Data and Reasoning Fabric (DRF)

Presentation to the NASA Community College Aerospace Scholars (NCAS)

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NASA Aeronautics Research Mission Directorate (ARMD)
Transformative Aeronautics Concepts Program (TACP)
Convergent Aeronautics Solutions (CAS) Project

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Kenneth Freeman began his career at NASA Ames Research Center working in local and wide area networking, network research and space communications, playing major roles in several engineering and research projects. He then led at team to implement NASA's Security Operations Center (SOC), building a cyber-security operations center that is the nerve center for the detection and monitoring information security incidents for NASA. He is now leading the Secure Airspace Technology Group, which develops and demonstrates capabilities, for secure data integrity, resiliency, and information privacy for national airspace environments.

Kenneth Freeman is the Principal Investigator for the Data & Reasoning Fabric (DRF) Activity. DRF is envisioned to enable the growth of future flight by enabling an ecosystem of data and AI-based decision support tools (reasoning) to enable the transportation of people and cargo to places previously not served or underserved by aviation.

Mobility Challenges

- Transportation shapes society, enabling economic and social interactions
- The quality of life is impacted by ever growing commute time
- Transportation is increasingly driven by door-to-door challenges

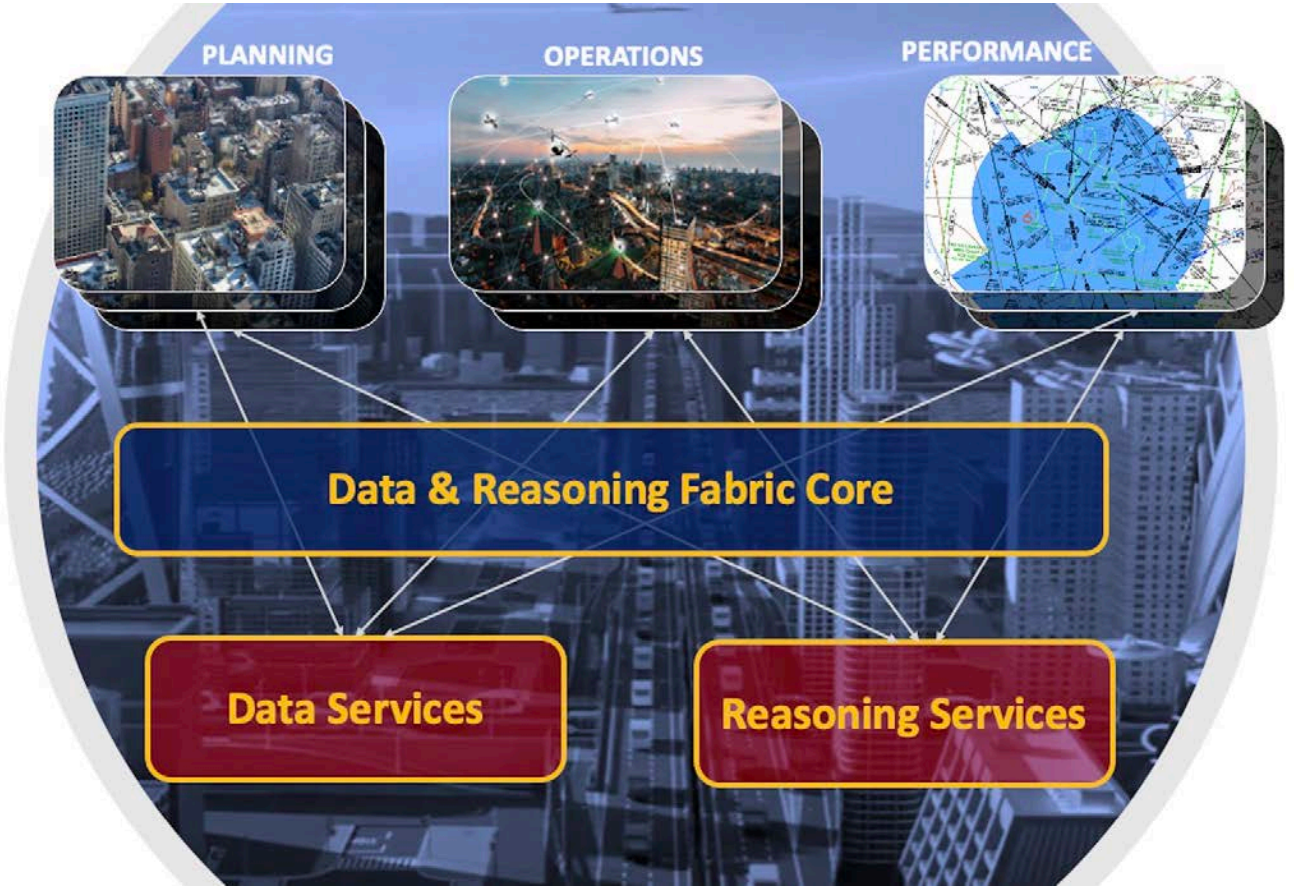
Mobility Challenges

Air Mobility can convert our 2D mobility system to a 3D mobility system, increasing mobility options for both people and goods

Data & Reasoning Fabric

DRF is envisioned to provide access to data and AI-driven decision support tools to:

- Provide transportation for people and cargo to places previously not served or underserved by aviation.
- Enable increased flights in congested urban areas
- Support the growth of AAM operations that depend on accurate, reliable, and current data



Barriers Related to AAM Community Adoption

- On its current trajectory, AAM will have many "stovepipe" efforts and inconsistent implementation quality, due to a lack of standards and foundations for planning, operations and performance monitoring.
- Several data access and decision support barriers must be overcome to enable advanced air mobility

Barriers	What is Needed?
Limited interoperability & data standardization between service providers and AAM & vertiport operators	Data exchange **Interoperability** between service providers and AAM or vertiport operators
Insufficient accurate data where it is needed to make airspace operations & management decisions	A **decentralized** approach to supporting data exchange and decision support across an AAM ecosystem
Highly Reliable and low-latency access to edge computing devices in support of tools to support safety related decisions	A **trusted** mechanism for transferring data across an AAM ecosystem
Reusable reasoning (decision support) services are not easily accessible	An approach for providing **low-latency** access to data needed for decision support
Clear economic incentives for data service providers	A mechanism to support the **monetization** of data and reasoning (decision support) services

Advancing AAM will require trusted access to data and decision support tools from decentralized sources

