UTM BVLOS CONOPS - Multi Operator Technology Assessment (MOTA)

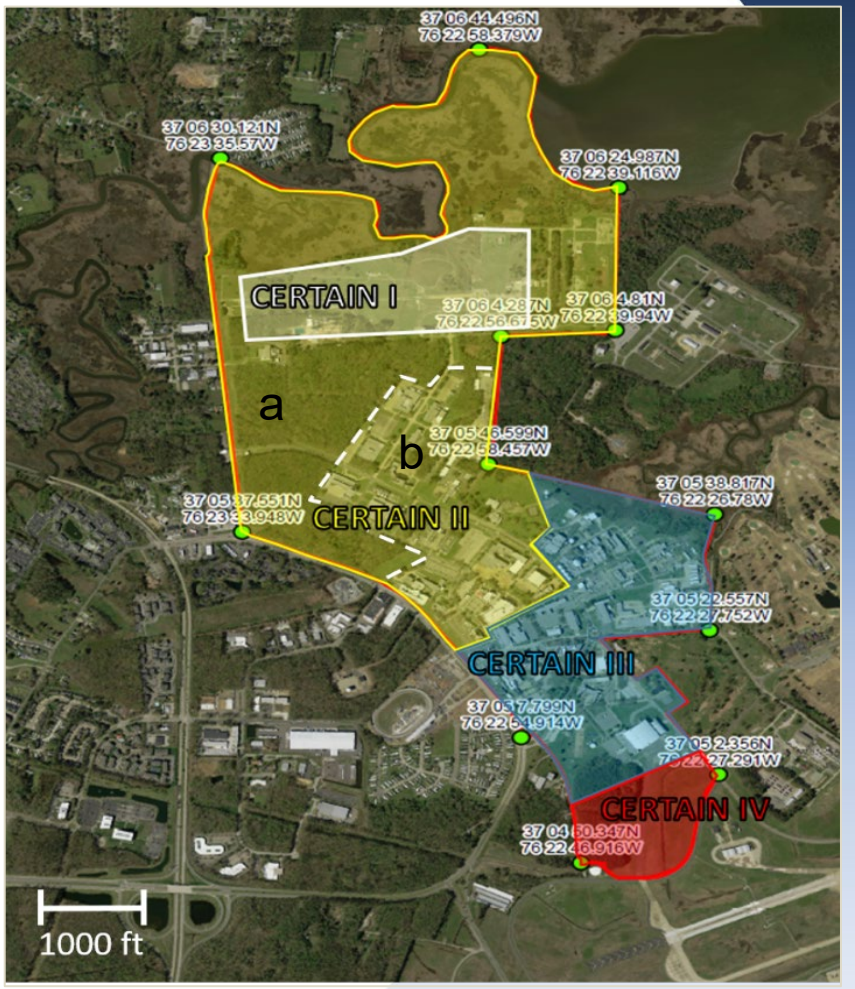
In support of NASA ATM-X UTM BVLOS

UTM BVLOS MOTA Test Objectives

- Acquire results to inform standards focused on C2, Surveillance, DAA and Weather through an assessment of a fully-integrated UTM BVLOS Ecosystem including:
  - Surveillance equipment with Radar, ADS-B, and FLARM on Integrated displays
  - Onboard autonomous systems equipped for DAA and Contingency Management
  - Multiple Operators with mixed overlapping and integrated operations
  - USS coordinated high-density flight operations
  - Human Factors usability results for nominal and off-nominal conditions
  - Multi-Vehicle Human Hardware In The Loop (HHITL) simulation
  - Subsequent multi-vehicle flight operations
- Exercise the NTAP process for the FAA to provide feedback on the process and documentation requirements

