
# Data and Reasoning Fabric (DRF)

September 2023

# 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

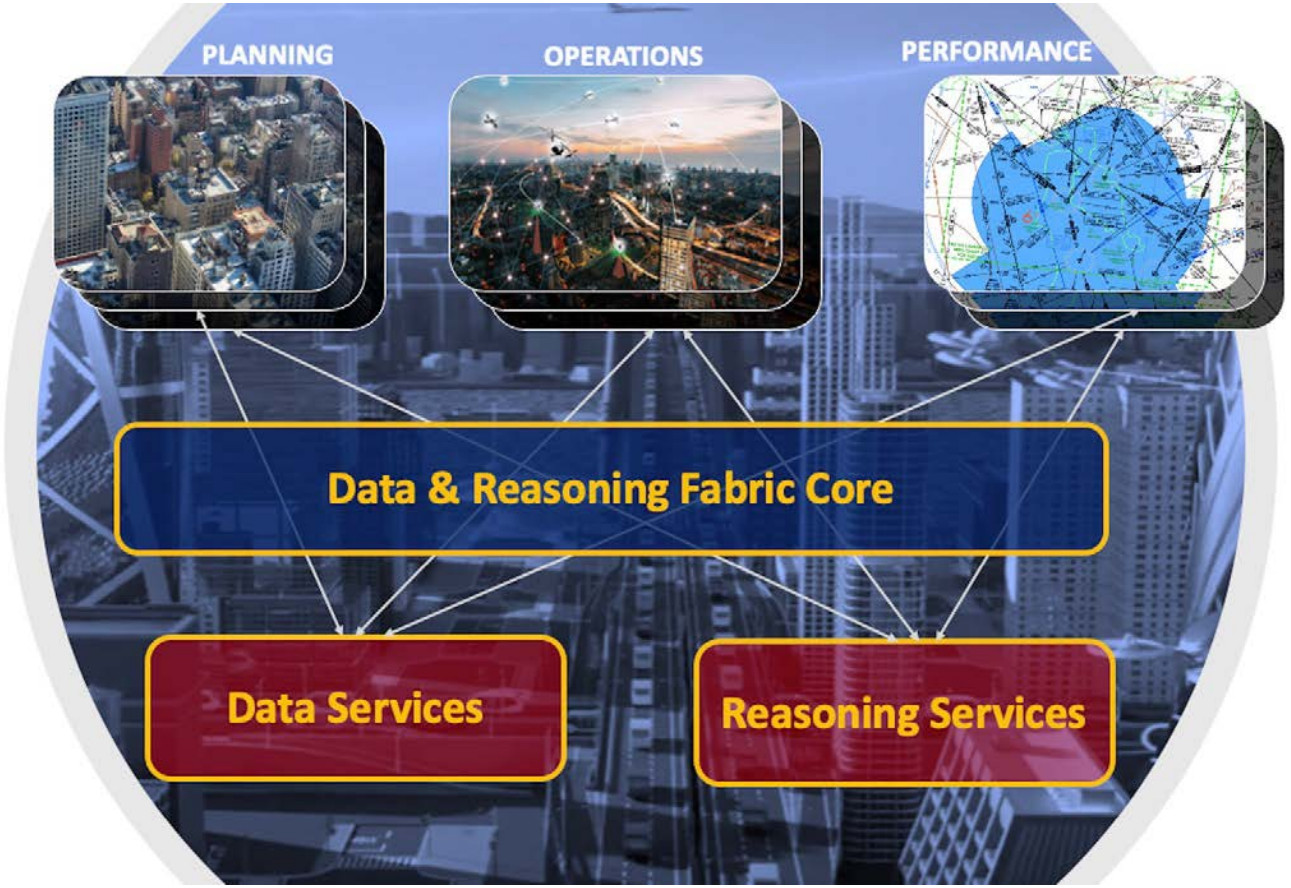
# Mobility Challenges

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 advanced air mobility (AAM) operations that depend on accurate, reliable, and current data




AAM is an umbrella term for aircraft that are likely highly automated and electric. These aircraft are often referred to as air taxis or electric Vertical Takeoff and Landing (eVTOL) aircraft.

