

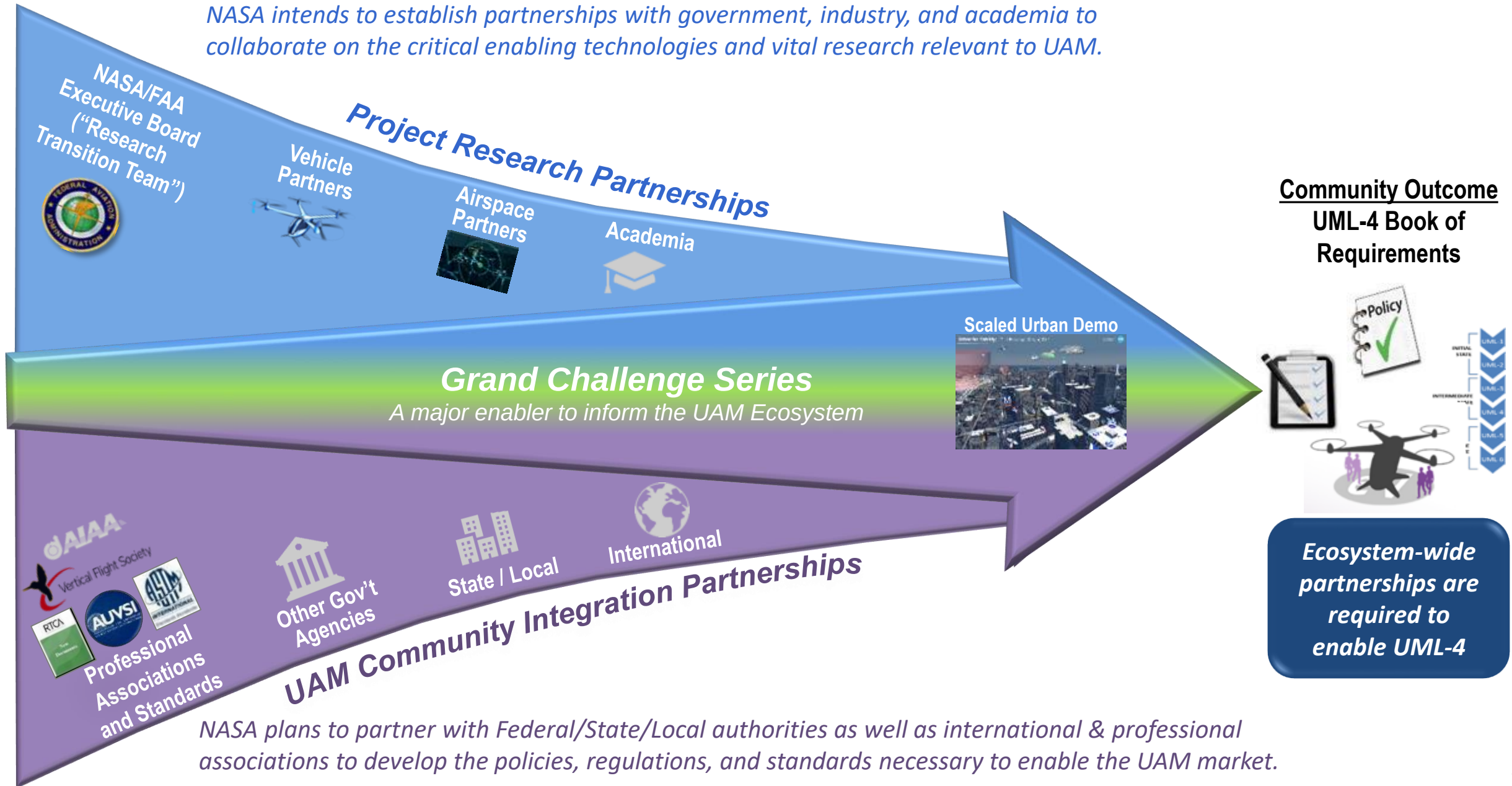


NASA/FAA Grand Challenge Overview
Starr Ginn UAM Grand Challenge Lead
VFS Electric VTOL Symposium
23 Jan 2020



Potential NASA UAM Ecosystem Partnership Approach

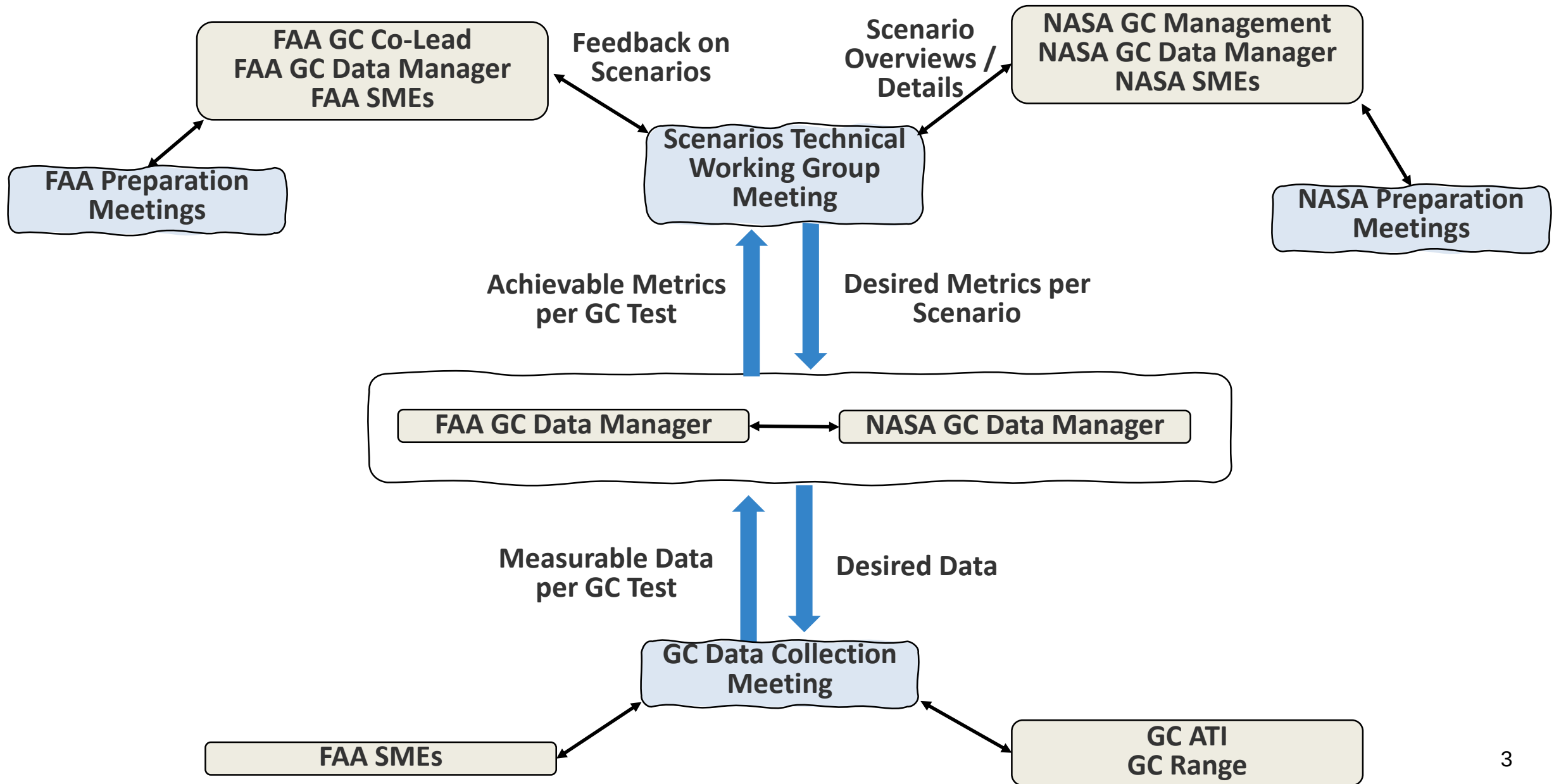
NASA intends to establish partnerships with government, industry, and academia to collaborate on the critical enabling technologies and vital research relevant to UAM.