UTM BVLOS MOTA Test Overview

- BVLOS UTM Operations with Off Nominal scenarios with Procedural and Sensors based separation from crewed aircraft.
- Flight operations on CERTAIN using NOVO BVLOS capabilities for assessment of end-to-end UTM ecosystem.
- Unscripted scenarios with multiple vehicles in the air simultaneously:
  - Operations mainly on CERATIN 1 and 2a, potential expanding to 2b/3
    - Operators coordinate their operations via USSs
  - “Sunny day ops”
    - Full conformant ops from vertiports around CERTAIN with no conflict
    - Some overlapping volumes – preflight check of overlapping volumes by USS
  - “Non-Sunny day”
    - Simulated emergency requiring landing – S2D, traffic conflicts, battery failure
    - Contingent Vehicle due to onboard DAA - ICAROUS maneuver needed
    - ADS-B/RADAR Traffic around the vehicle well clear (off board DAA)
- HHITL simulations with up to 7 HHITL vehicles.
- Simulations followed with live flight operations of 5 vehicles with the HHITL vehicles used to supplement with m:N research.



NTAP Phases

FAA Drone Integration

Intake Criteria

Phase 1 Early Engagement

- **Service Provider** develops ConUse
- **Operator** develops ConOps using service
- **Service Provider** and **Operator** document their roles & responsibilities

Outputs:
- ConUse & ConOps
- Artifacts of roles (SLA, Master Agreement, etc.)

Phase 2 SRM

- **FAA** prepares and conducts SRM panel
- ***Prior to*** application submittal
- Includes hazards introduced by svc

Outputs:
- SRM document
- Incl. resolved gaps

Phase 3 Formal Review

- **Operator** submits exemption request
- **FAA** reviews request against SRMD

Operation (waiver/exemption) **Approval**

Service Acceptance

Phase 4 Path to Repeatability

- ✓**Operator** receives waiver/exemption
- ✓**Service Provider** receives operational parameters to support scalability
- ✓Service-enabled operations begin

Outputs:
- Ops data for validation
- Streamlined waivers for other operators

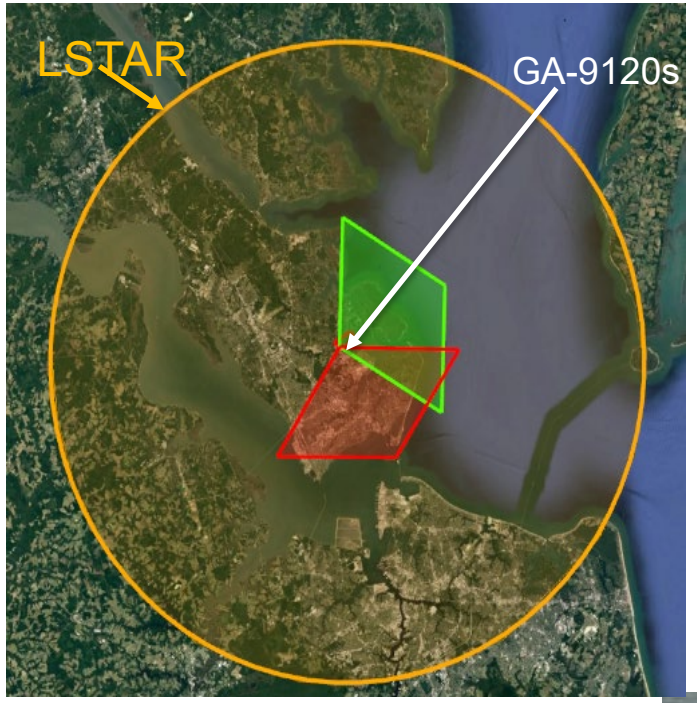
Flight Vehicle – FreeFly Alta 8 HDV BVLOS Config