# 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

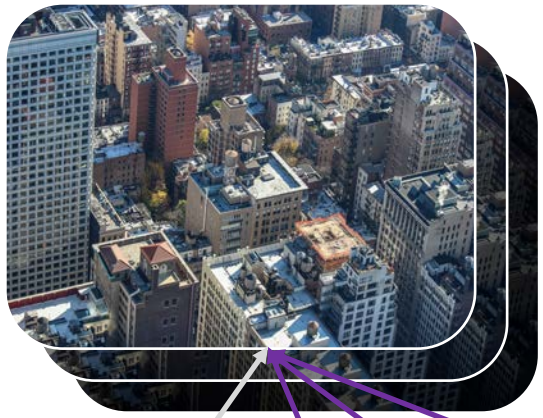
# Evolving Complexity of the Info-Centric NAS

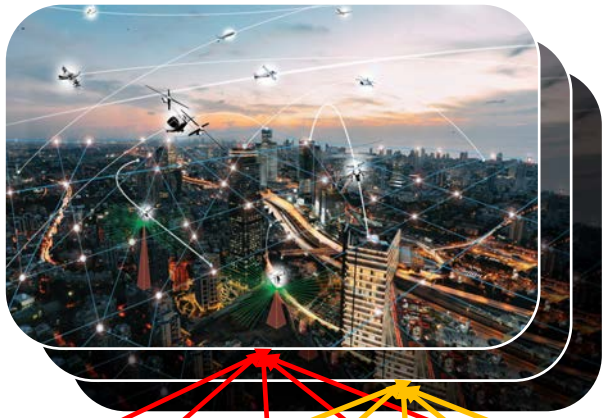
Aerospace Service Users

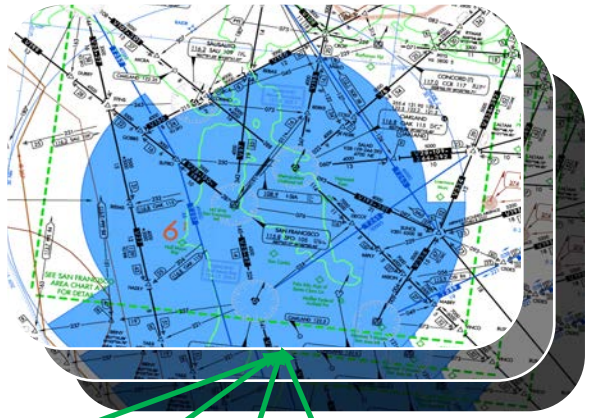
PLANNING

OPERATIONS

PERFORMANCE







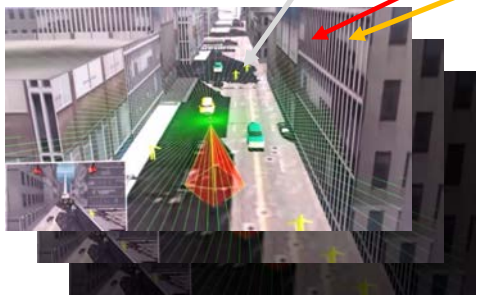
CASE-BY-CASE DATA
- DISCOVERY
- AGGREGRATION
- VETTING
- DATA/$ TRANSACTIONS

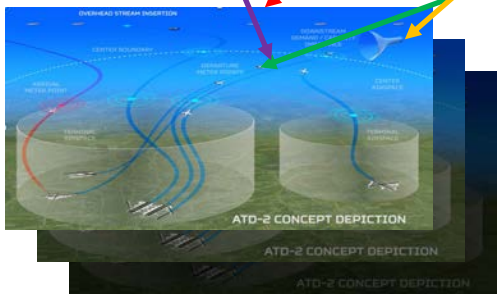
City "A" Planner

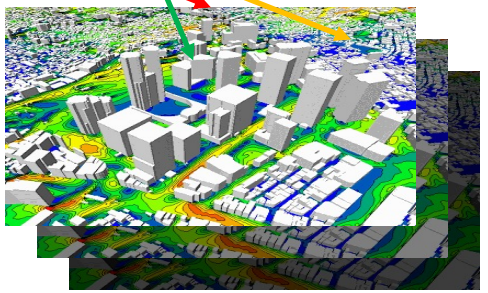
Package-As-Service Provider "A"