NASA 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.

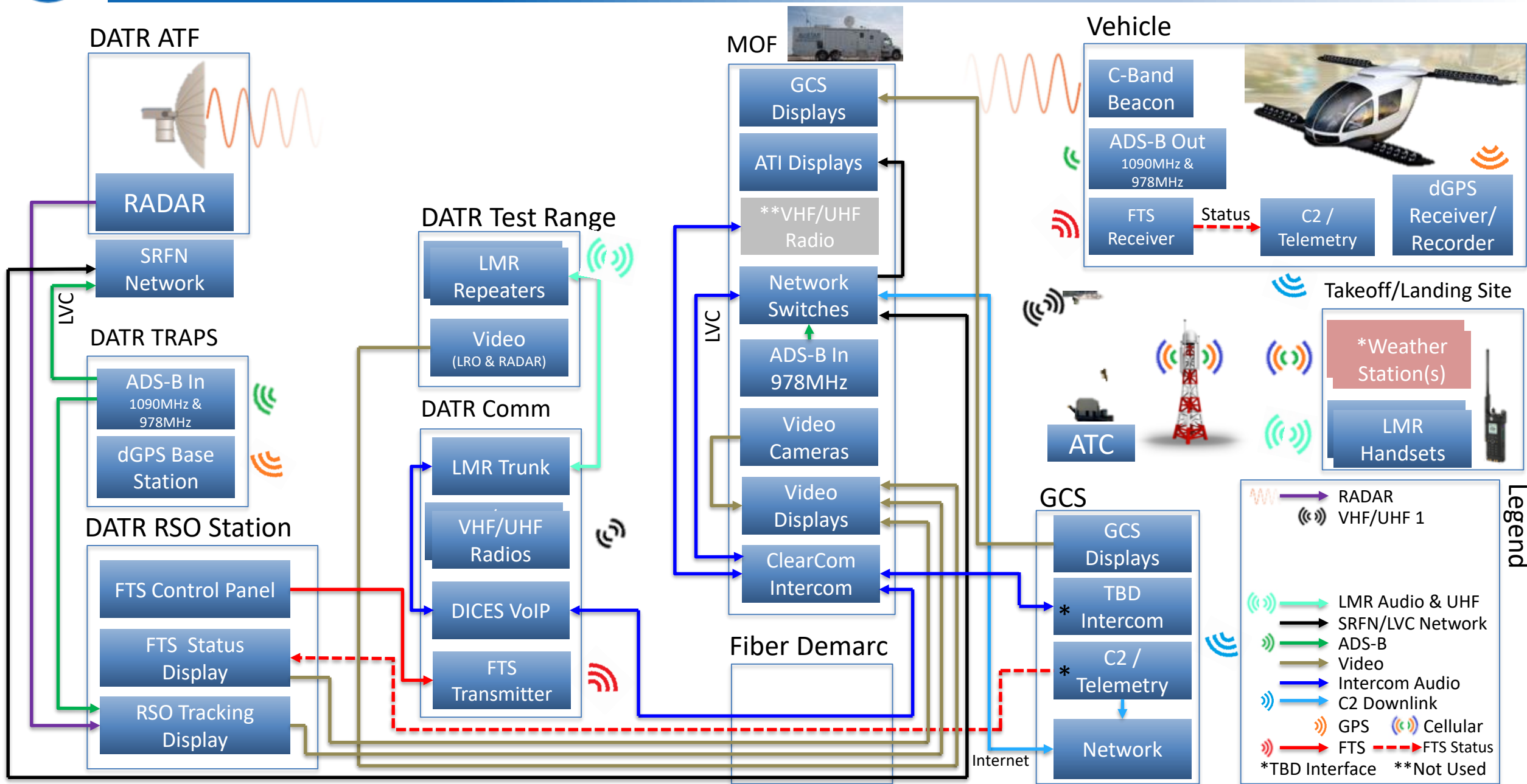


Roles of the Scenarios Technical Working Group: Data Collection



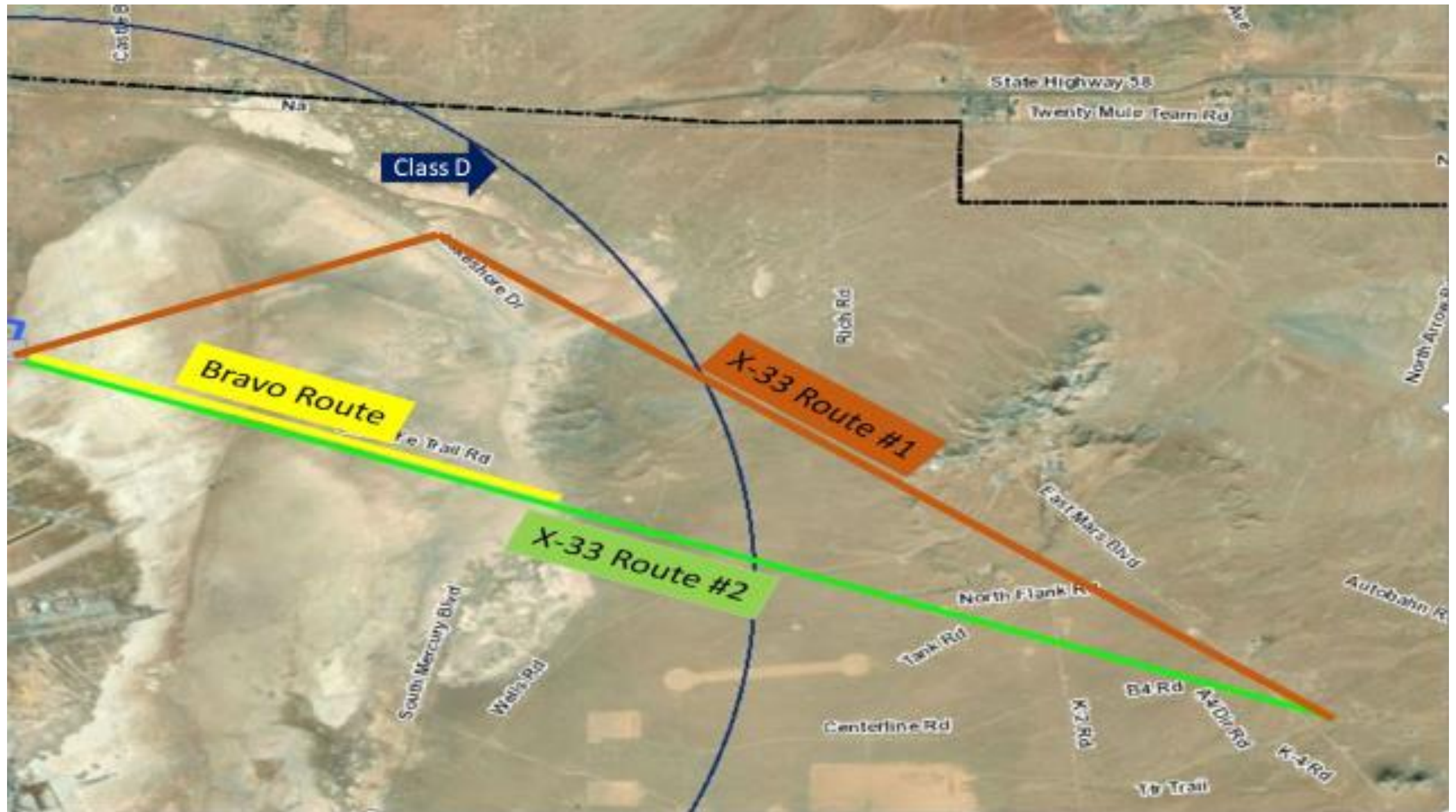


Range Systems - Remotely Piloted Vehicle





Area A to X-33 Route

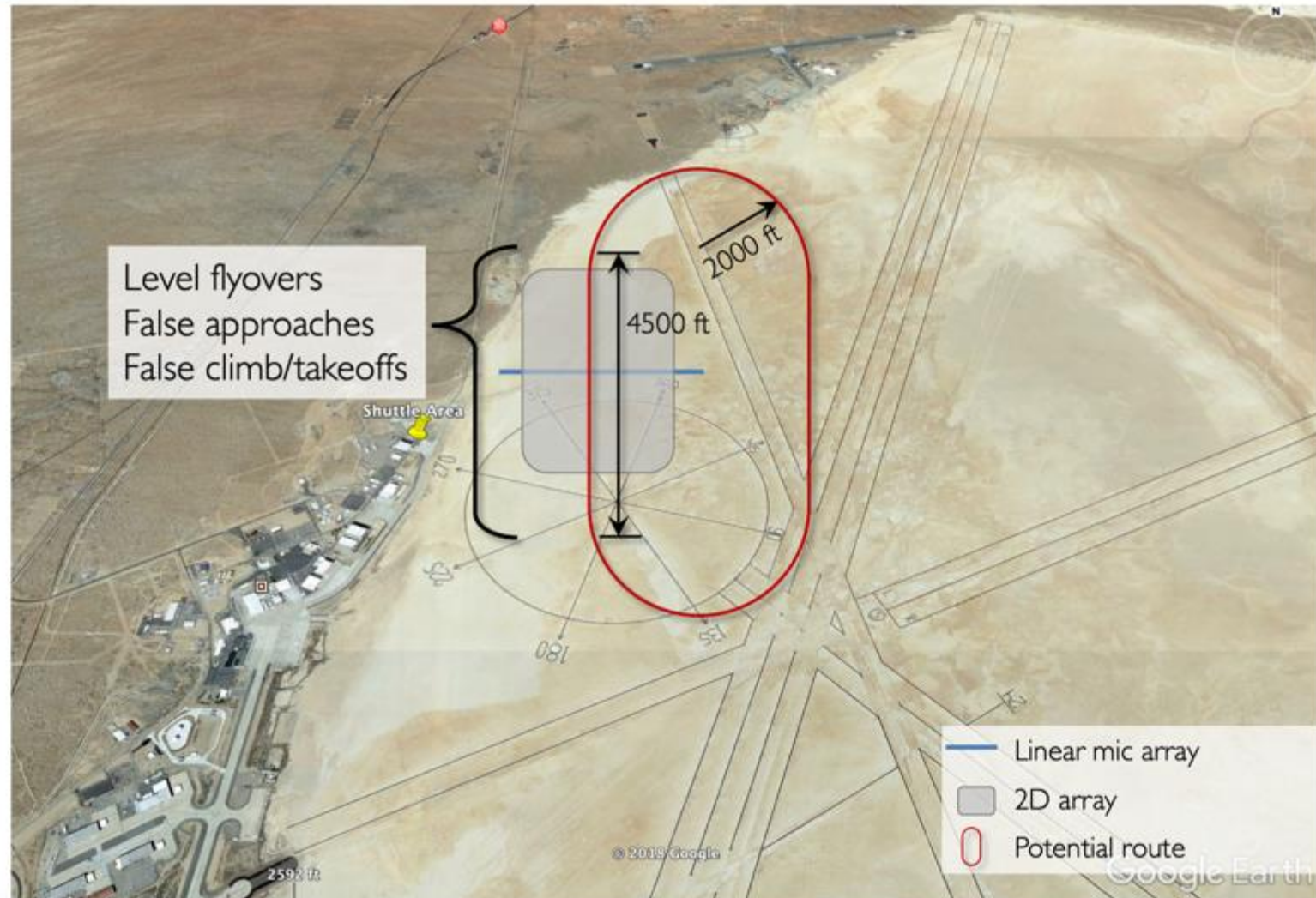