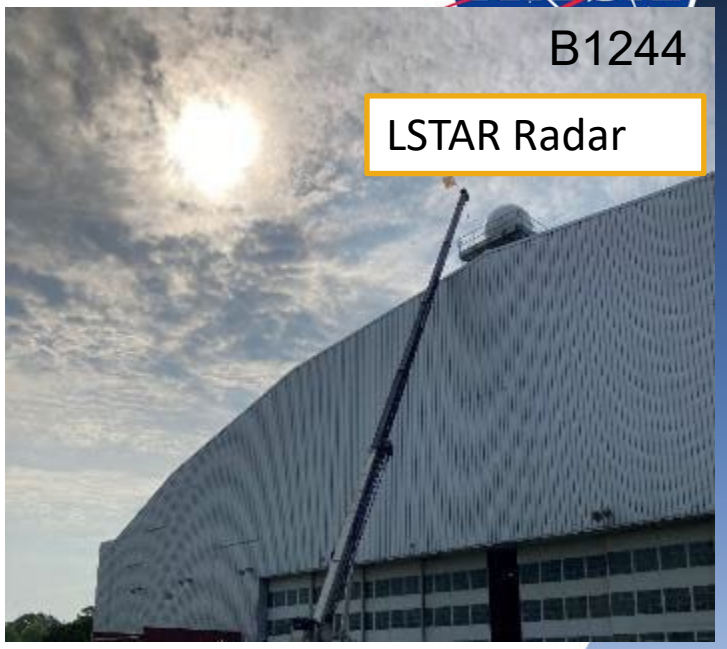
Langley sUAS Category	I
sUAS Type	Multi-Rotor, 8 Motor(Brushless)
Diagonal Length	52 in (1.3 m) *Does not include Props
Maximum Weight	40 lbs (18.14 kg)
Empty Weight	22.0 lbs (6.2 kg)
Propulsion Battery	6-cell Li-Poly (Nominal 22.2V)
Speed	0 – 30 kts (0-15.4m/s)
Max Endurance	34 mins (empty) 15 mins with 30% reserve in this config with 16Ah
Operating Frequency	2.4 GHz RC TX C2 (VLOS Only) 900 MHz C2 & Flight Data 700MHz/1700MHz C2 & Flight Data & Video
Command and Control	RC TX (VLOS Only) Workstation in ROAM/MOSAIC LTE Tablet
Replacement Cost	Approx $20k

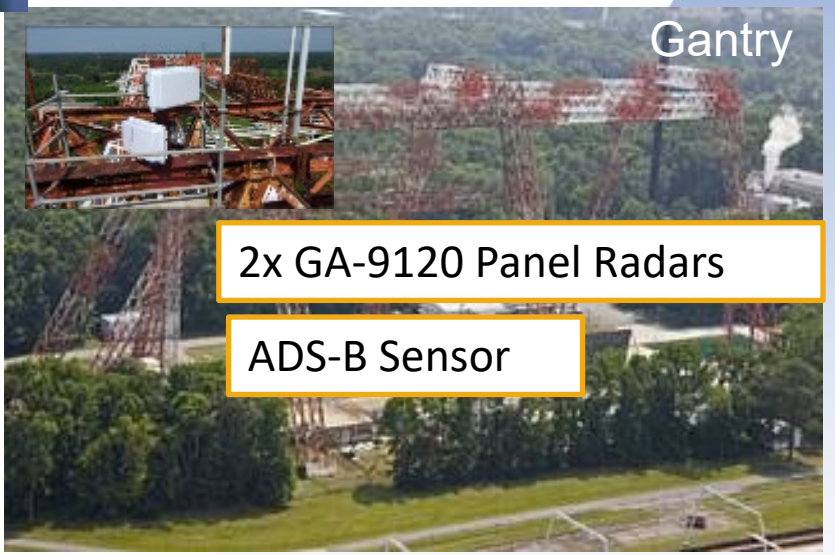
- **Software/firmware throughout the system**
  - Autopilot PX4 (FreeFly version of 1.12.3)
  - MPATH – NASA GCS (QGroundControl Based)
  - NASA Developed autonomous systems (ICAROUS/S2D)
- **Hardware components**
  - uAvionix microLink for C2 Communications
  - Botlink XRD 2 for C2 and video stream
  - Nvidia Xavier or Orin nano onboard computer for autonomous software
  - ADS-B and FLARM in for ICAROUS DAA
  - S2D camera for geo-location of movement

