

The top banner features a composite background. On the left, a satellite view of Earth's surface is framed by a dark blue, curved, abstract shape. The center shows a vast expanse of white clouds against a clear blue sky. On the right, a deep space image with a purple and pink nebula and stars is also framed by a similar dark blue, curved shape. The NASA logo is positioned in the top right corner.

National Aeronautics and
Space Administration



LaRC WFF UAS Corridor Concept Mission

Lou Glaab, Branch Head Aeronautic Systems Engineering Branch, LaRC

WFF LaRC UAS Symposium, 10/16/2024

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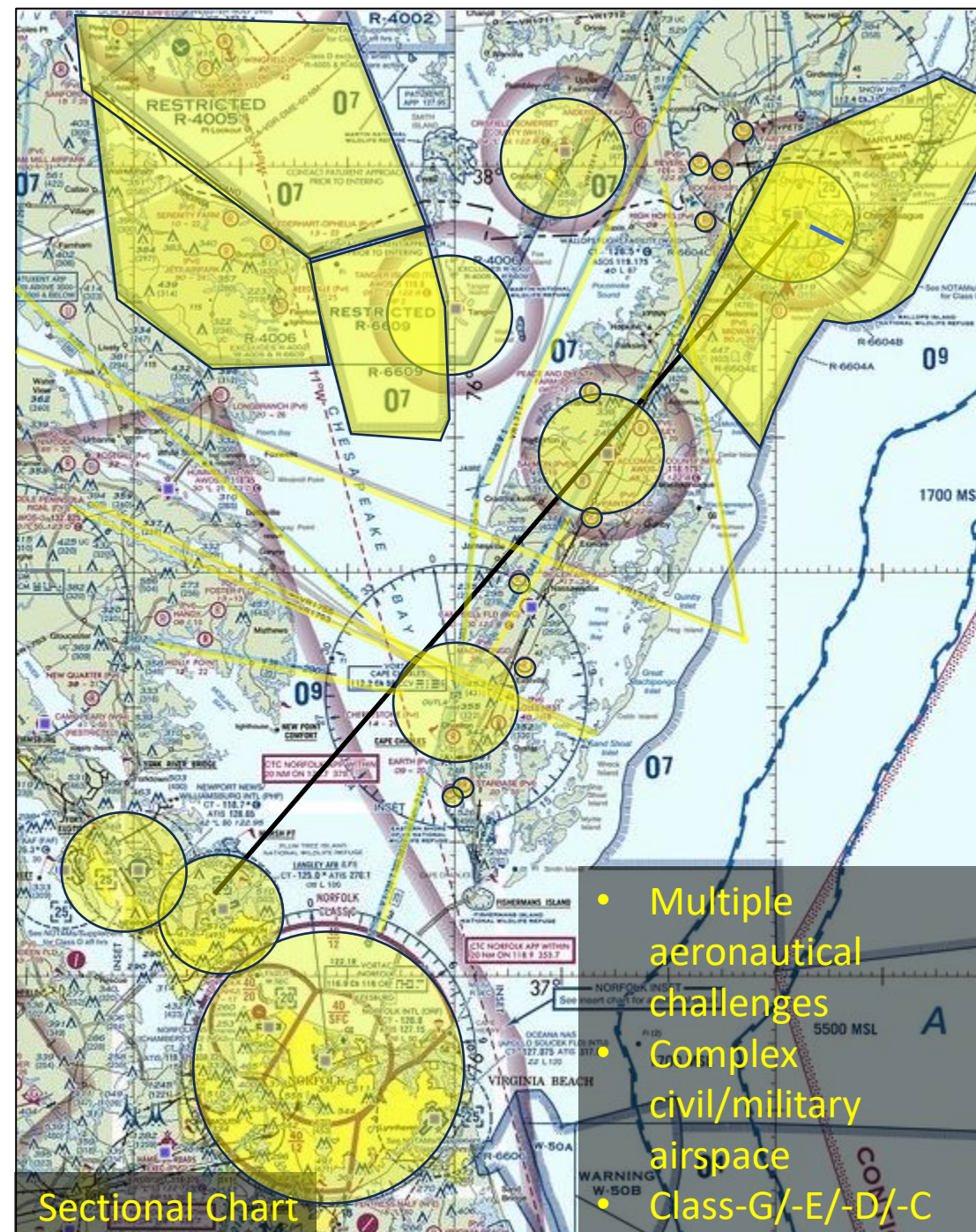
Introduction and Overview

- The future of Unmanned Aerial Systems (UAS) is paced by our ability to prototype and test future applications and systems to generate comprehensive results
- While a corridor between two locations has tangible value, the inherent overarching value lies within the results generated from the development, integration, safety risk analysis and subsequent usage
- Application of NASA and/or Industry technologies will accelerate their implementation for a broad array of similar relevant use cases
 - For NASA the value resides within Technology Transfer
- NASA has the ability and relevance to develop and execute advanced UAS missions
- The envisioned LaRC WFF Corridor is an example of an advanced UAS pathfinder prototype mission that will accelerate the future

Initial Look

66 nm direct

Google Earth



What is a Corridor for this application?

- Defined flight path/area potentially connecting several locations
- Substantially different usage of existing airspace resulting from comprehensive safety and risk assessments, including:
 1. Analysis of existing air traffic
 2. Analysis of ground risk from resulting overflights
 3. Defined Concept of Operations (CONOPS)
 4. Description of Vehicle systems
 5. Required ground infrastructure
 6. Procedures for nominal and off-nominal operations
 7. Crew training
 8. Limitations (eg Wx)
 9. Safety Risk Assessment
 10. Associated Mitigations
- A Safety Case is developed including the elements listed above and used to establish and communicate the level of mitigated risk for the planned operations
- The resulting Safety Case and subsequent results serve as a foundation for similar future use cases

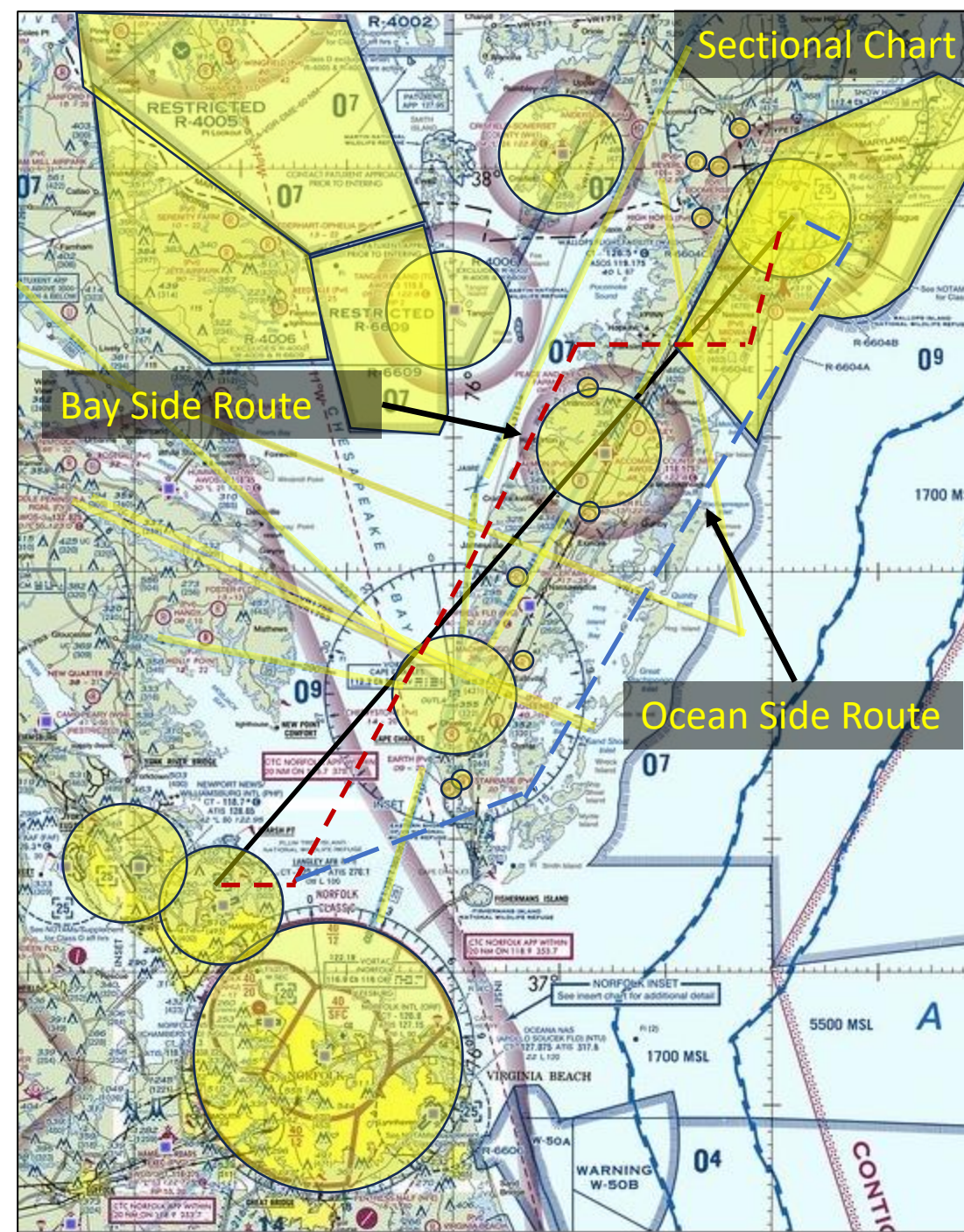
First Pass Assessment

- Benefits

- In general very low population densities
- Much of the corridor can be over water
- Airports in the vicinity are lower usage
- Most challenging airspace due to lack of ADS-B requirement (Class-G/-E/-D)
- Would support a Maritime Surveillance application
- Counter UAS surveillance for points of origin
- Science applications include: algal blooms, air quality, sea surface temperature, wildlife migration, coastal erosion, pollution monitoring, etc
- Military stakeholders (PAX, LAFB, Ft Eustis)

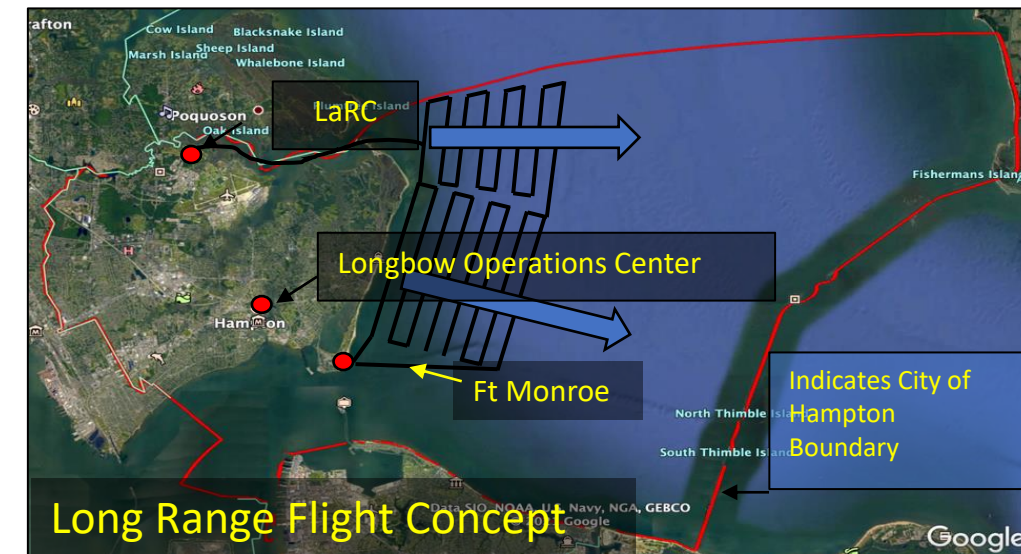
- Challenges/threats

- Most challenging airspace due to lack of ADS-B requirement (Class-G/-E/-D)
 - Commercial Fish Spotting area
 - Agriculture aircraft operations
- Many private/restricted airports in the area
- Two routes are envisioned: Bay Side and Ocean Side



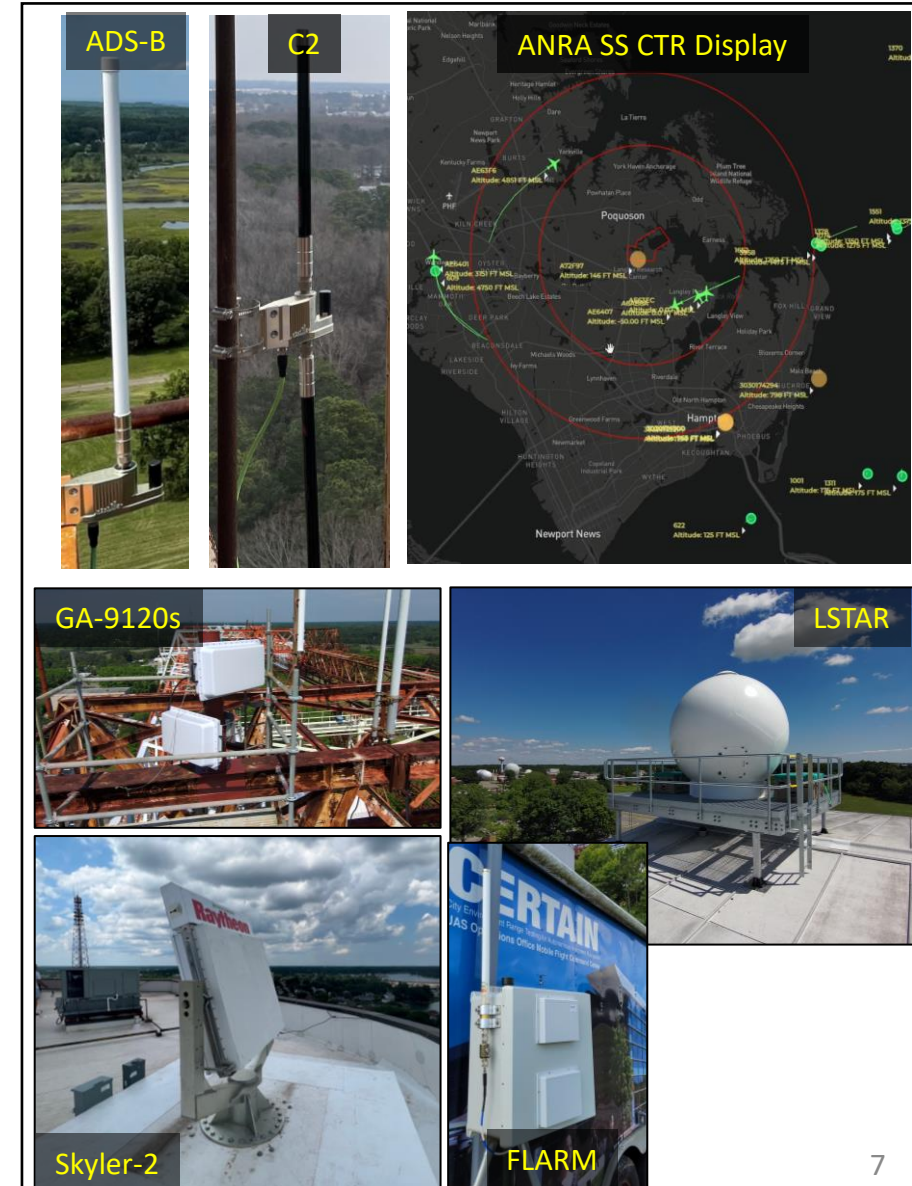
Existing Capabilities

- No Visual Observer Beyond Visual Line of Sight Operations (NOVO BVLOS) at NASA LaRC
 - Established through the High Density Vertiplex Project in AAM/AOSP
 - Features Remote Operations for Autonomous Missions (ROAM I/II) UAS Control Lab
 - Integrated ground-based surveillance systems
 - Human+Hardware+In+The+Loop integrated simulation testing
 - Ground Control Station Operator Remote Pilot In Command Training
 - Application of NASA UAS Technologies to enable NOVO BVLOS Operations: ICAROUS and Safe2Ditch
- ATM-X UTM BVLOS Project underway
 - Multi Operator Technology Assessment (MOTA) Simulation and Flight test to be completed in Q1FY25
 - Expanded to use MOSAIC UAS control center
 - Includes Multi Operator NOVO BVLOS ops at CERTAIN
 - Expansion beyond CERTAIN also underway
 - Supervolo long endurance vehicles procured
 - Simulation model development underway
 - Long Range flight beyond CERTAIN planned Q4FY25
 - SAAs with Anra, uAvionix, Longbow, AeroX



LaRC Integrated Ground Based Surveillance and Command and Control

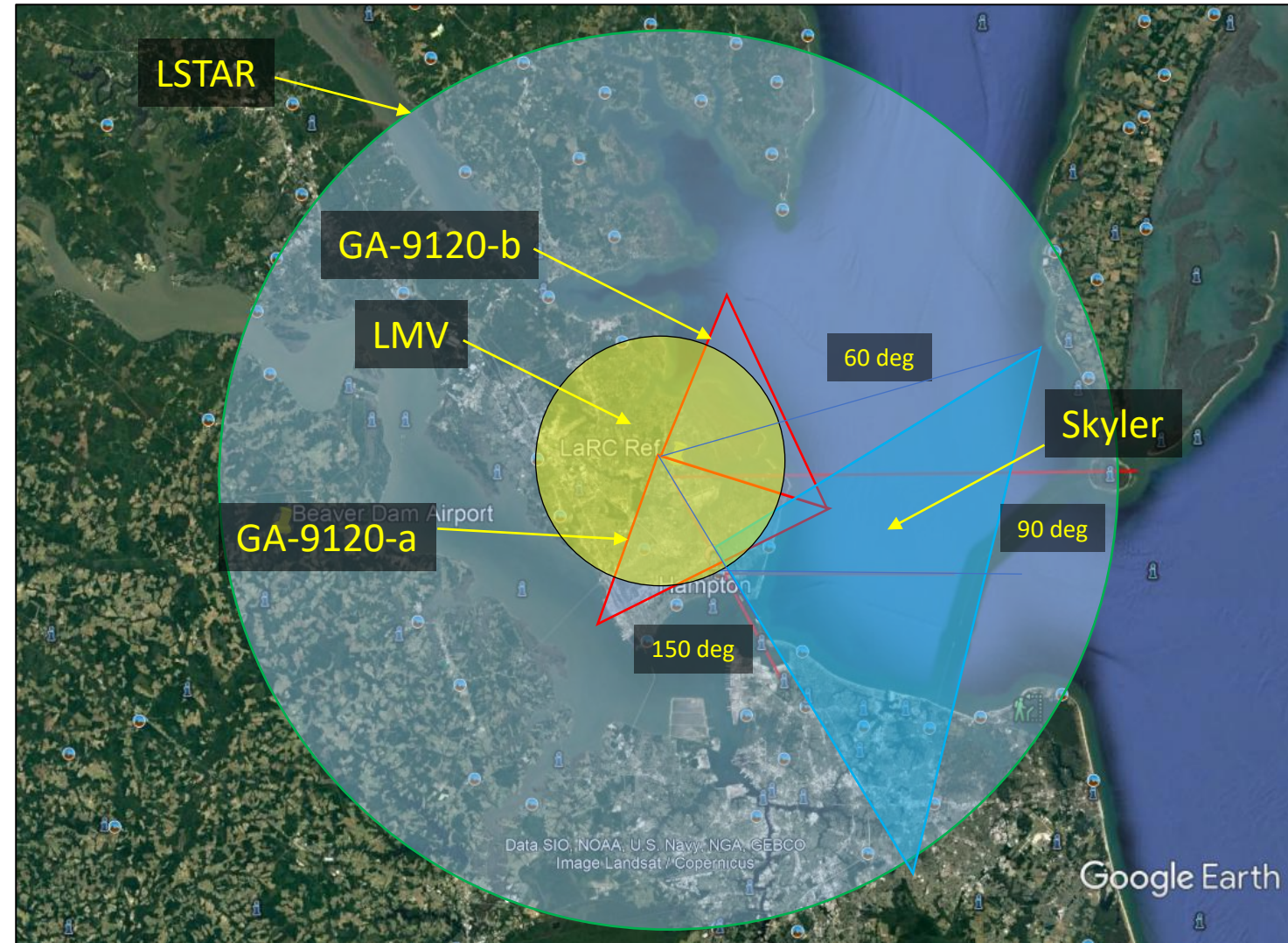
- SRC LSTAR
 - Installed on B1244 Hanger
 - Multiple radar flights test completed
- Ground Aware GA-9120s
 - Panel radar systems
 - Mounted on Gantry
 - Shorter range, higher frequency
 - Can track UAS
- Raytheon Skyler II
 - Installed on Harbor Center building
 - 14 story elevation
 - Access through SAA with Longbow
- uAvionix ADS-B V2
 - Installed on Gantry and B1230
- uAvionix C2
 - Skylink and Skyline systems
 - Installed on Gantry (200 ft)
- Ground FLARM
 - Developed dedicated weather proof ground FLARM unit
 - Receives UAS FLARM signals
 - Fully redundant UAS position
- Anra Smart Skies Control (CTR) and NASA TAURUS systems
 - Integrates and displays all surveillance inputs
 - NASA LARCNET and IoT system used for surveillance data integration



LSTAR: Lightweight Surveillance and Target Acquisition Radar, FLARM: Flight Alarm

Approximate Integrated LaRC Radar Coverage

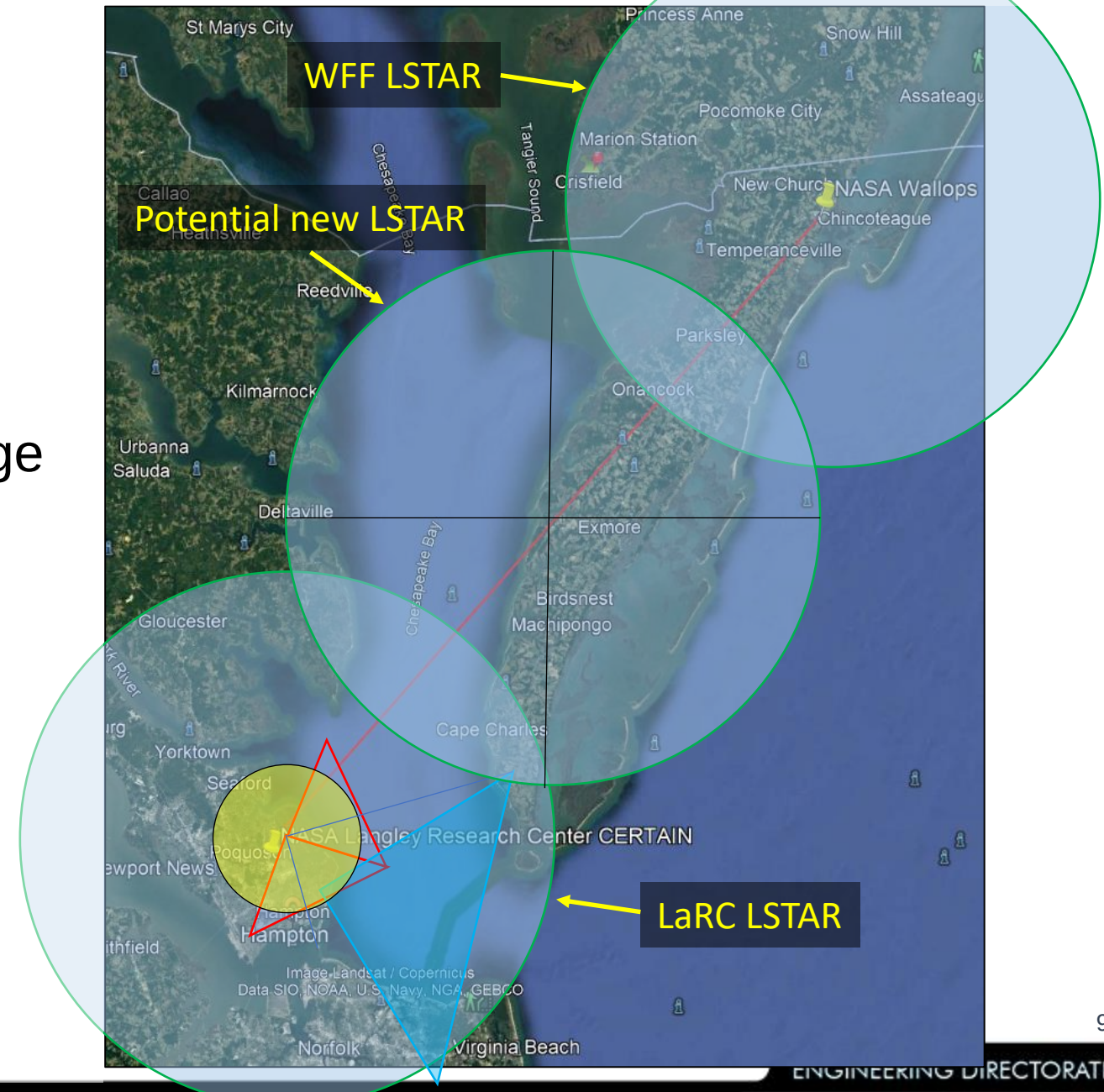
- LSTAR
 - 40 km (22 nm) max spec
 - 1.2 to 1.3 GHz
 - 360 Az, +30/0 El FOV
- GA-9120
 - 10 km range (5.4 nm)
 - 3.2 to 3.3 GHz
 - 120 deg Az, 12.5 El FOV
- Skyler II
 - 20 km range (11 nm)
 - 9 to 9.6 GHz
 - +/-60 deg Az, +/-20 deg EL FOV



LMV: Langley Monitoring Volume

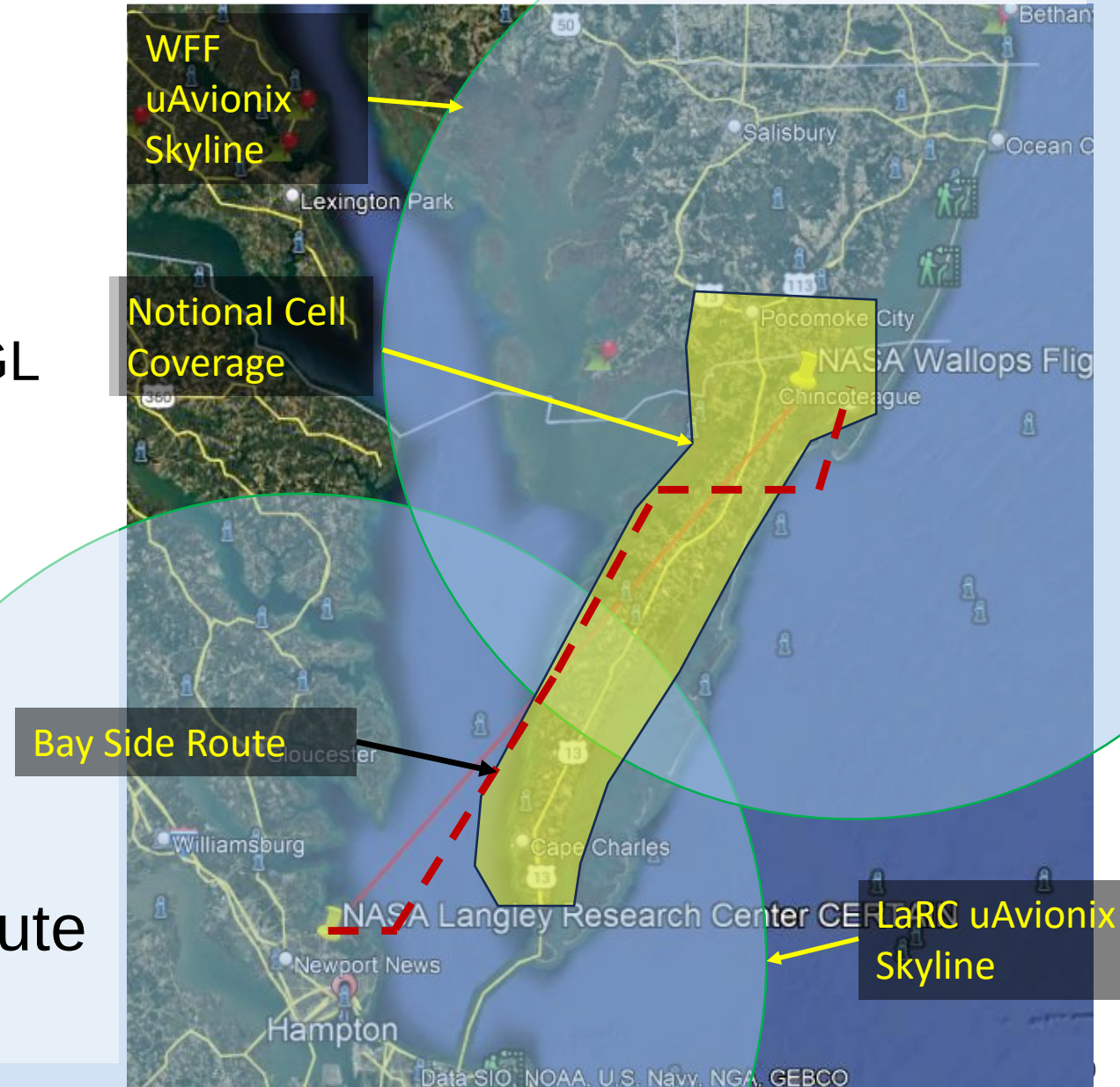
Approximate Integrated Full Corridor Surveillance Coverage

- LSTAR coverage exists at NASA LaRC and WFF
- WFF surveillance potential additions
 - Install ADS-B and Ground FLARM
 - Would replicate LaRC system
- Adding an LSTAR or equivalent at/near Exmore could provide complete coverage
 - LSTAR costs: ~\$1M, +~\$400k installation
- Install distributed integrated weather sensors
- Route all surveillance and Wx through NASA IoT



Communication and Control Considerations

- uAvionix Skyline C2
 - Capable of long range comm
 - Can be Daisy Chained
 - Radio line of sight is one limit
 - Estimate ~32nm link range at 400 ft AGL
- Cell coverage (alt C2 link) could be more focused around Route 13
- Will need to perform test/expansion flights at various locations
 - Ascertain actual as installed link performance
- C2 aspects could favor Bay Side Route



Supervolo: Potential Flight Test Demonstration Vehicle

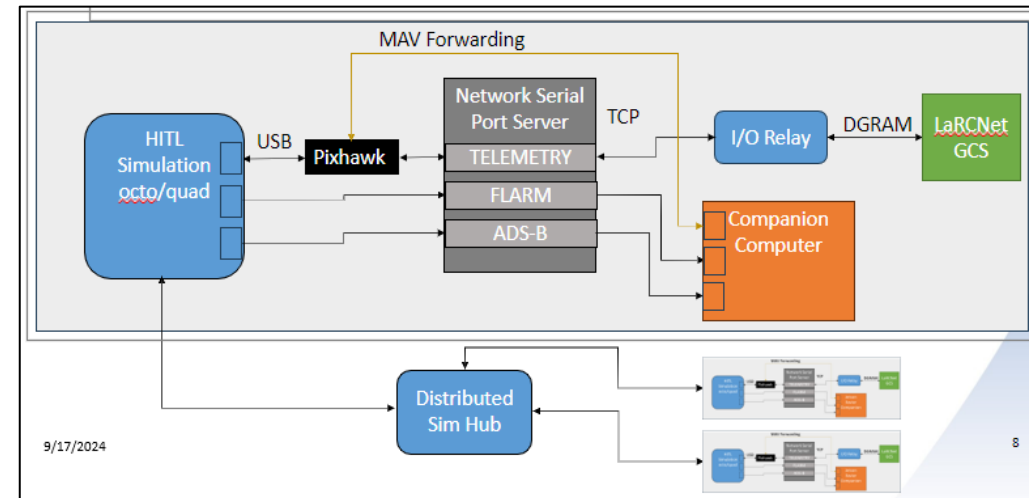
- General specifications
 - Separate Lift+Thrust eVTOL configuration
 - Hybrid propulsion system
 - Max Takeoff weight: 35 lbs
 - Payload: 5-7 lbs
 - Cruise: 48 kts
 - Endurance: ~6 hrs, depending on payload
 - Cost: \$50k
- Two Supevolos at LaRC, another one on order
 - Supporting FireSense, ACERO, and UTM BVLOS projects
 - Within Visual Line of Sight Operations
- Requirements for envisioned NOVO BVLOS operations
 - Establish 6DOF simulation
 - Perform system integration testing and HHITL simulations
 - Need to equip with nVidia Oran Mission Computer, C2 links, S2D camera, ADS-B in, FLARM in/out
 - Add required mission sensors (ie FLIR, High Res Camera)
 - Greatly build flight time and experience



Integrated Simulation Testing and Training

- Comprehensive hardware in the loop simulation is essential
- Enables full evaluation of autonomous system interactions with actual vehicle autopilot systems
- Provides tremendous foundation for safety risk assessments
- Used to train ground control station operators to manage contingencies
- Can perform full route simulations and assess vehicle performance

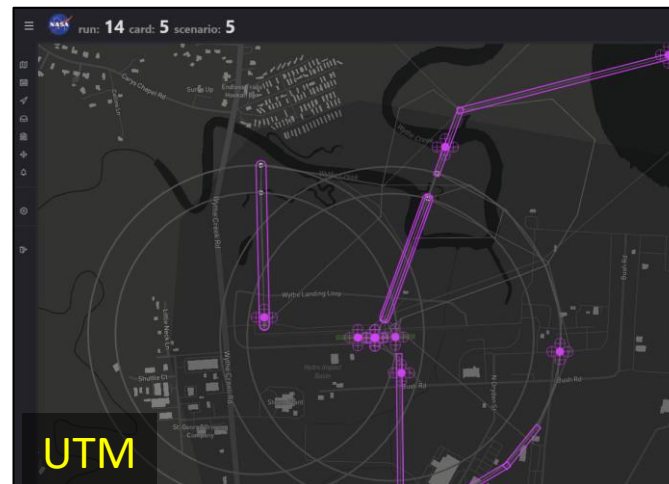
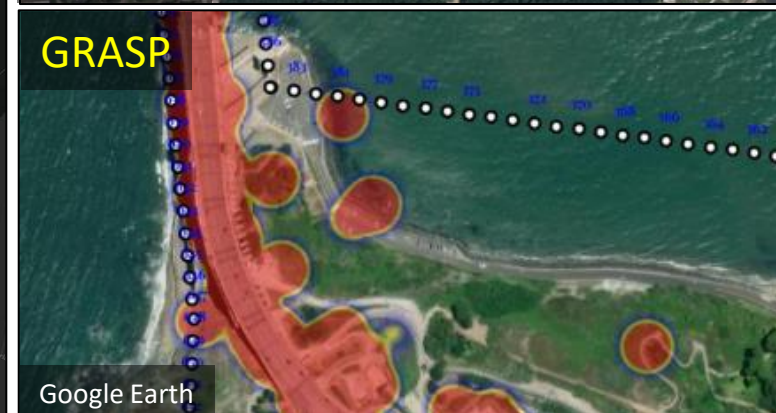
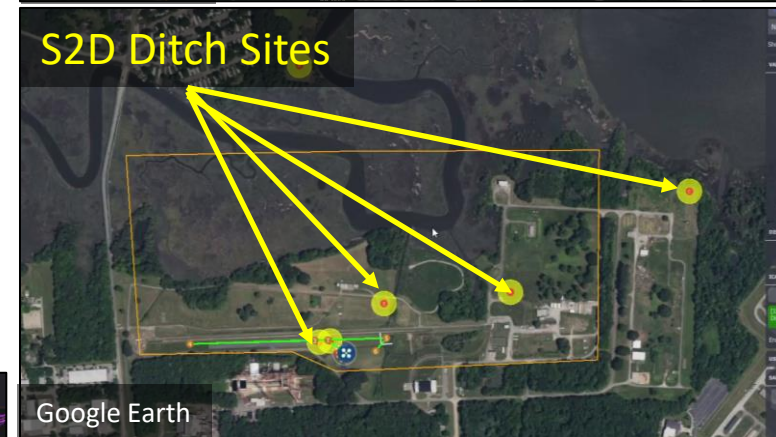
System Integration and Validation Lab (SIVL)



SIVL Multi Vehicle Simulation System Diagram

NASA Technologies (short list)

- ICAROUS
 - Autonomous Detect and Avoid Functionality
- Safe2Ditch
 - Autonomous remote emergency landing capability
- Ground Risk Assessment Service Provider
 - Integration of high-fidelity population databases into UAS flight planning and operations
- UAS Traffic Management Systems
 - Strategic deconfliction and conformance monitoring
- Integration, testing and flight operations accelerates NASA Tech Transfer



Develop Safety Case

- Perform historical air traffic analysis for envisioned corridor
- Document defined operational system, including vehicle and ground-based systems
- Establish and document UAS crew operations and procedures
- Perform Hazard and Risk Analysis
- Document results from integrated simulation and expansion testing
- Fully publish Safety Case and results
- Apply for BVLOS Waiver for WFF LaRC Corridor

NASA/TM-2023003007



Safety Case for Small Uncrewed Aircraft Systems (sUAS) Beyond Visual Line of Sight (BVLOS) Operations at NASA Langley Research Center

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National Institute of Aerospace, Hampton, Virginia*

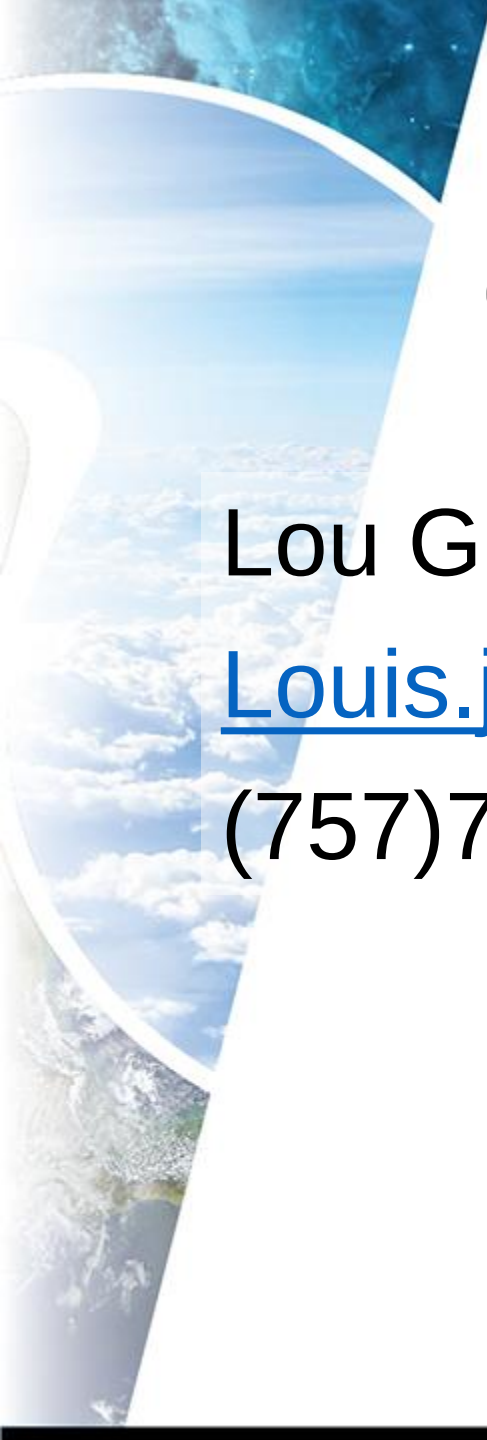
*Robert G. McSwain and Jacob R. Schaefer
Langley Research Center, Hampton, Virginia*

June 2023

ENGINEERING DIRECTORATE

Where can we go from here?

- Why here why now?
 - Existence of NOVO BVLOS ops capability and expertise at LaRC
 - Greatly expanded collaboration capability with Industry through augmented operations area
 - Significant science mission results
 - Significant surveillance infrastructure at LaRC and WFF
 - Highly complex and diverse airspace and relatively low-risk overflight
 - Substantial existing UAS Industry in the region (ie DroneUp, Anra, Longbow, etc)
 - Can engage and collaborate with Mid Atlantic Aviation Partnerships (MAAP) and University of Maryland
- List of things to do:
 - Need to create a coalition to establish resources to cover the projected costs
 - NASA Programs/VA State/Industry Collaboration/DoD/Other resources/??
 - Develop detailed project plan and Road Map
 - Implement and test surveillance system installations
 - Generate Safety Case and engage with FAA
 - Complete system integration and initiate flight expansion testing
- Could be as fast as 1.5 years from start to initial operations



Questions/Comments?

Lou Glaab

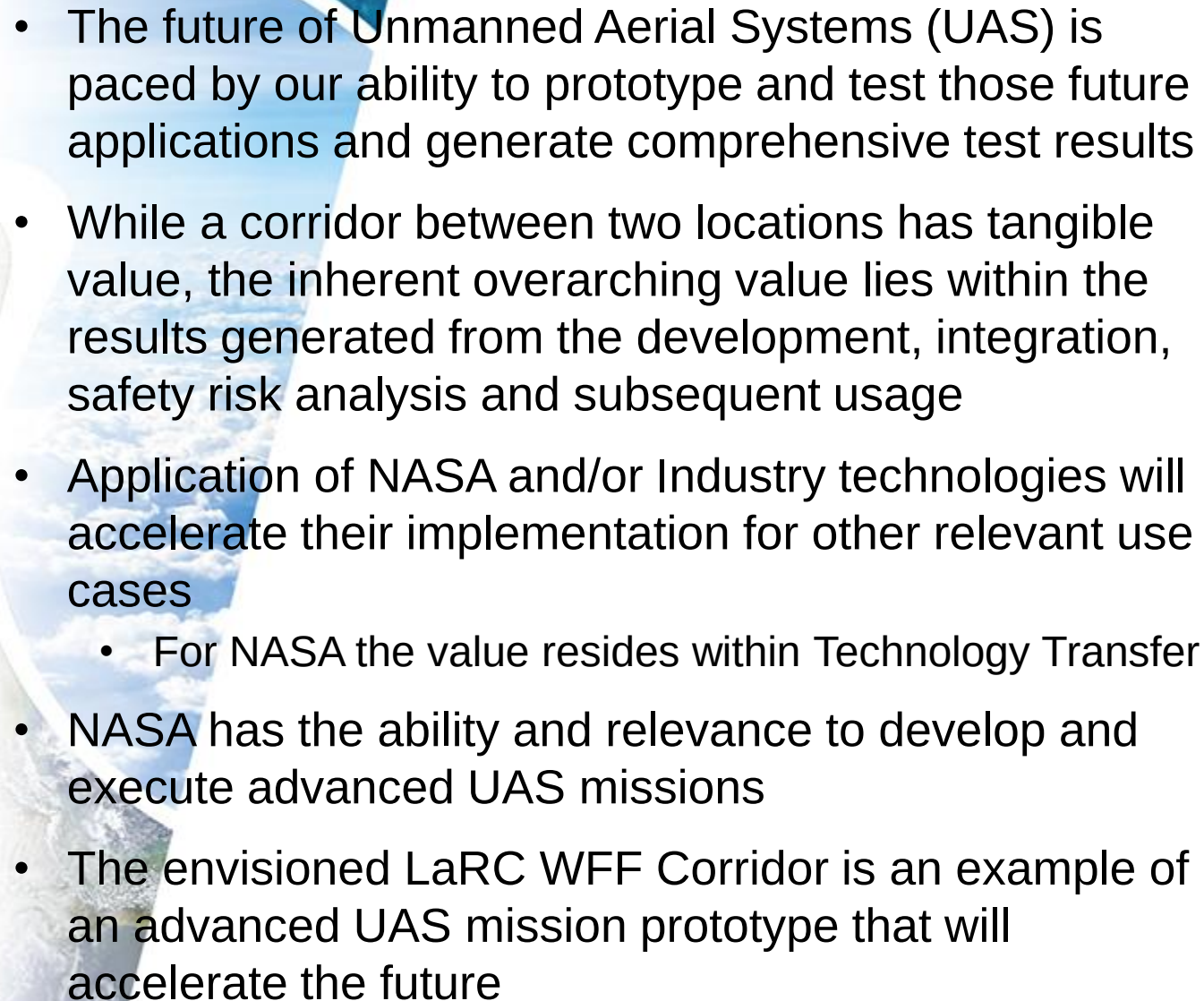
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BACKUP

Accelerating the future

- 
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