Potential flight routes

National Aeronautics and
Space Administration



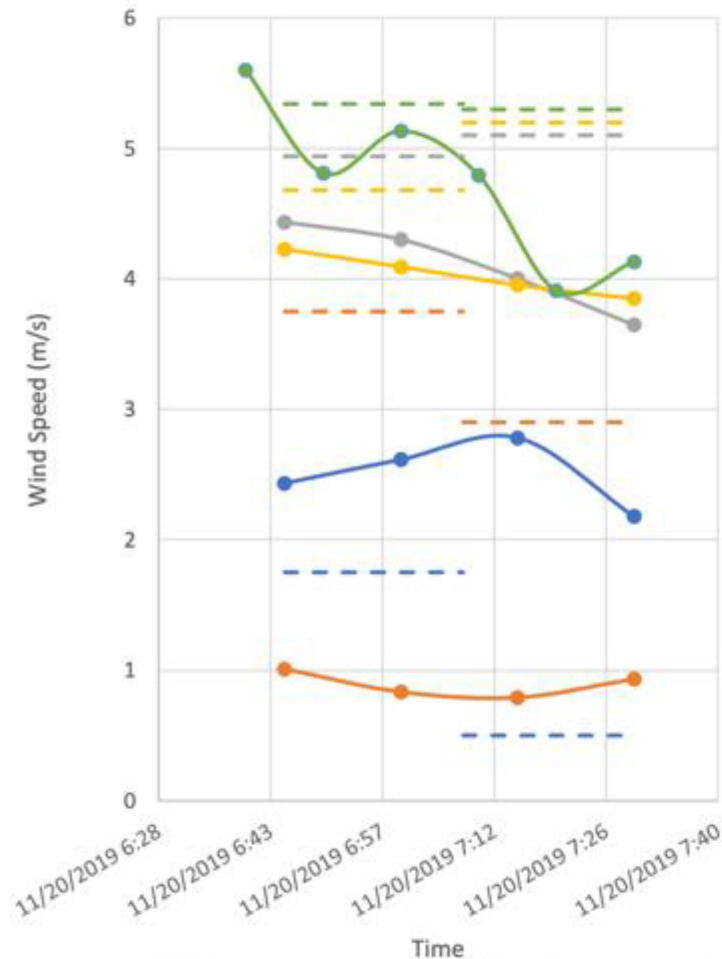
- Rough route estimate based on conventional helicopter capabilities
- Depending on vehicle capabilities, approach and takeoff tested along level flyover flight path
- Surrounding area needs to be quiet!
- Proposing weekend testing