Flight Surveillance Systems available

- **LSTAR Radar**
  - Azimuth coverage: 360 ˚
  - Elevation coverage: 0 – 30
  - Instrumented range: 40km
- **GA-9120 Radars**
  - Azimuth coverage: 120
  - Elevation coverage: 12˚ to 90˚ selectable
  - Instrumented range: 15km
- **Skylar Radar – Partner Device (Longbow)**
  - Longbow radar on Hampton University building
- **uAvionix Ping3 ADS-B Sensors**
  - Range dependent upon the output power of the transmitting ADS-B transceiver
- **Ground FLARM sensor**
  - Used to track position of sUAS independent of the C2 link
- **Tower Communication**
  - RSO communication with LaRC Tower for procedural Airspace Deconfliction with the class D airspace



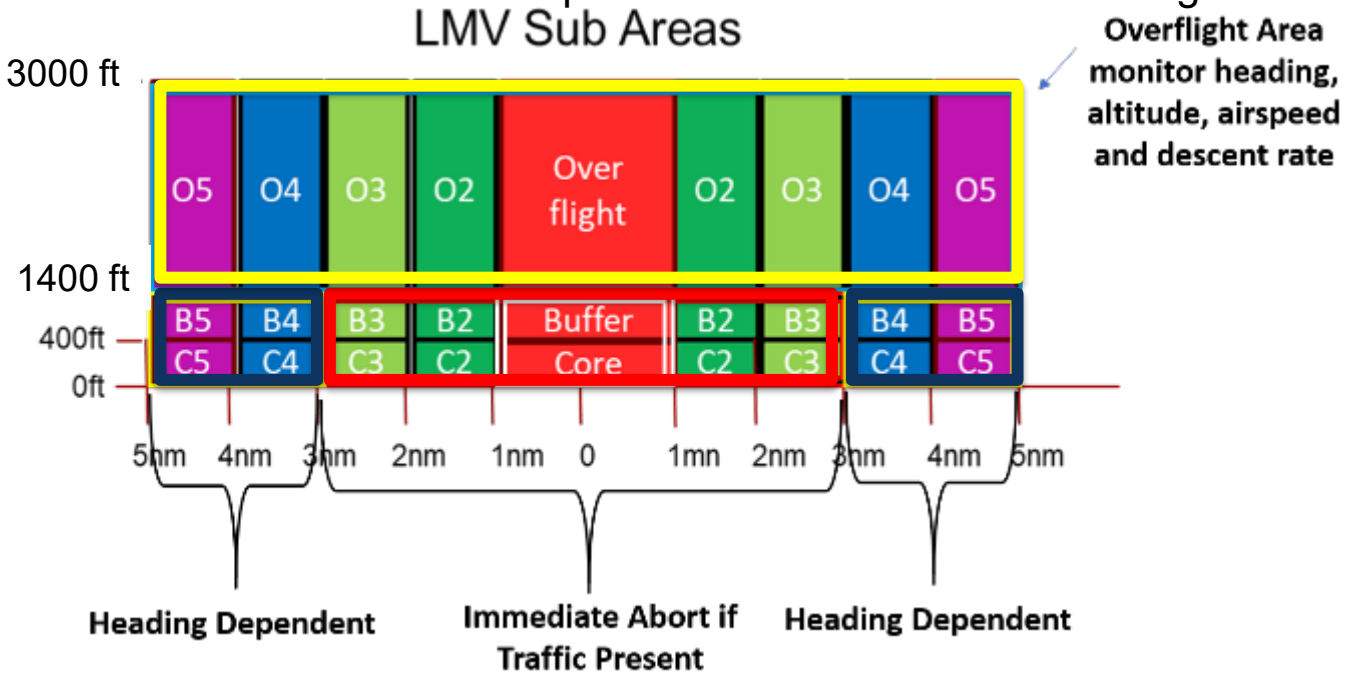




Langley Monitoring Volume (LMV)

The Langley Monitoring Volume is defined as rings of 1,2,3,4,5 NM radius from the CERTAIN range, with altitude bands of 400 ft, 1400 ft, 3000 ft.

