = Obstacle MSL elevation ft.
E = OCS start elevation MSL
D = Distance (NM) OCS origin to obstacle

*Assumed: 200 FPNM CG – OCS 40:1
300 FPNM CG – OCS 20:1
400 FPNM CG – OCS 15:1





Grand Challenge Task Elements (vehicle performance; airspace)

Task Elements are discrete test points which we will mix into the Grand Challenge Operational Scenarios

Required Performance:

- Included for NASA's consideration as a minimum entry parameter for safety of flight
- Generally is far less than what will eventually be required for FAA certification

Desired Performance:

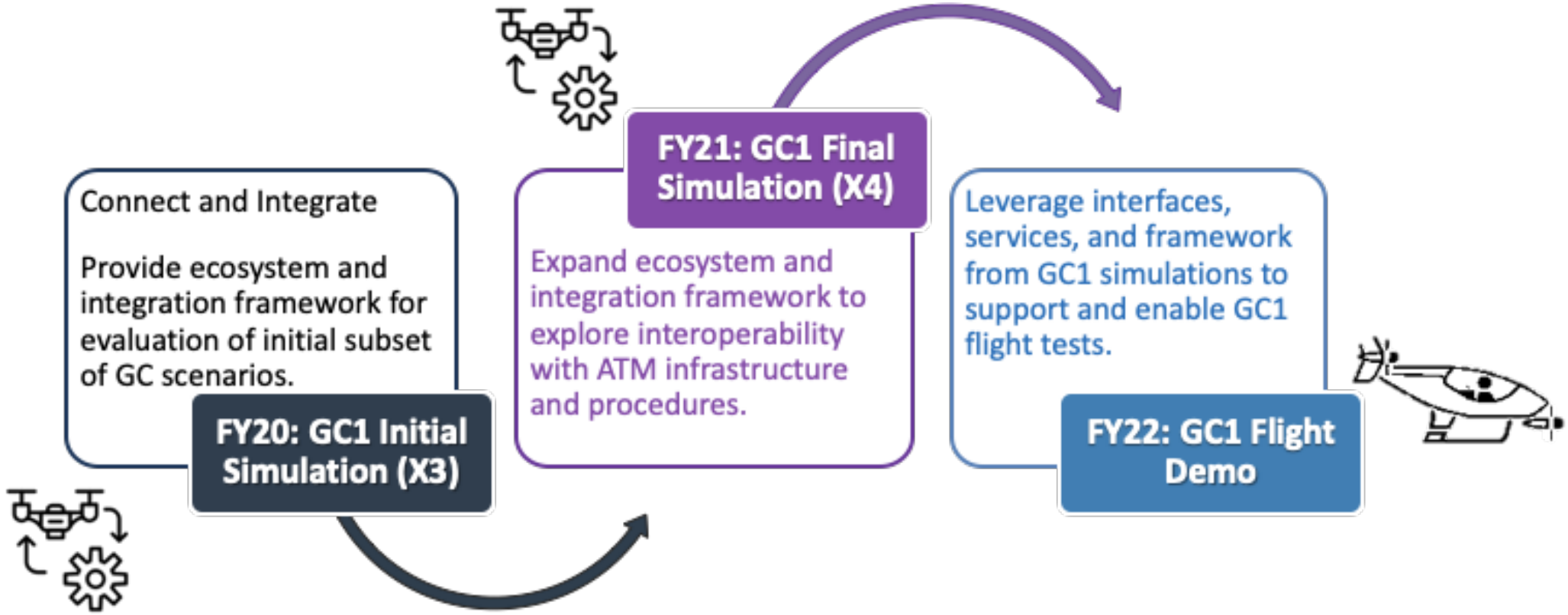
- Denotes level of performance that are approaching levels likely* required to gain FAA certification
  - *The FAA has not yet decided on applicable regulations nor minimum design standards for this emerging class of aircraft
- Similar performance level to conventional fixed or rotary wing aircraft

All Azimuth
Taxi
Takeoff Performance
Level Flight Decel/Accel
Flight Path ChangesSteep Turns, Pull Up, Push Over
Approach/Landing
Land-Quick Charge-TO
Energy Storage/Reserves
Function & Reliability
Precautionary landing
Balked Landing
Takeoff Failure Case
Landing Failure Case

Elements are designed to shed light on operational challenges that will drive future acceptable certification standards

BACKUP

ATM-X's Role in Grand Challenge



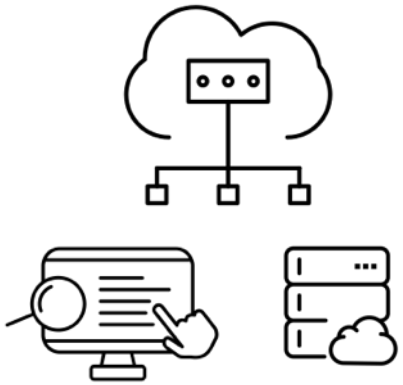
Connect and Integrate

- Connectivity and sandbox sims with GC Airspace Participants using multiple GC scenarios

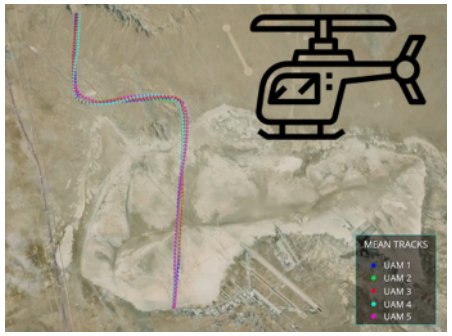
Prepare for Flight Test and Airspace Concepts Testing

- Implement and evaluate procedures
- Additional sims with partners and NASA as airspace partner

Vision for GC DT and X3 (FY20)

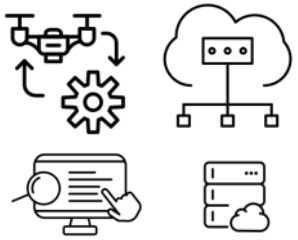


Develop ATI infrastructure and data pipeline



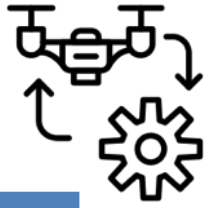
Dry Run at AFRC

Industry Partner



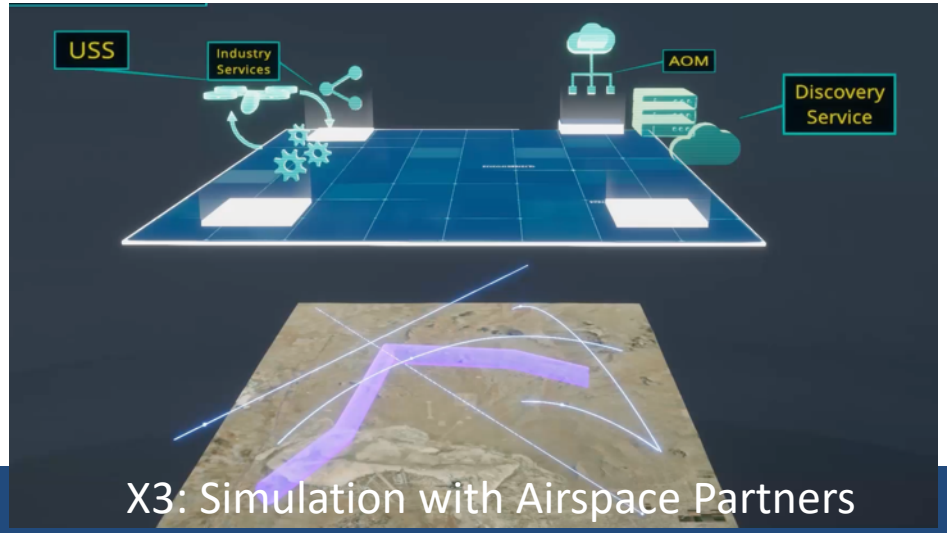
NASA

Integration with vehicle partner for flight at external range



ATMX Delivery of NUP for DT

ATI & ATMX UAM



X3: Simulation with Airspace Partners