November 20 @ 7:08Z WX Station Surface Data

11/20/2019

WX_1 WX_2 WX_3 WX_4 WX_R
CFD_1 CFD_2 CFD_3 CFD_4 CFD_R
CFD_1 CFD_2 CFD_3 CFD_4 CFD_R



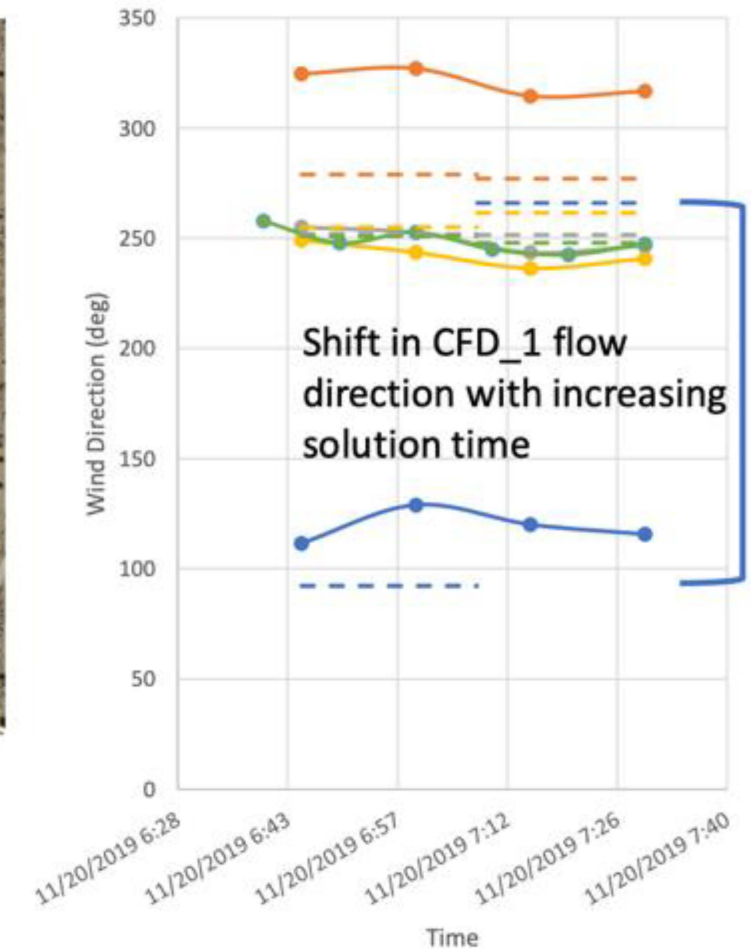
Fair agreement with windspeeds



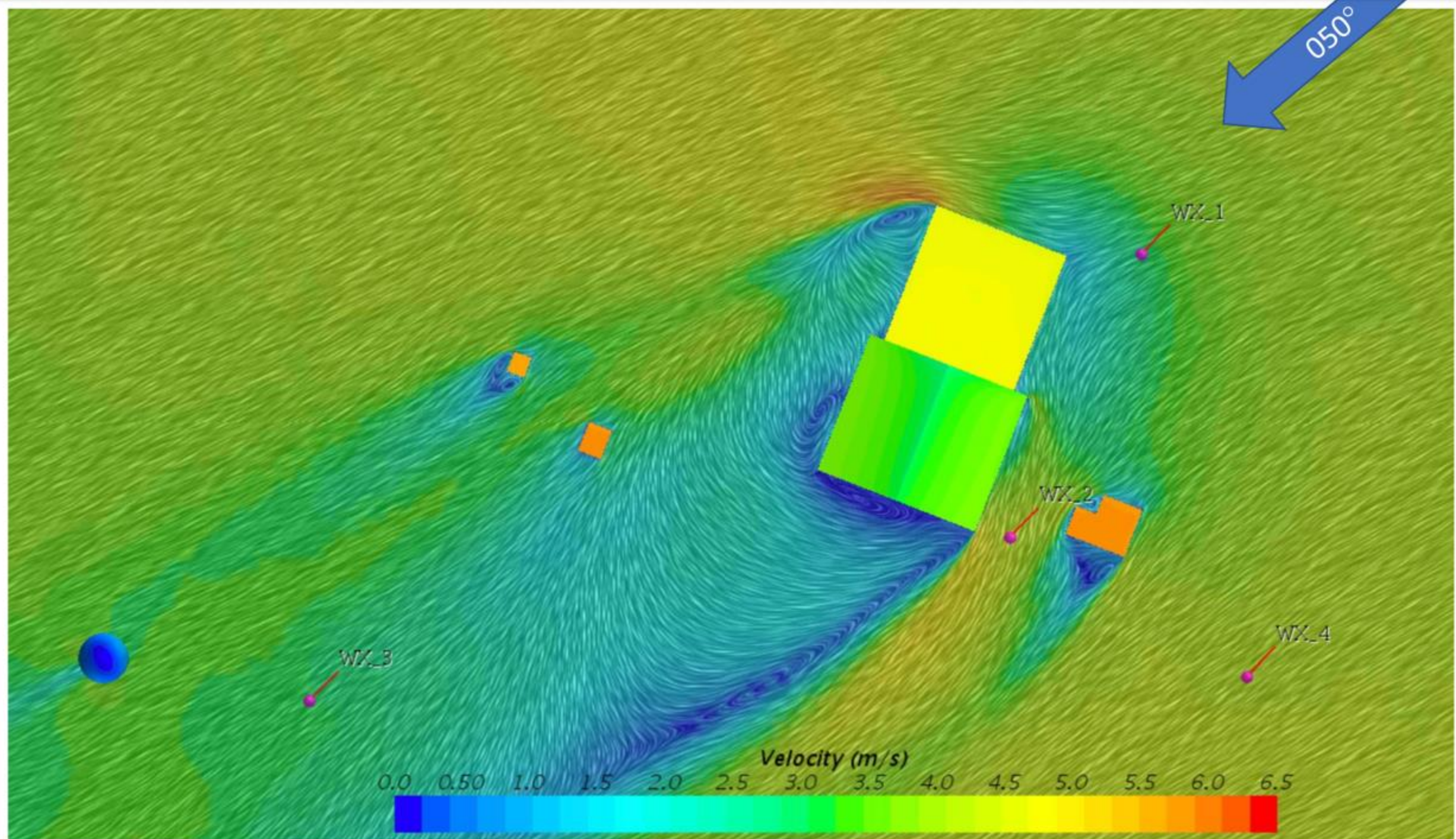
Left half dashed lines < 500k iters