- Abort triggered if traffic is:
  - Within 3 NM and below 1400 ft
    - sectors C3, B3, C2, B2, Buffer
  - Heading dependent if between 3 NM and 5 NM and below 1400 ft
    - sectors C5, B5, C4, B4
    - 120 kts = ~2 minutes alerting
  - Exception
    - Local traffic in the pattern at KLFI and RSO listening to tower

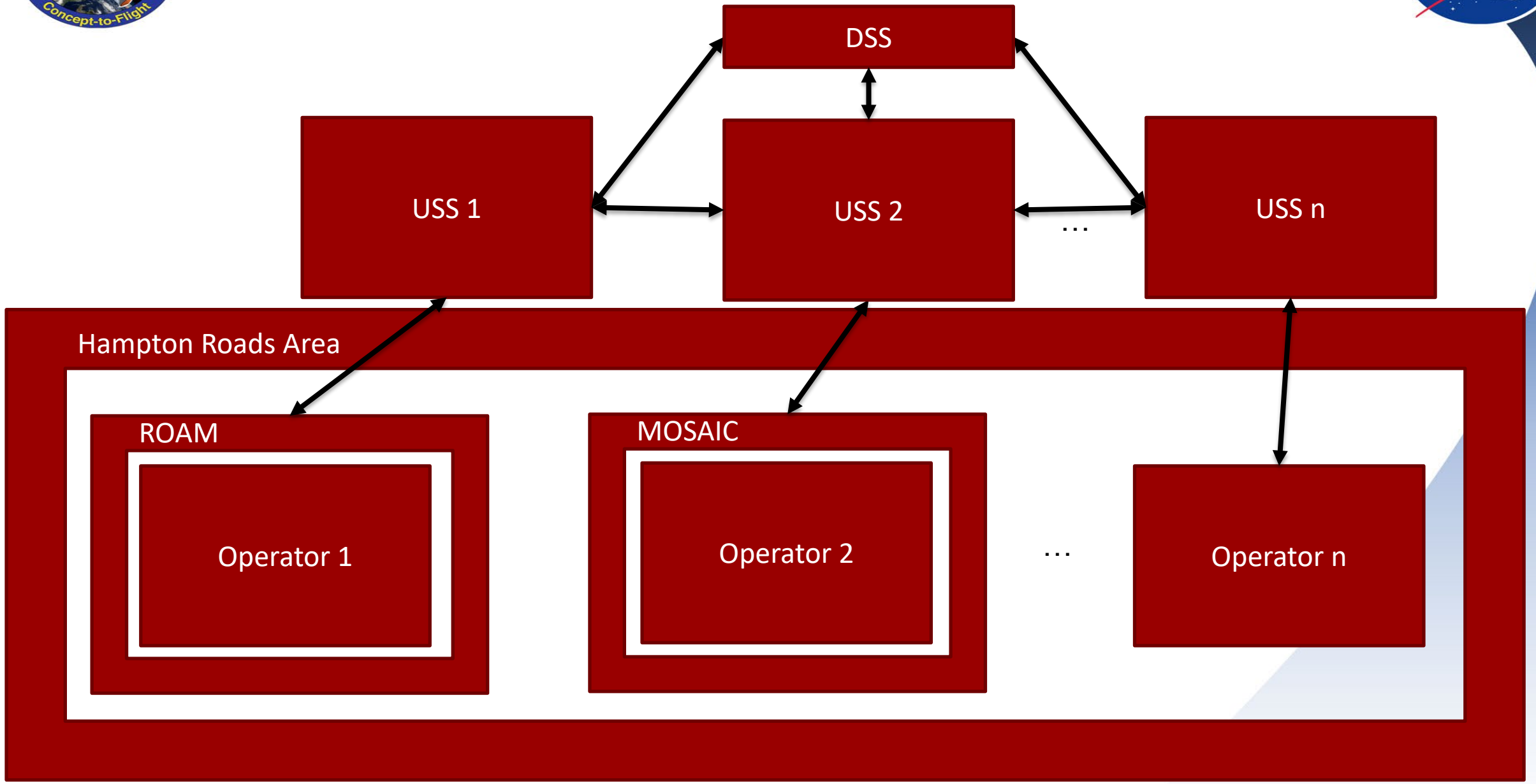


Vertiports On CERTAIN

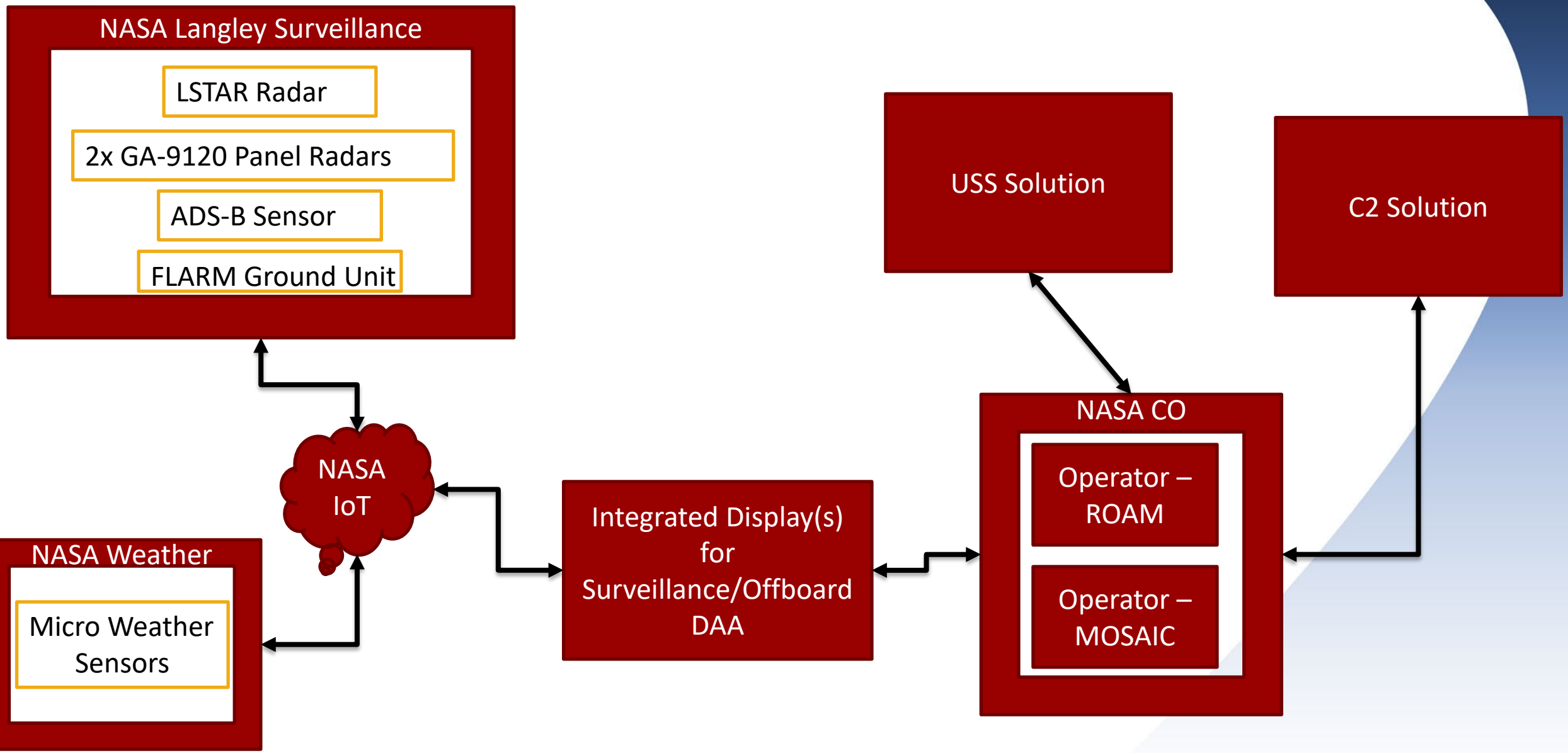
Overlapping Operations

Multi-Operator Technology Assessment (MOTA)