City "L" Planner

Mobility-As-Service Provider "U"





SMART AIRSPACES

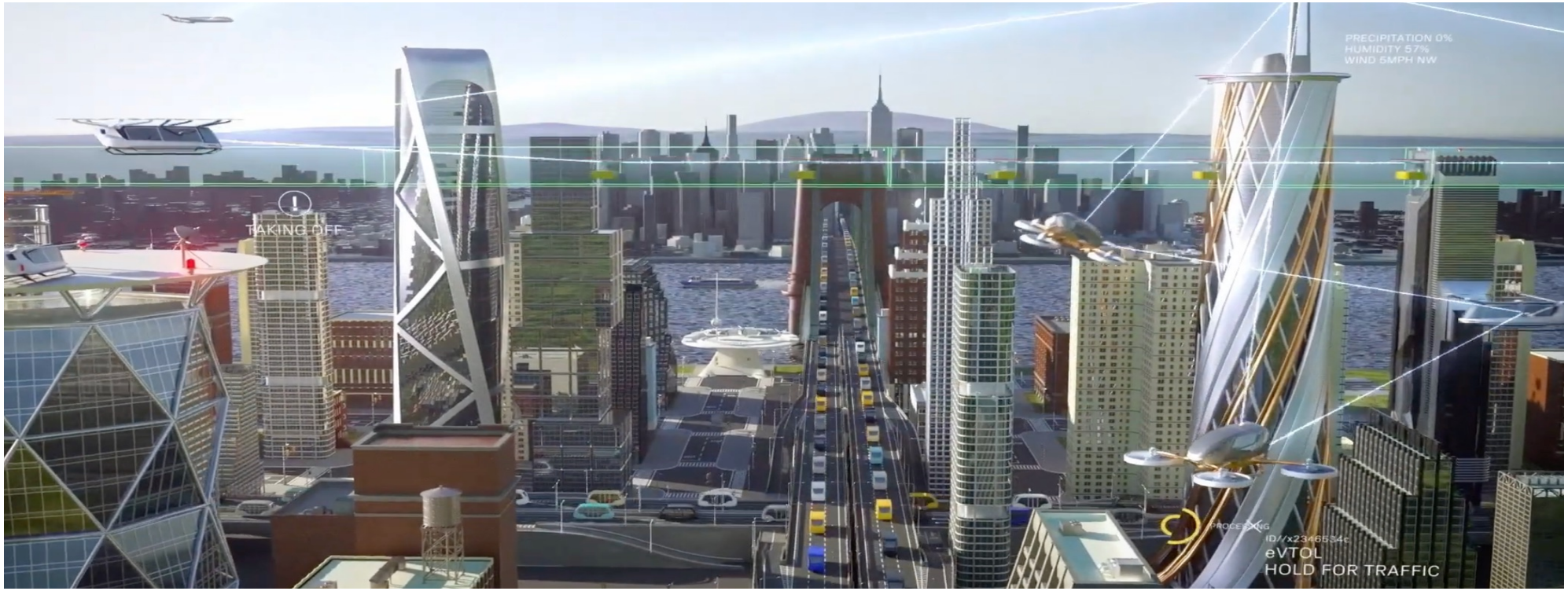
SMART CITIES

REGULATORY

MICRO-WEATHER

Data & Reasoning Services

# Data & Reasoning Fabric (DRF)

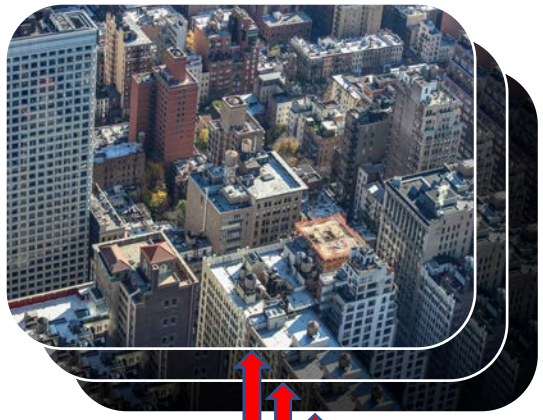



Trusted Service Discovery and Exchange Backbone for the Future Airspace Ecosystem

# Data & Reasoning Fabric

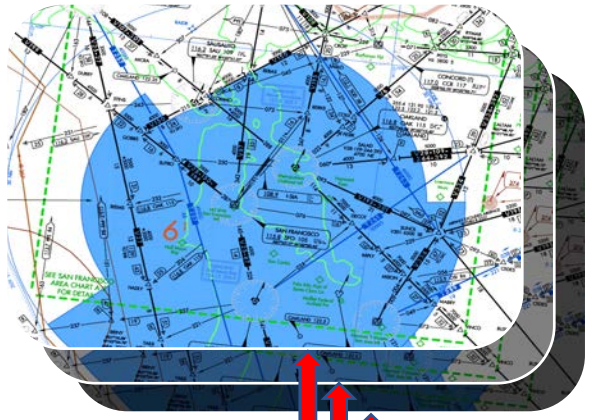
Service Providers

PLANNING



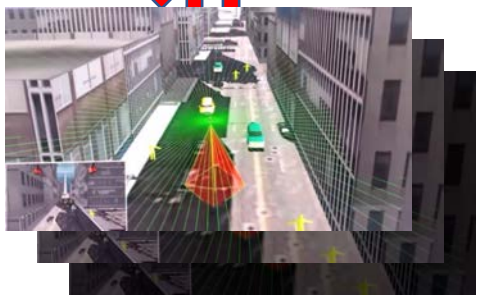
OPERATIONS

PERFORMANCE

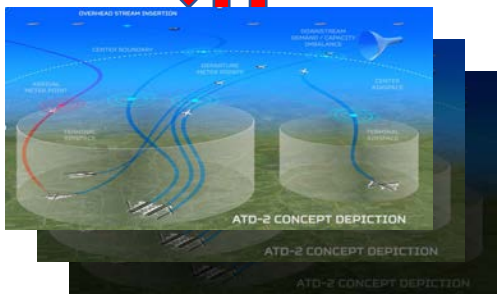


DATA & REASONING FABRIC

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

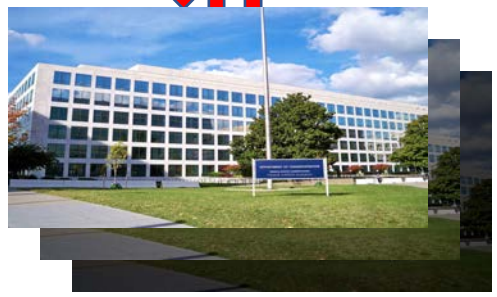


SMART VEHICLES