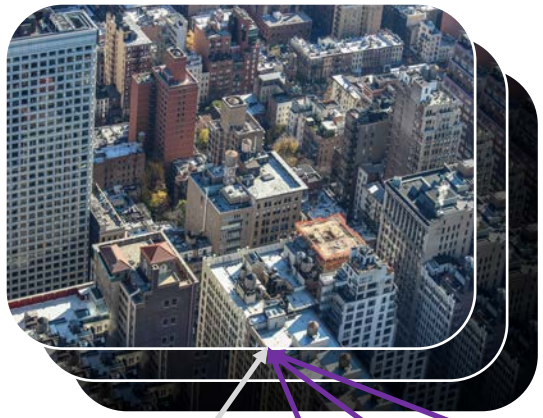
Evolving Complexity of the Info-Centric NAS

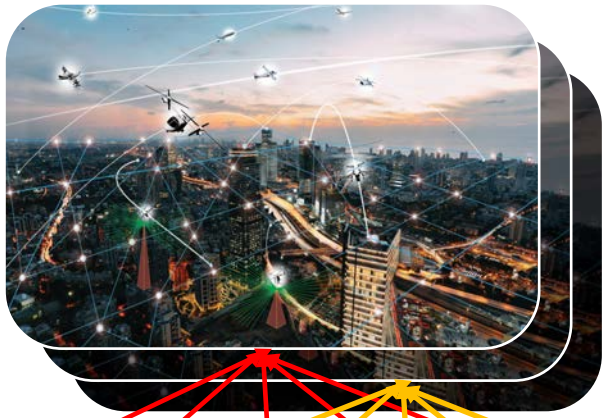
Aerospace Service Users

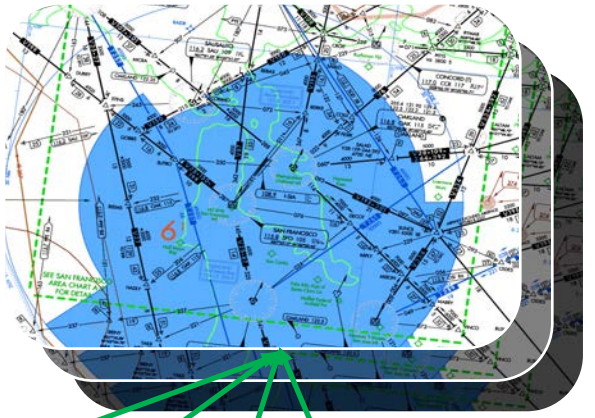
PLANNING

OPERATIONS

PERFORMANCE







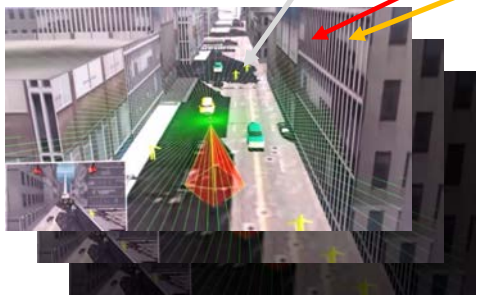
CASE-BY-CASE DATA
- DISCOVERY
- AGGREGRATION
- VETTING
- DATA/$ TRANSACTIONS

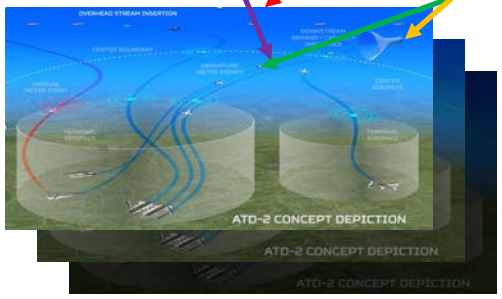
City "A" Planner

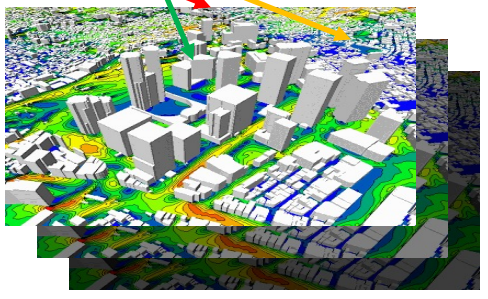
Package-As-Service Provider "A"

City "L" Planner

Mobility-As-Service Provider "U"







SMART AIRSPACES

SMART CITIES

REGULATORY

MICRO-WEATHER

Data & Reasoning Services

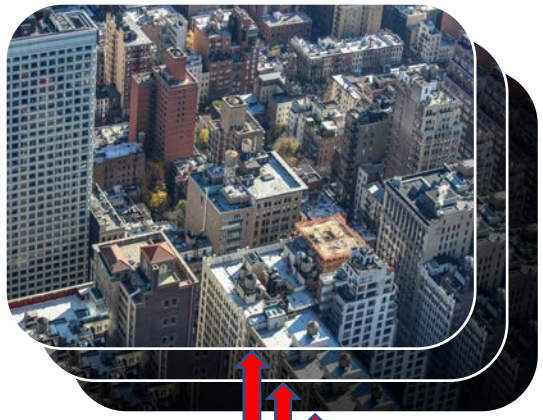
Data & Reasoning Fabric (DRF)

Trusted Service Discovery and Exchange Backbone
for the Future Airspace Ecosystem

Data & Reasoning Fabric

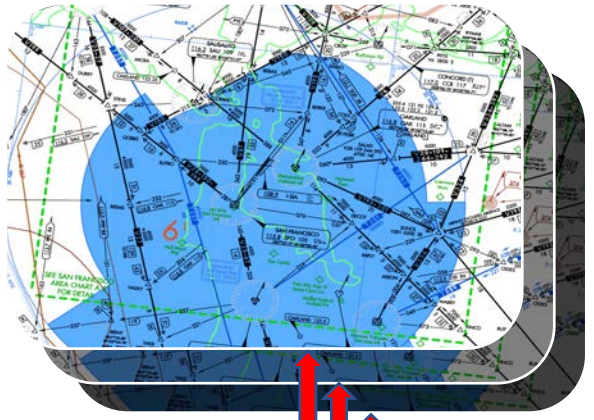
Service Providers

PLANNING



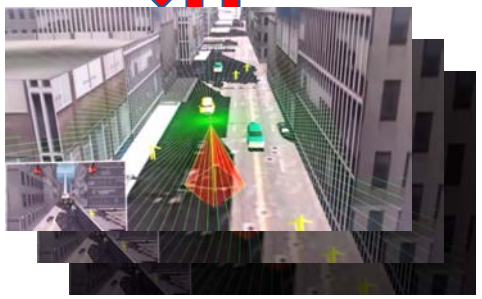
OPERATIONS

PERFORMANCE

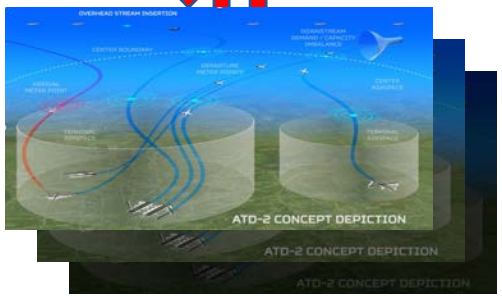


DATA & REASONING FABRIC

ENABLE EFFICIENT AND PERVASIVE DATA DISCOVERY, AGGREGRATION, AND DATA/$ TRANSACTIONS, IN ORDER TO ENABLE A DATA AND REASONING SERVICE EXCHANGE FOR AAM ENVIRONMENTS

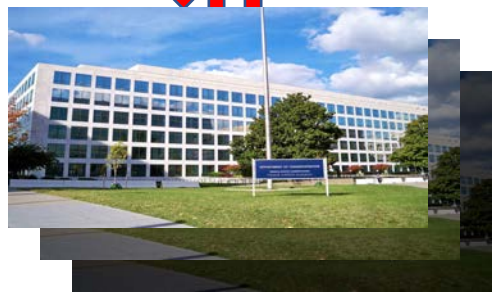


SMART VEHICLES



SMART AIRSPACES

SMART CITIES



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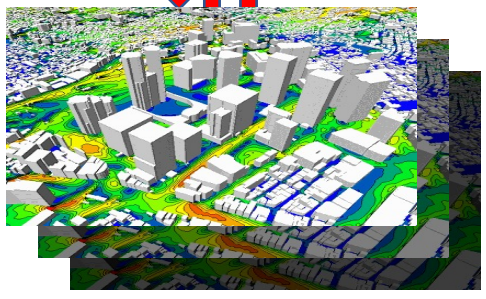


MICRO-WEATHER

Data & Reasoning Services

Data & Reasoning Fabric

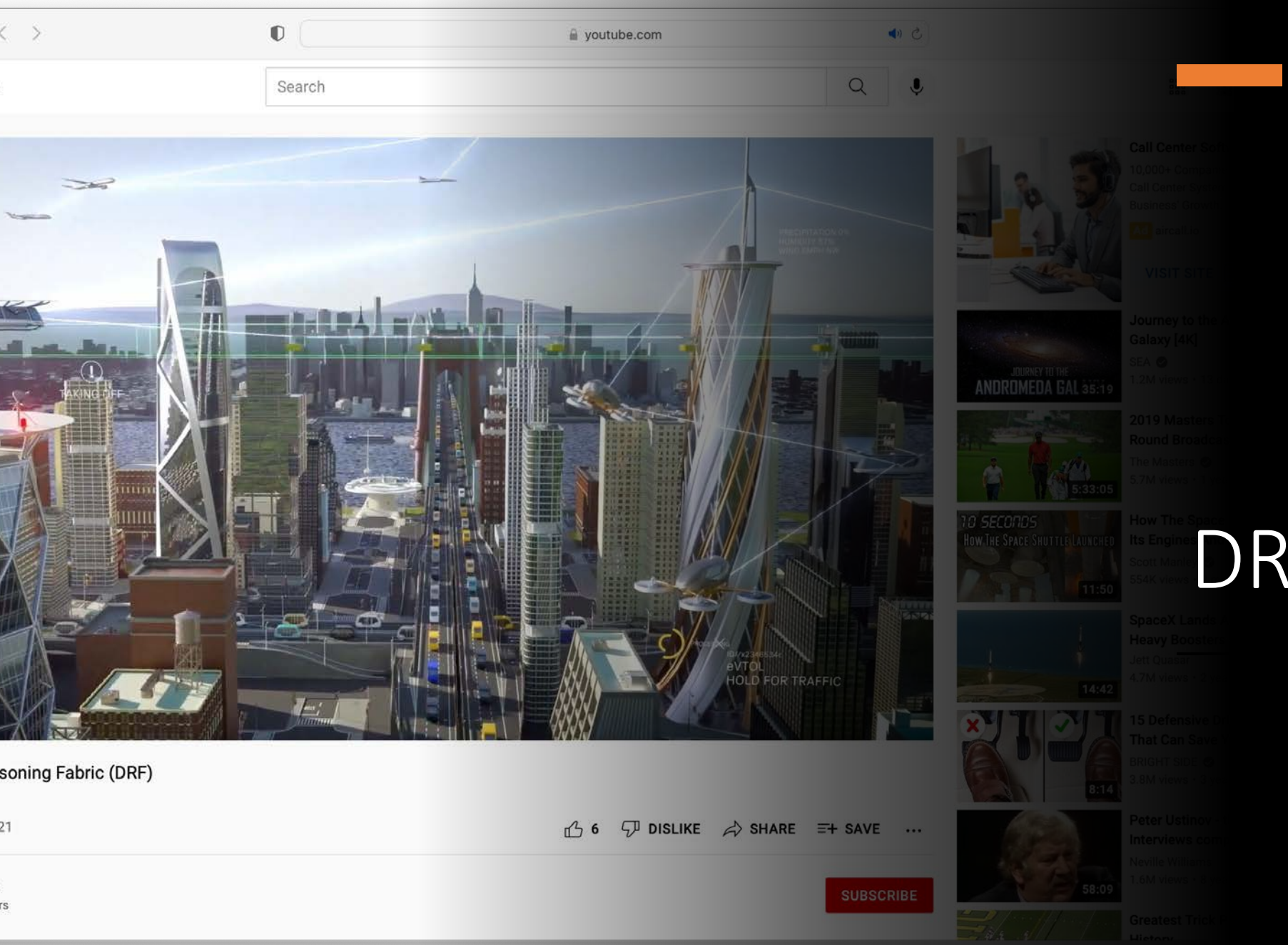
Registration

Service Transactions

Interoperability

Cybersecurity
(Blockchain)
(Distributed Identities)

DRF Video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DISLIKE
SHARE
SAVE
SUBSCRIBE
JOURNEY TO THE
ANDROMEDA GAL 35:19
5:33:05
10 SECONDS
HOW THE SPACE SHUTTLE LAUNCHED
11:50
14:42
8:14
58:09

DRF – A Project Perspective

Organization

Collaboration between project management, DRF core software development, data and reasoning service development, systems engineering and partnership outreach, to meet the DRF objectives.

Technology Development

Develop a prototype implementation of the DRF framework and capabilities, in order to enable the rapid deployment of candidate data and reasoning capabilities

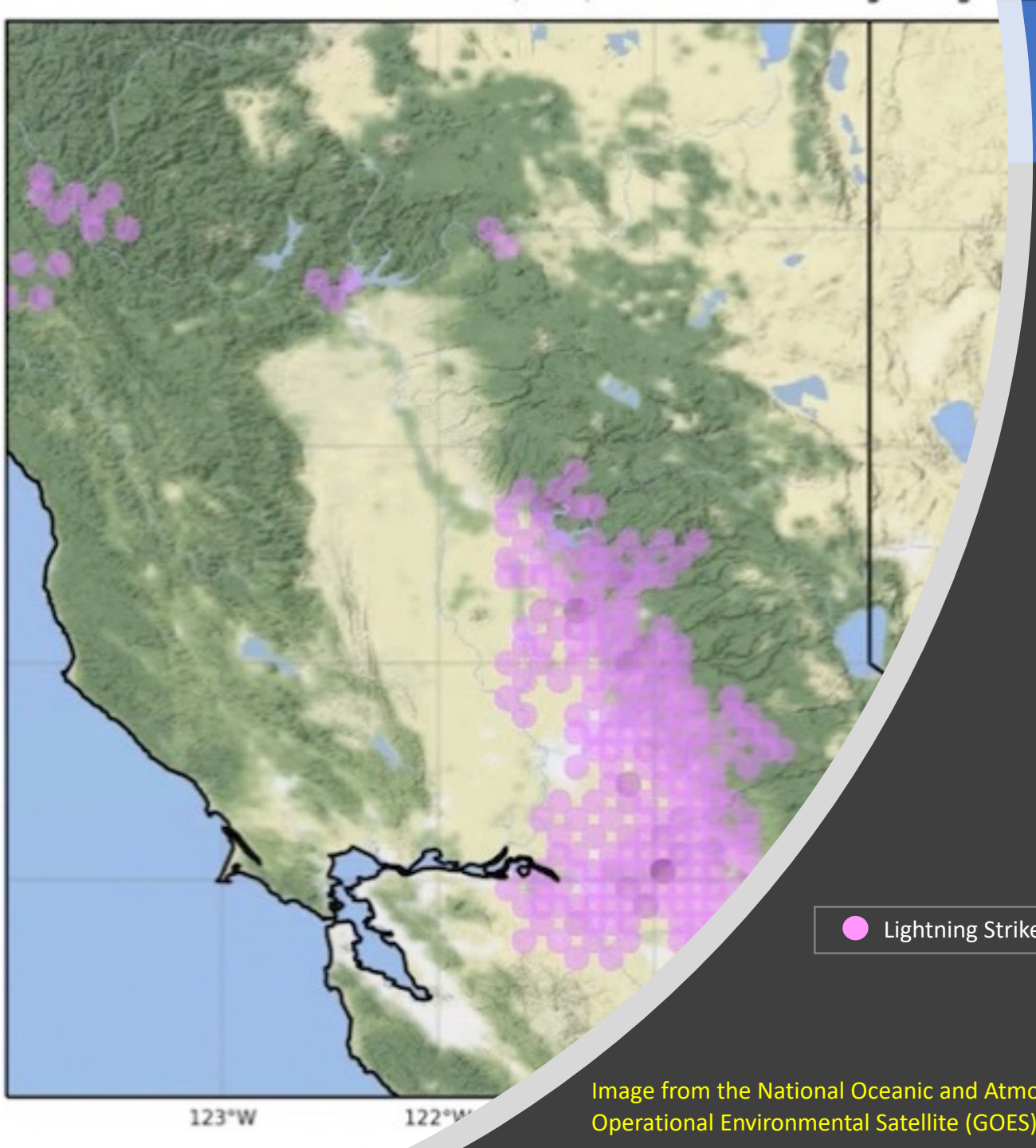
Partnership Approach

Work with the community through workshops, working groups and interviews, in order to refine representative use cases that can be used to validate DRF concepts.

Field Test Approach

Work with partners to leverage community defined use cases to validate the capabilities of DRF, while demonstrating a capability that is of value to the partner.

Wildfire Detection Field Test



The DRF team in collaboration with the California Civil Air Patrol (CAP), executed a field test that identified a preliminary set of data and reasoning service areas that can be enabled and enhanced by DRF to potentially bring forth improved accuracy and reduced latency to CAP's mission critical decision making, in wildfire detection.

Image from the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) 16, a geostationary spacecraft

- CAP's Air Mobility Missions:
  - CAP operates manned and unmanned flights, in coordination with CalFire and other government entities in the state of California, to collect aerial imagery data of regions sustaining recent lightning strikes and, therefore, are more likely to have a fire started there.
  - Additionally, CAP provides mission support in search and rescue operations, and cadet training programs.

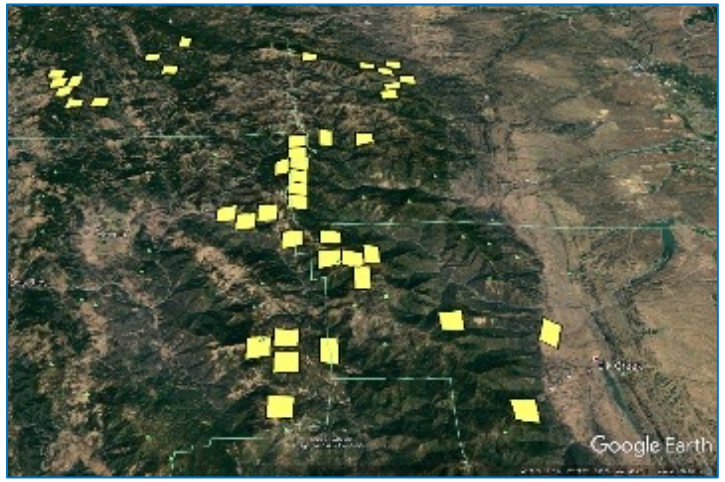
CAP – NASA DRF Partnership
Data-Driven Decision Making for Emergency Response and Training Missions

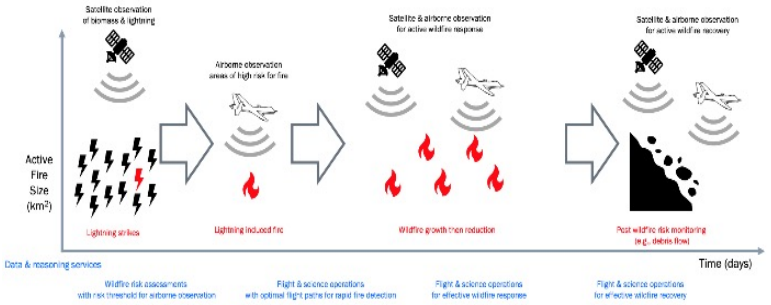
- Technology Fit for NASA DRF:
  - DRF is based on an open foundational ecosystem of data and reasoning exchange between systems that must seamlessly interplay to manage complex and/or dense airspace operations.
- Current Pain Points and Bottlenecks in CAP Missions:
  - Timely access to holistic data for mission-specific decision making
  - Availability of ready-to-use data processing services for actionable information gathering
  - Mission framework structuring and automation

CAP – NASA DRF Test and Demonstration

NASA/DRF – CAP/Wildfire Collaboration:

- The California Wing of CAP and the DRF Data Service Team came together during the Fall of 2020.
- The NASA DRF Team gathered an understanding of CAP's operational process flow for their wildfire reconnaissance missions
- In collaboration with CAP, the NASA DRF team is identifying a preliminary set of data and reasoning service areas that can be enabled/enhanced by DRF to potentially bring forth improved accuracy and reduced latency to CAP's mission critical decision making.





Example services may include target package down-selector, trend analyzer, global situational awareness builder etc.

DRF and CAP Support for Wildfire Detection

Registration of Data & Reasoning Services

Registration of Users & Service Discovery

Simulated Lightning Strike

Identification of Fly Target Areas

Identification of Flight Trajectories

Leveraging weather and environmental data and decision support reasoning services to plan wildfire detection missions

Onboarding data & reasoning services	Enabling data & reasoning service discovery	Access weather data services	Interoperable access to diverse data to support reasoning service	Leveraging multiple reasoning services for decision support

Enabling Data & Reasoning Service Discovery

Leverage DRF to discover the data or reasoning (AI-driven decision support) services to select region for wildfire detection.

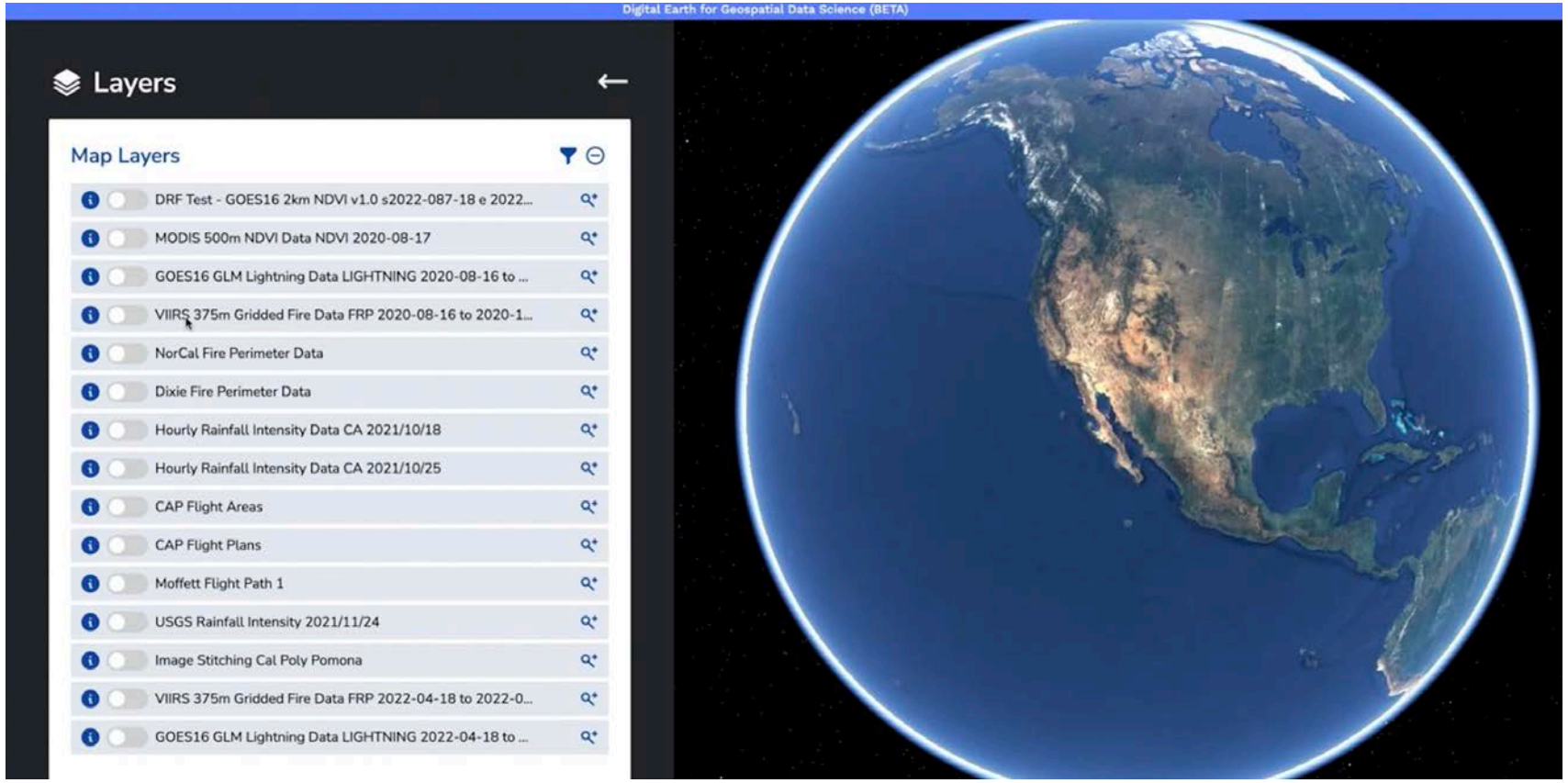


Image from from the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) 16, a geostationary spacecraft and Universities Space Research Association (USRA)

Access Weather Services

Leverage DRF to access weather services, such as lightning strike and terrain data, to select target areas for wildfire detection

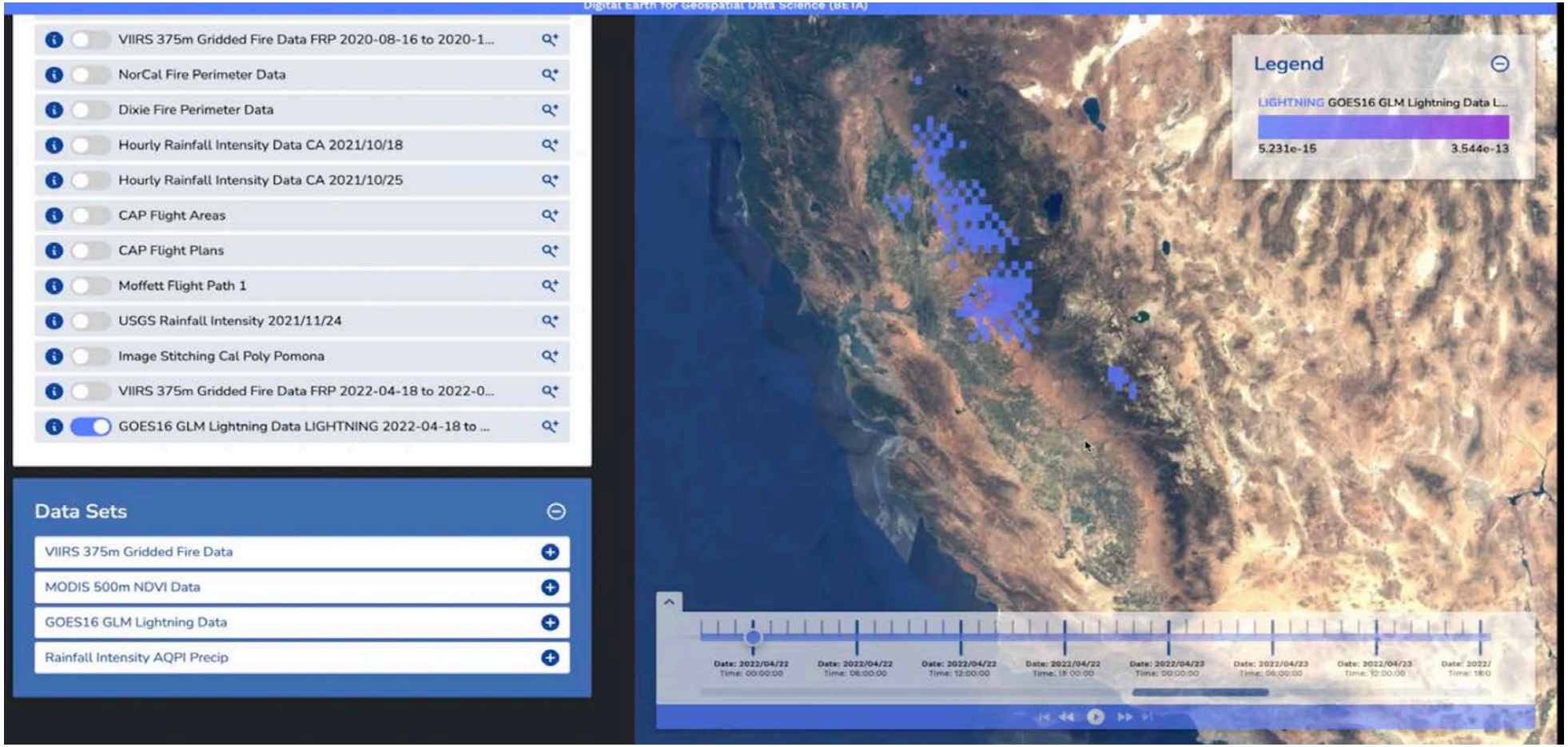


Image from from the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) 16, a geostationary spacecraft and Universities Space Research Association (USRA)

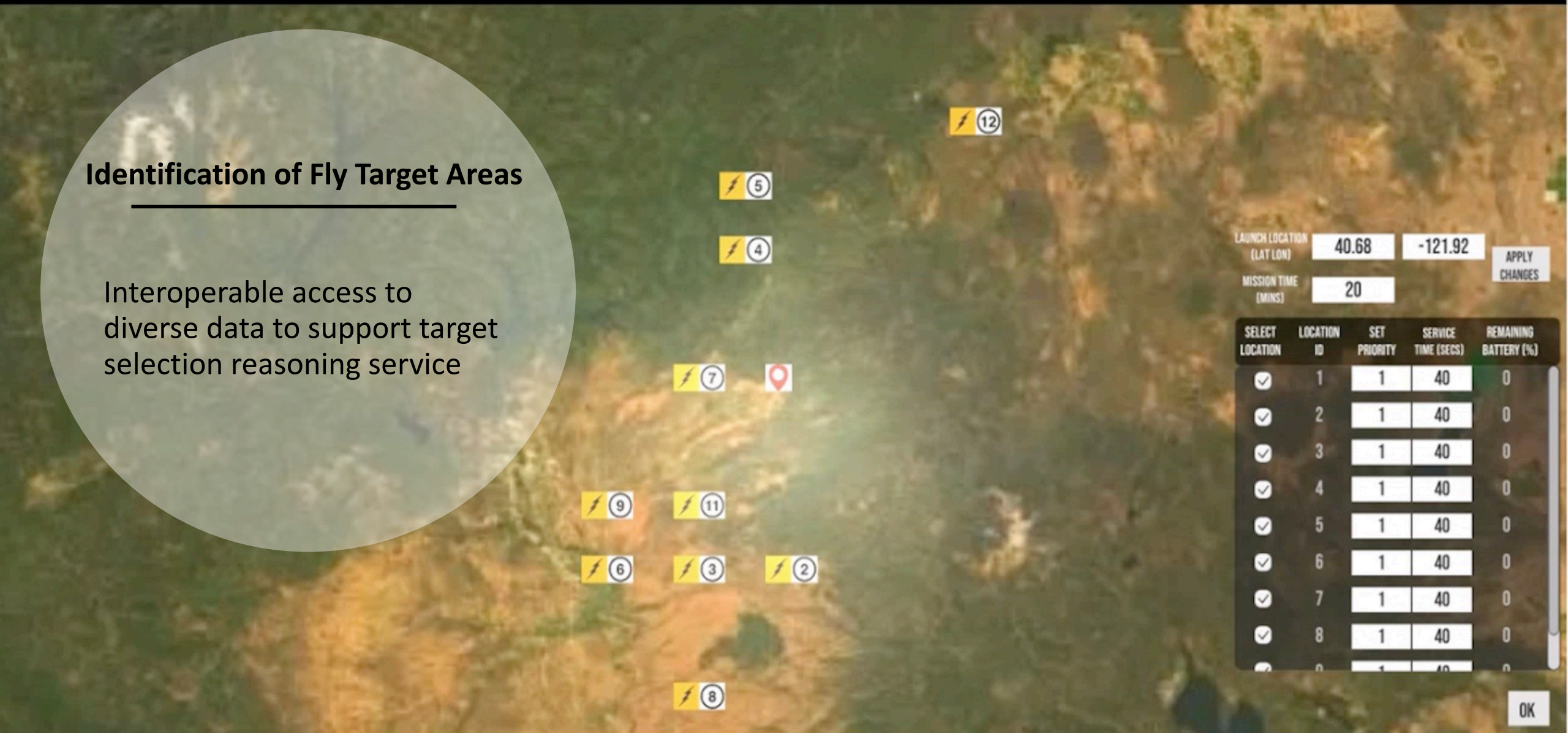
DRF
Reasoning Services

MISSION VIEW

VIEW1

Identification of Fly Target Areas

Interoperable access to diverse data to support target selection reasoning service



Identification of Flight Trajectories

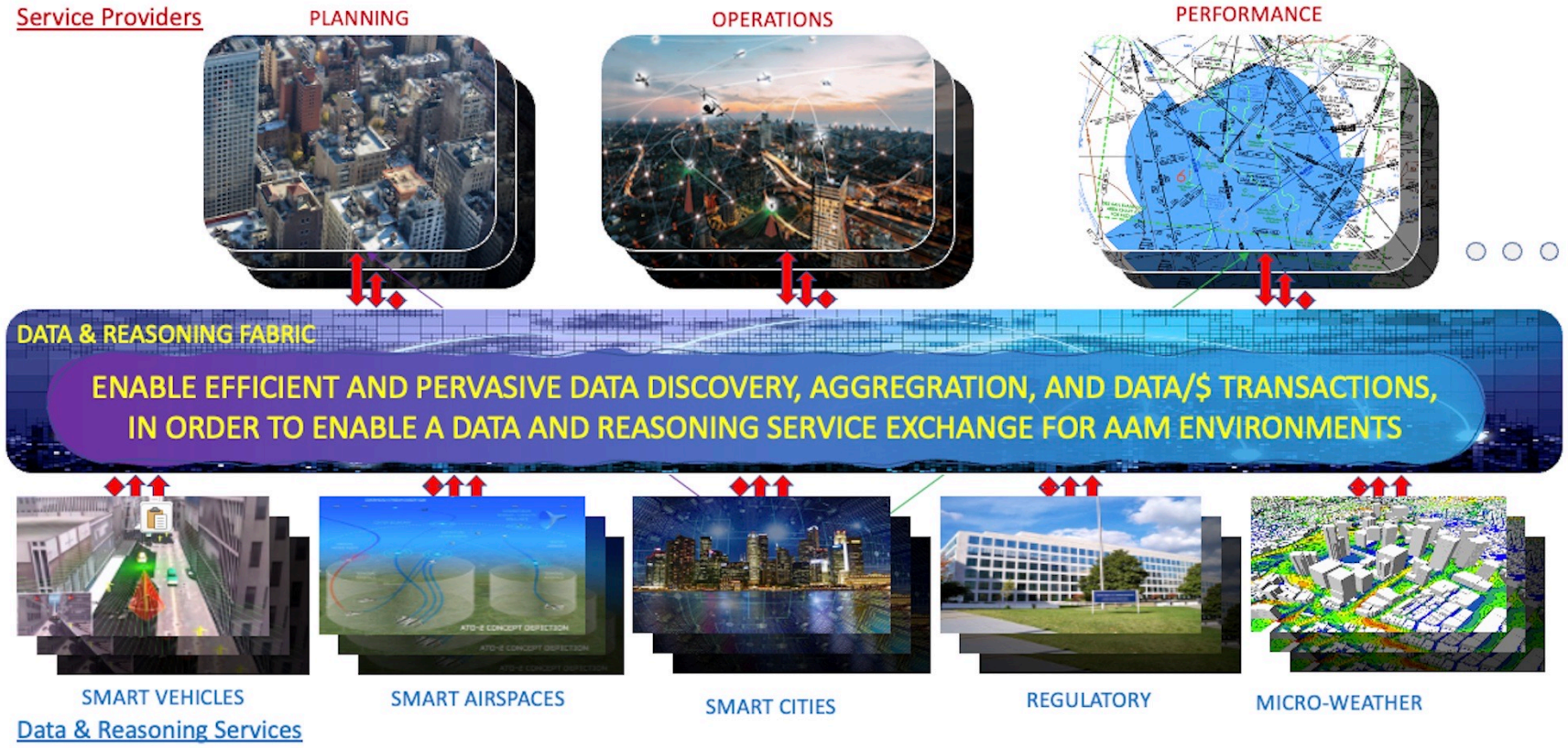
Leveraging multiple reasoning services for decision support to select flight path for wildfire detection

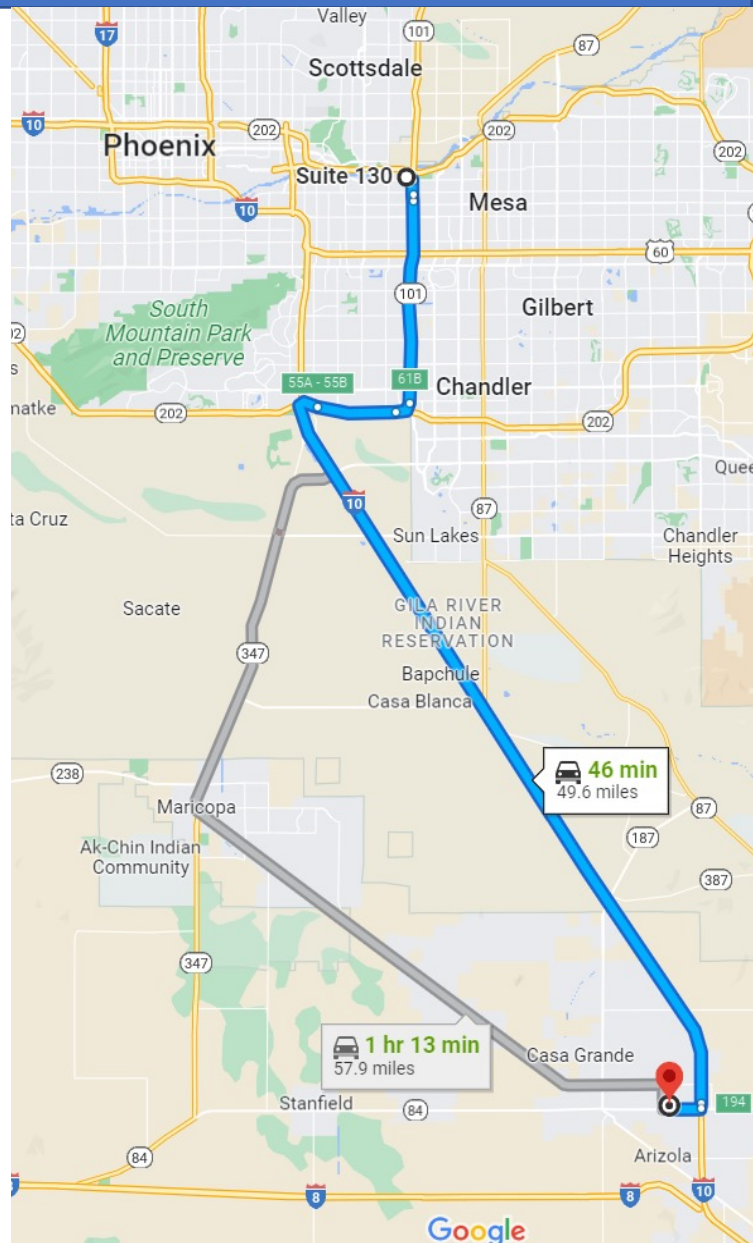
Advanced Air Mobility (AAM) with DRF

- To achieve an inclusive AAM system, we must get autonomy and data management and access to decision support right
  - The new entrants will require safe and efficient operations
  - There will be requirements to migrate to comprehensive autonomy, better data links and distributed information systems
  - Operations in real time as needed
- Access to data and AI-driven decision support tools will be required to expand AAM

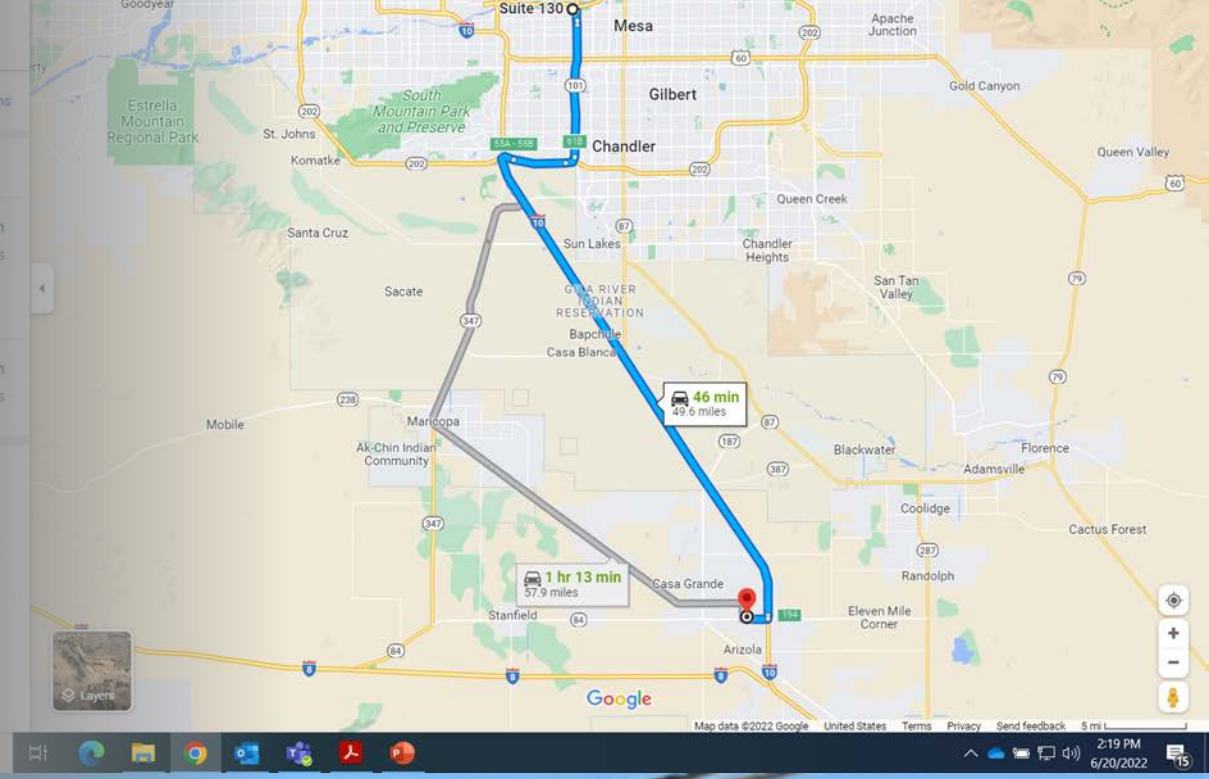
Data & Reasoning Fabric - Greater Phoenix Metropolitan Area

DRF is ran a Field Test with the Greater Phoenix Metropolitan Area (GPMA) that will advance AAM research, based on local community requirements





Data & Reasoning Fabric - Greater Phoenix Metropolitan Area Flight Test – June 2023



Urban Air Mobility

The next generation of aerial passenger and cargo transportation may leverage the concept of Urban Air Mobility (UAM). UAM is a concept that proposes to develop short-range, point-to-point transportation systems in metropolitan areas using vertical takeoff and landing (VTOL) or short takeoff and landing (STOL) aircraft to overcome increasing surface congestion.

Vascik, P. D., Hansman, R. J., & Dunn, N. S.

Questions ?

https://drf.nasa.gov