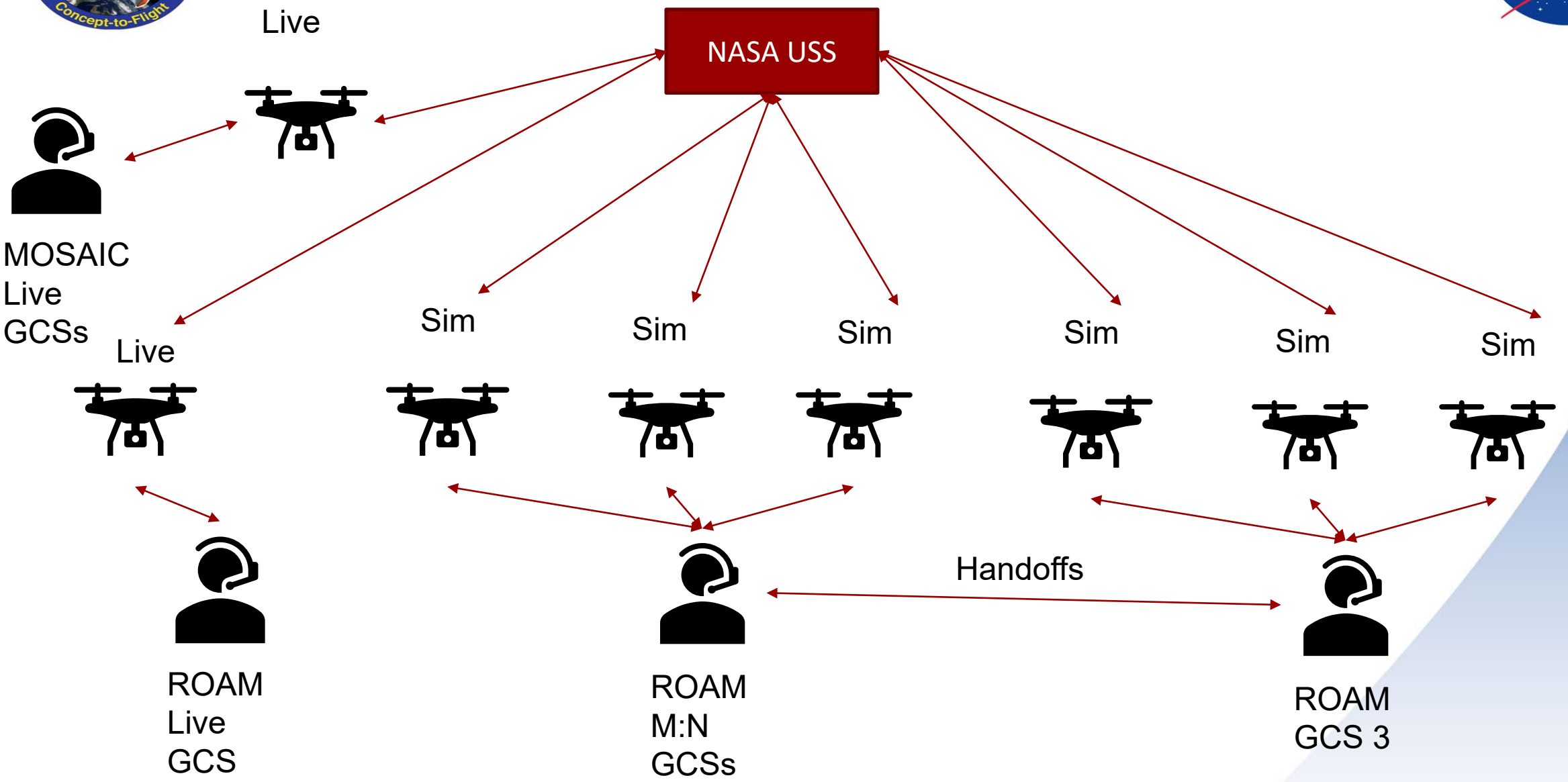
Multi Operator Flights using USS comms



Multi-Operator Technology Assessment (MOTA) Setup



Initial MOTA testing implementation with m:N support from TTT



Design/Planning | Fabrication/Assembly | Flight Test | Documentation/Reports

Estimated Schedule

Project	Apr 24	May 24	Jun 24	Jul 24	Aug 24	Sept 24	Oct 24	Nov 24	Dec 24	Jan 24

CONOPS/CONUSE/SLA Generation

Lesson learned/Notes on NTAP process

Integration Testing

Sim

Flight Testing – Phase 1

Flight Testing – Phase 2

Internal Approval Processes

Flight and Sim Reports

UTM BVLOS

Multi-Operator Technology Assessment (MOTA) Sim / Flight

NTAP Submittal

NTAP Final Submittal

Q3 FY24 | Q4 FY24 | Q1 FY25 | Q2 FY25

Summary

- **The Multi-Operator Technology Assessment is design to generate essential results for a representative UTM BVLOS Operation in non-Mode-C Veil airspace**
  - Will lead to an acceleration of UAS operational expansion
  - Through directly supporting standards development and validation
- **Results are extensible to other UTM operations**
- **Expansion of flight operations beyond the CERTAIN is envisioned**
  - Enables integrated collaborative flight operations with Longbow
  - Supports a Maritime Surveillance public benefit operation
  - Considered substantial compared to Package Delivery CONOPS