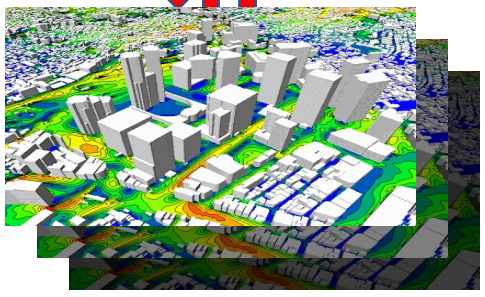



SMART AIRSPACES

SMART CITIES



REGULATORY



MICRO-WEATHER

Data & Reasoning Services

# Data & Reasoning Fabric

Registration

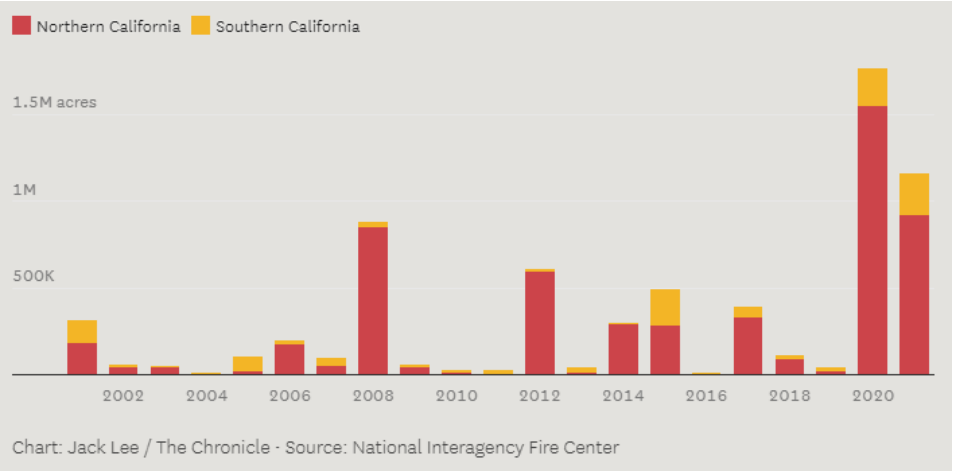
Service Transactions

Interoperability

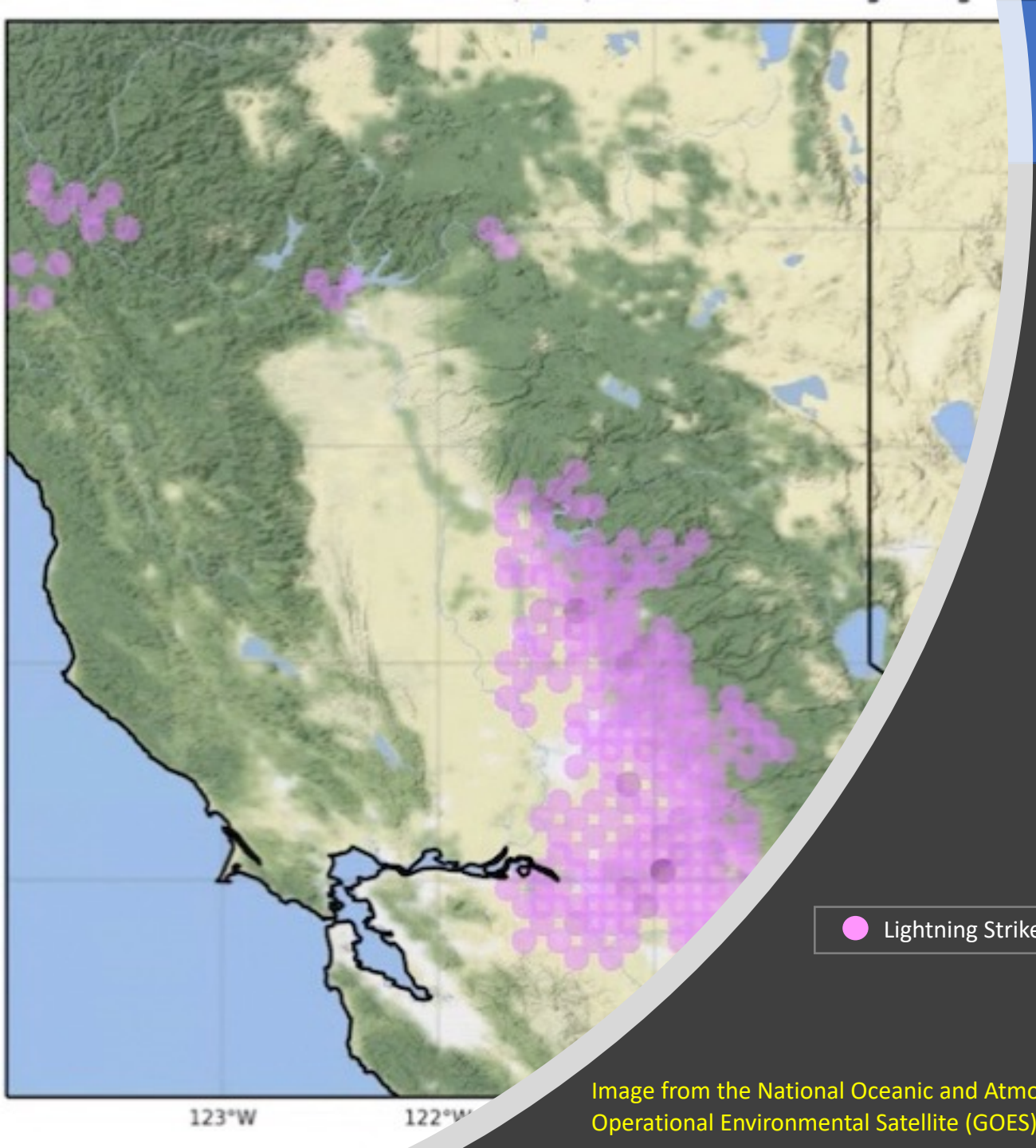
Cybersecurity
(Blockchain)
(Distributed Identities)

# Wildfire Detection Background

- Lightning is the primary natural cause of wildfire.
- About 40 million lightning strikes hit the ground in the United States each year.
- Although California receives much fewer lightning strikes in comparison to other parts of the country, due to its geographical nature, such strikes can lead to giant blazes.
- With suitable environmental conditions such as fire promoting weather, dry ground vegetation, nearby fires, distance from human presence etc., lightning can cause large wildfire.



# Wildfire Detection Field Test




Wildfire Detection Field Test

Between 16th and 20th of August 2023, NASA Data and Reasoning Fabric (DRF) team in collaboration with the California Wing of the Civil Air Patrol (CAP) conducted a successful flight test in the Santa Clara Unit (SCU) lightning Complex fire region, to validate the usability and impact of the DRF technology in critical wildfire detection and response operations involving coordinated air and ground activities.

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

# Civil Air Patrol (CAP)

- 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.

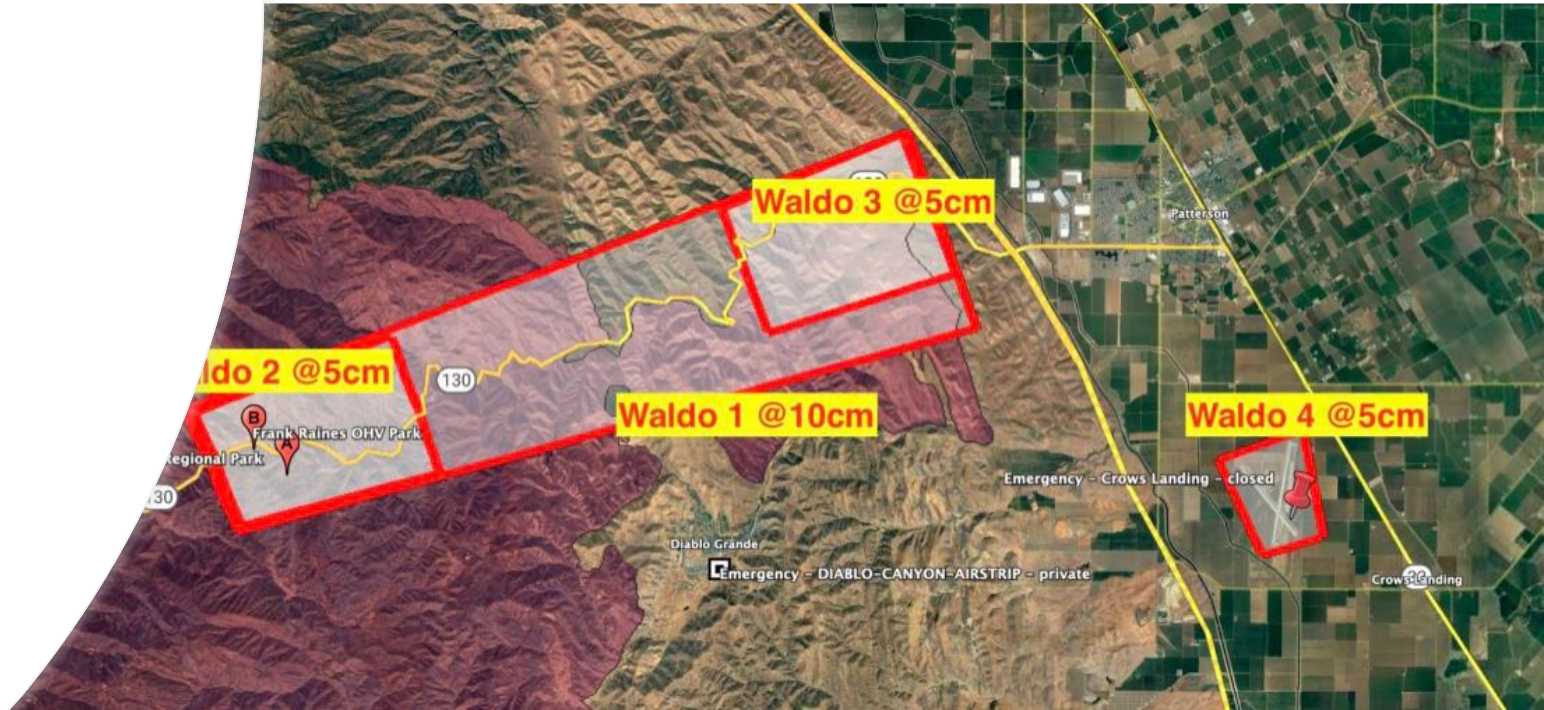

# CAP – NASA DRF Partnership
# Data-Driven Decision Making for Emergency Response and Training Missions

- 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

# Selected Investigation Test Site:
Santa Clara Unit (SCU) Lighting Fire

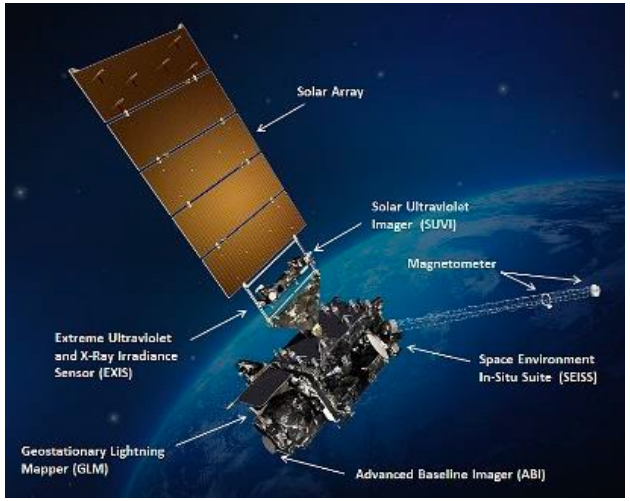
- SCU lightning complex fire burnt 393,624 acres during August September of 2020, making it the fourth largest overall wildfire recorded in California's modern history.

- 3 potential fire mockup sites are selected for investigation during the 18th, 19th and 20th of August 2023

# DRF Support Scope for CAP Mission

To support the lightning induced fire detection flight mission of CAP, the use of the DRF aims to facilitate:




- PRE FLIGHT: Streamlined access to decision support data that includes:
  1. Lightning strike data [sourced from the GOES 16 and GOES 17 satellites managed by NASA/NOAA]
  2. Normalized Difference Vegetation Index (NDVI) data [sourced from GOES satellite]
  3. Existing fire data [sourced from the VIIRS equipment onboard the Suomi NPP satellite]
  4. Weather data [sourced from openweathermap.org data]
  5. Wind data [sourced from openweathermap.org data]
  6. Population density data [sourced from US Census Bureau data]
  7. Route planning [internally developed by NASA DRF team]
- IN FLIGHT: Coordinated information gathering and exchange among flight entities for:
  1. Detection and processing of fire markers [internally developed by NASA DRF team]
  2. Notification of mission status and task assignments [internally developed by NASA DRF team]
- POST FLIGHT: Information sharing for the fire response team that includes:
  1. Publishing of actionable data [internally developed by NASA DRF team]

# DRF and CAP Support for Wildfire Detection

**Registration of Data & Reasoning Services**

**Registration of Users & Service Discovery**


**Simulated Lightning Strike**

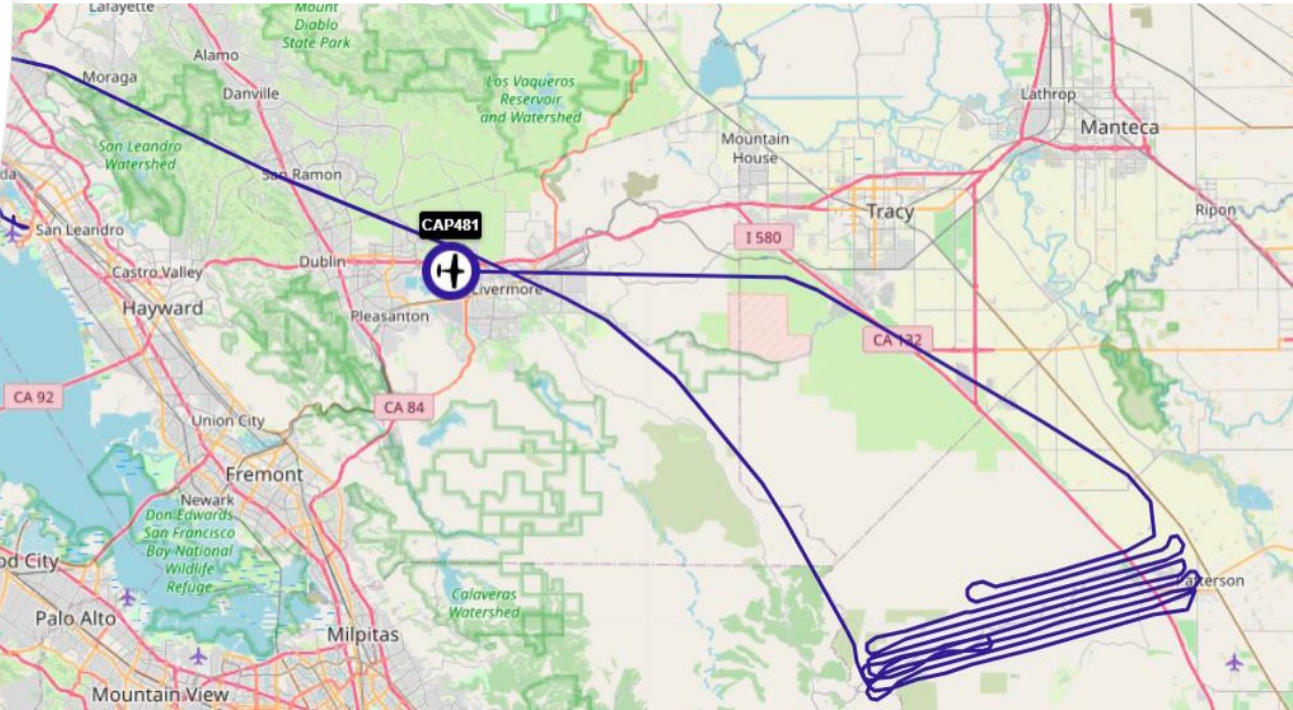
**Identification of Fly Target Areas**

**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 |

# Crewed Aircraft Track



# Crewed Flight Imagery Analysis

50 Mega Pixel High resolution (8688 x 5792) image captured by the XCAM Ultra50

Segmented image
(1086 pixels x 724 pixels) for processing

Detection of suspicious area

# Questions ?


https://drf.nasa.gov