Right half dashed lines > 500k iters

11/20/2019

WX_1 WX_2 WX_3 WX_4 WX_R
CFD_1 CFD_2 CFD_3 CFD_4 CFD_R
CFD_1 CFD_2 CFD_3 CFD_4 CFD_R

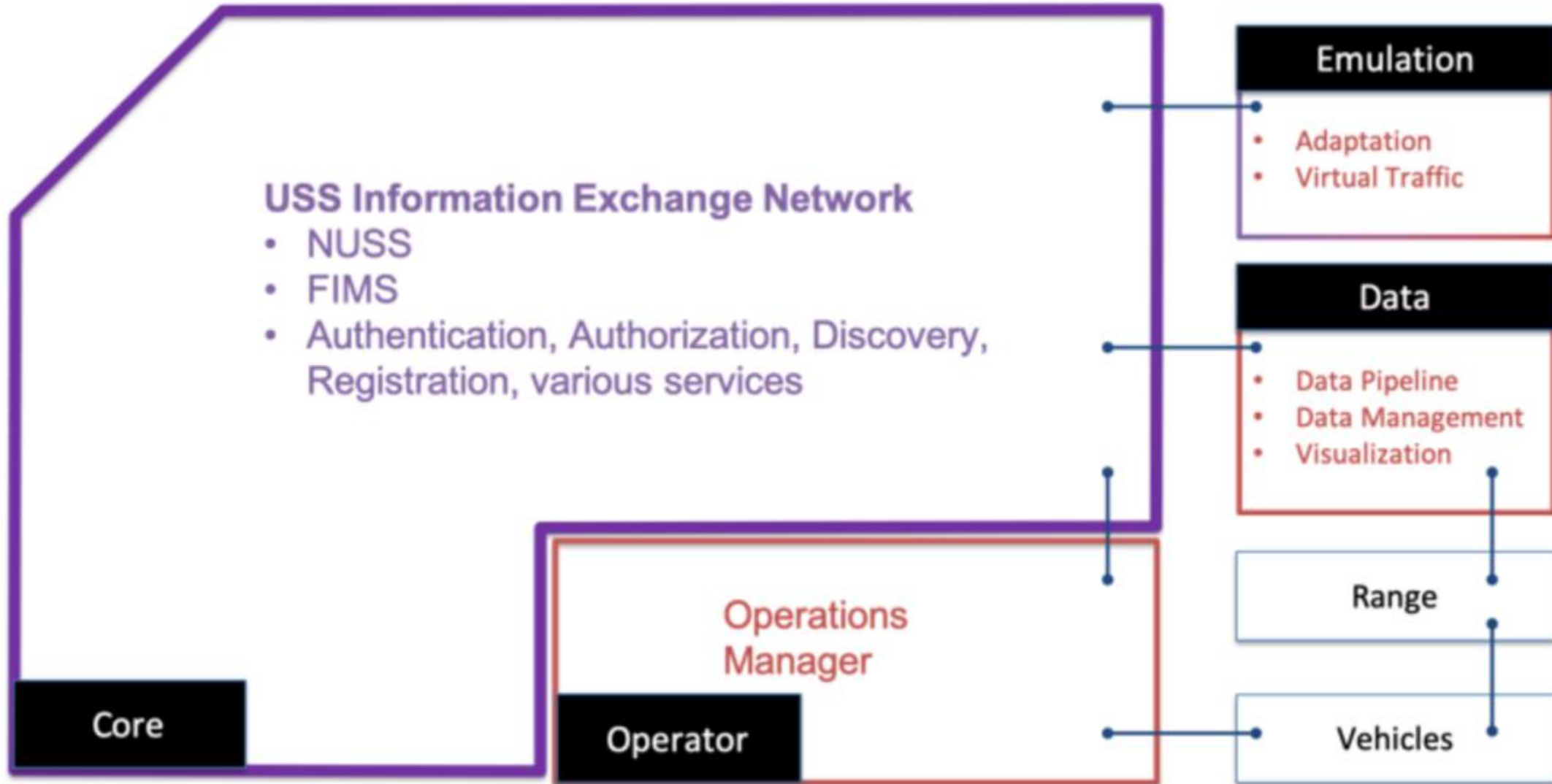


Shift in CFD_1 flow direction with increasing solution time





ATI/ATM-X Airspace Operation Manager (AOM)





Data Visualization

- Grafana dashboard
- Google earth
- iUTM





GC DT Flight Test – Scenario 3

	Description	Airspace Assumptions	ATC Interaction	Background Traffic
Scenario 3	<p>Manned vehicles will fly from Area A to X-33 site</p> <p>Unmanned vehicles without a FTS will fly from Area A to X-33 site if two GCS are available (beyond line of sight)</p> <p>Unmanned vehicles with FTS will fly from Area A to Area A</p> <p>Emulate off nominal conditions during UAM port approaches and landings in Class D airspace and the associated interactions with UAM operators (USSs) and ATM along with the associated timing of messages and interactions</p> <p>Scenario 3a: Go Around</p> <ul style="list-style-type: none">Emulate occupied or obstructed <u>vertipad</u> that requires the UAM vehicle complete a go around and enter a loiter patternUSS provides a consistent off nominal approach as part of initial predeparture flight plan submission <p>Scenario 3b: UAM vehicle divert to a runway</p> <ul style="list-style-type: none">Emulate an emergency landing that requires priority sequencing and diversion to alternate landing locationVehicle requires a runway landing due to limitations in controllability with given power conditionsUAM operator and vehicle will initiate interaction with ATC in Class D to obtain clearance for landingThe handoff and interactions between UAM operator, vehicle, and ATC need to be definedEmulated environmental conditions require a balked landing to be executed	<p>Class D and Class G</p> <p>Day VFR</p> <p>UAM corridor has been established and is in use based on a helicopter-like Letter of Agreement (LOA)</p> <ul style="list-style-type: none">Allows for multiple UAM flights in the corridorNo <u>2 way</u> VHF/UHF communication required in nominal opsUAM operator will <u>resequence</u> vehicle performing a go around into stream of virtual traffic	<p>3a: ATC Interaction not required</p> <p>3b: ATC interaction required with vehicle and UAM operator</p>	<p>IFR, GA, and UAM virtual traffic. The IFR and GA traffic will emulate a Class D airport and the UAM virtual traffic will follow route and adjacent routes following a static schedule</p>



Airspace Network

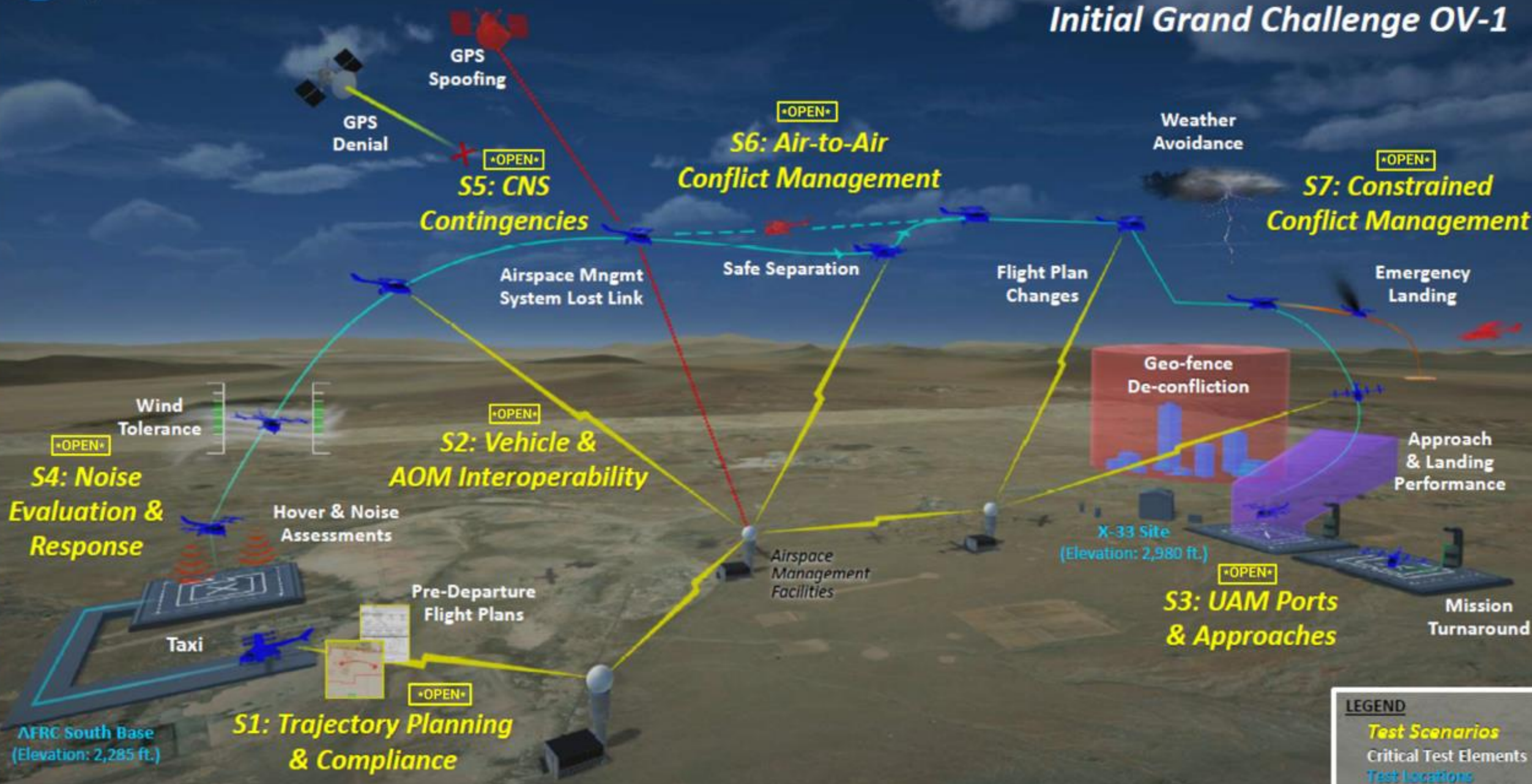
Elements	Services	AOM Component	Minimal Information Requirements
Balked landing	<ul style="list-style-type: none">•USS discovery•Operational plan negotiation•Flight position updates•ATC clearance•State maintenance•Conformance monitoring	NUSS FIMS	<ul style="list-style-type: none">•Operational state notifications (Cancel)•Operational boundaries•Aircraft position•Flight plans•Static and dynamic constraints•Terrain and weather•



National Aeronautics and
Space Administration

NASA Grand Challenge

Initial Grand Challenge OV-1



PRE-FLIGHT

Flight planning and communication.

Industry
Services

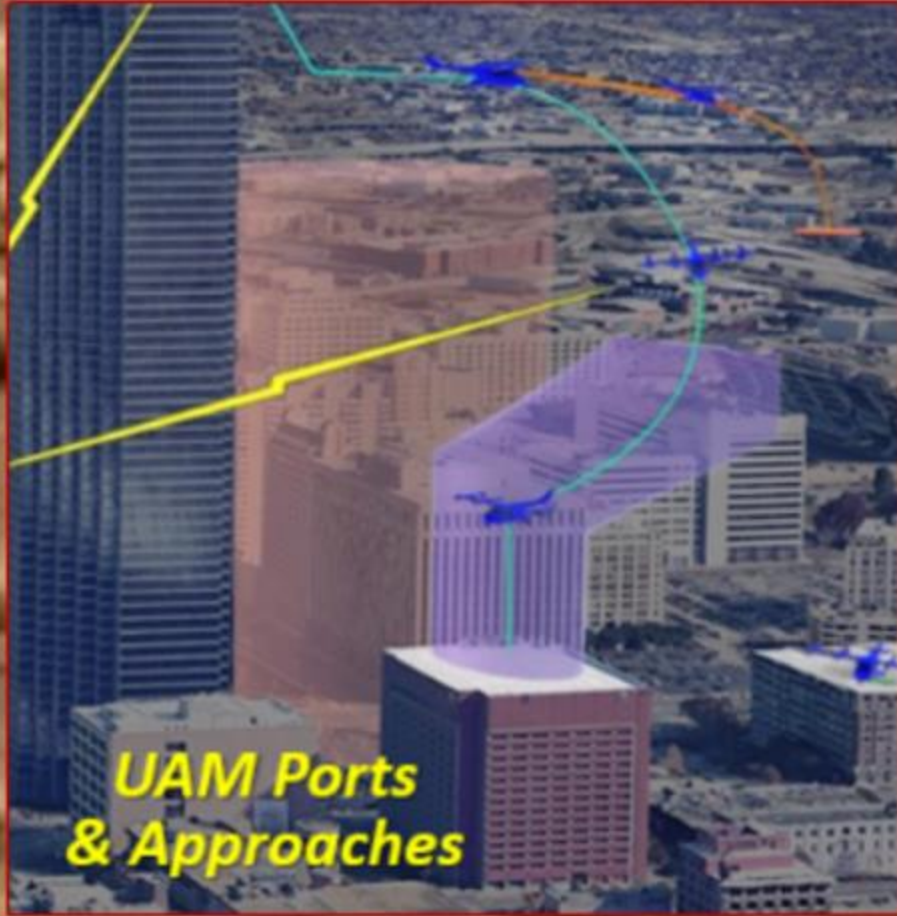
USS

AOM

Discovery Service

UAM Pilot

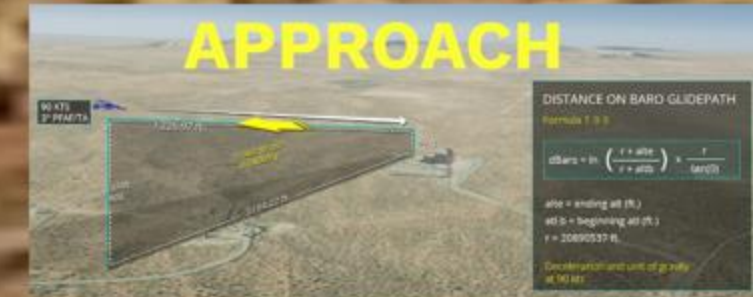
Scenario 3: UAM Ports and Approaches



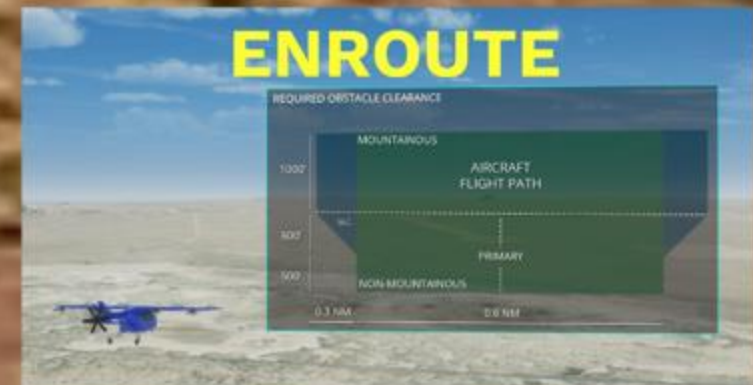
OPEN



OPEN



OPEN

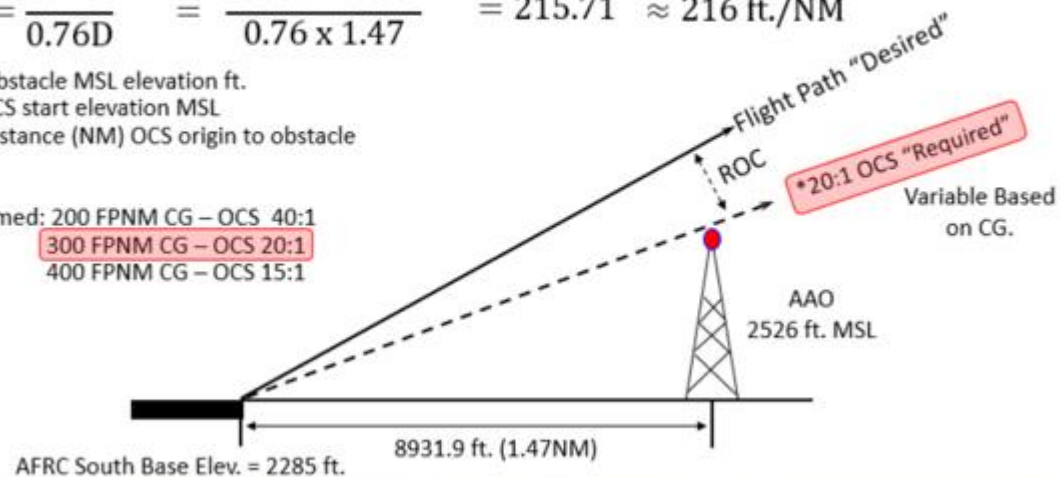


OPEN

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

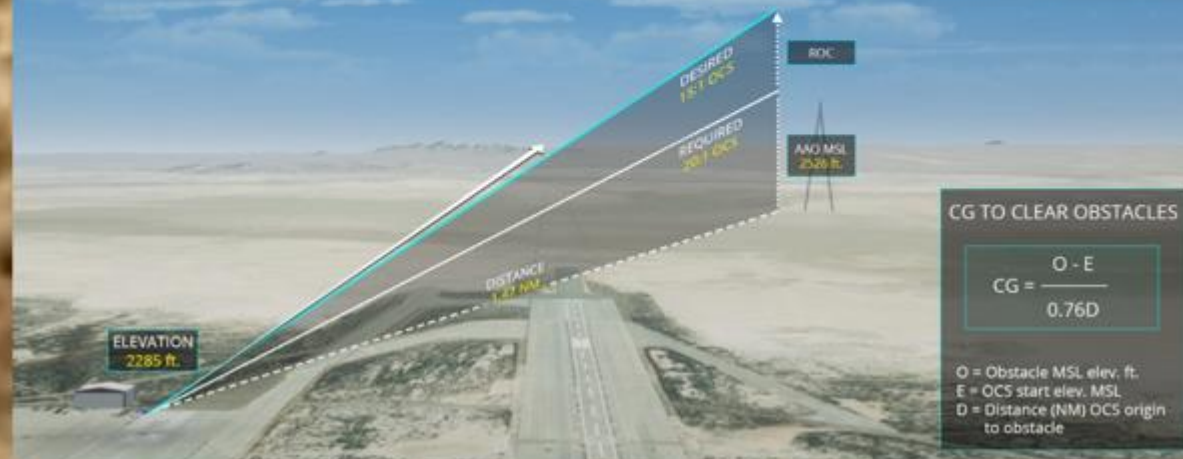
O = Obstacle MSL elevation ft.
E = OCS start elevation MSL
D = Distance (NM) OCS origin to obstacle

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



CALCULATING CLIMB GRADIENT

Animate diagram being generated in 3D space -
Illustrating how required/desired climb gradients are
calculated. Camera follows UAS as it climbs.



FLIGHT PATH TRACKING

Show mean flight tracks that have been collected for
different aircraft.

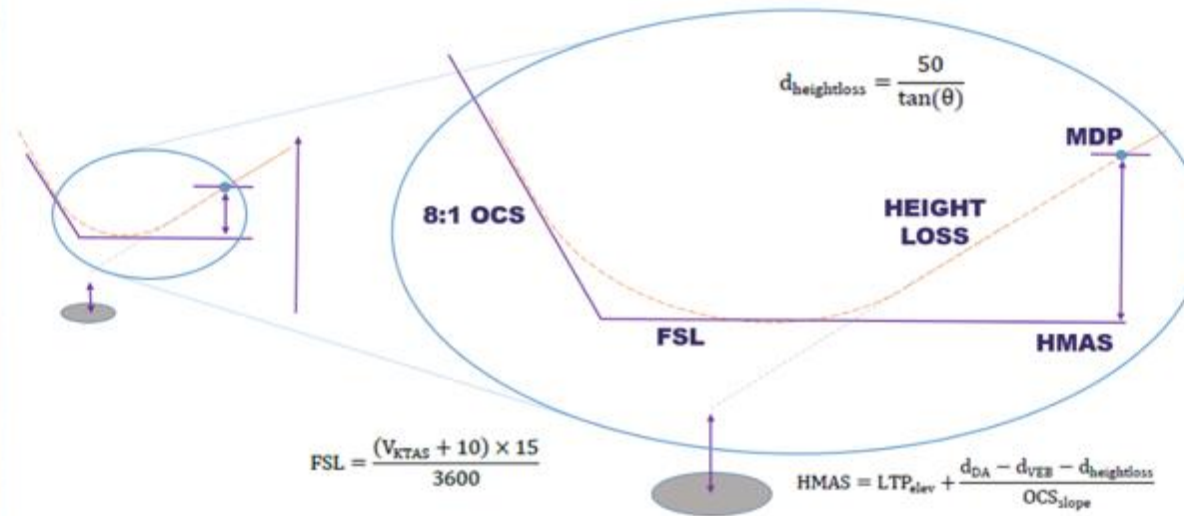


FLIGHT PATH TRACKING

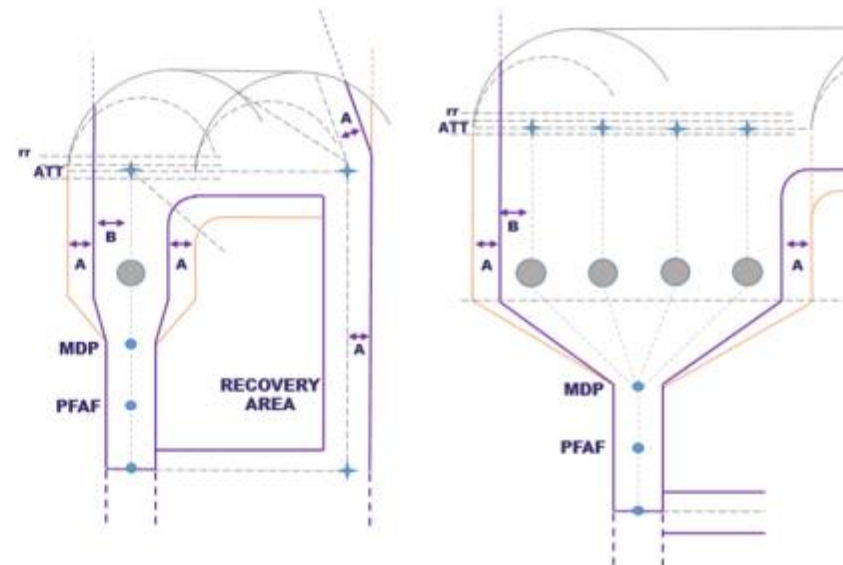
Ground track overlay for all
aircraft within containment
area.



APPROACH DECOUPLING



PROCEDURE RECOVERY



1. TOLA OEA
Operation Agnostic
2. Recovery Entry Fix
Calculated
3. Standard Holding
OEA

$$\begin{aligned} A &= 1 \times \text{XTT} \\ B &= 2 \times \text{XTT} \end{aligned}$$



Grand Challenge Mission Task Elements (MTEs)

Mission 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

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