  - Class-G airspace

Acronyms

- MOTA – Multi Operator Test Assessment
- UTM – UAS Traffic Management
- BVLOS – Beyond Visual Line Of Sight
- ATM-X – Air Traffic Management eXploration
- NOVO BVLOS – No Visual Observer BVLOS
- CERTAIN – City Environment Range…
- HDV – High Density Vertiplex
- FAA – Federal Aviation Administration
- S2D – Safe2Ditch
- VPX – VertiPort X
- USS – UAS Service Supplier
- UAS – Uncrewed Aerial Vehicle
- ADS-B - Automatic Dependent Surveillance–Broadcast
- ICAROUS - Independent Configurable Architecture for Reliable Operations of Unmanned Systems
- RTL – Return to Launch
- COA – Certificate of Waiver or Authorization
- NTAP – Near Term Approval Process
- ASTM – Standards body (not sure if it is short for anything anymore)
- SDSP – Supplemental Data Service Provider
- CONOPS – Concept of Operations
- CONUSE – Concept of Use
- SLA – Service Level Agreement
- SAA – Space Act Agreement
- DSS – Discovery and Synchronization Service
- ROAM – Remote Operations for Autonomous Missions
- MOSAIC – Mission Operations & Autonomous Integration Center
- FLARM – Flight Alarm
- TTT – Transformative Tools and Technologies
- DAA – Detect and Avoid
- RSO – Range Safety Officer
- C2 – Command and Control
- ER-ARB – Eastern Region Airworthiness Review Board

Questions or notes?

- Notes from F38 attendees: