



An Overview of Advanced Air Mobility Research at NASA

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- Background
 - UAS Traffic Management (UTM)
 - Advanced Air Mobility (AAM)
- Current NASA research in AAM
- Public Good Missions
 - NASA and JAXA's collaborative research
 - Advanced Capabilities for Emergency Response Operations (ACERO)
- Summary

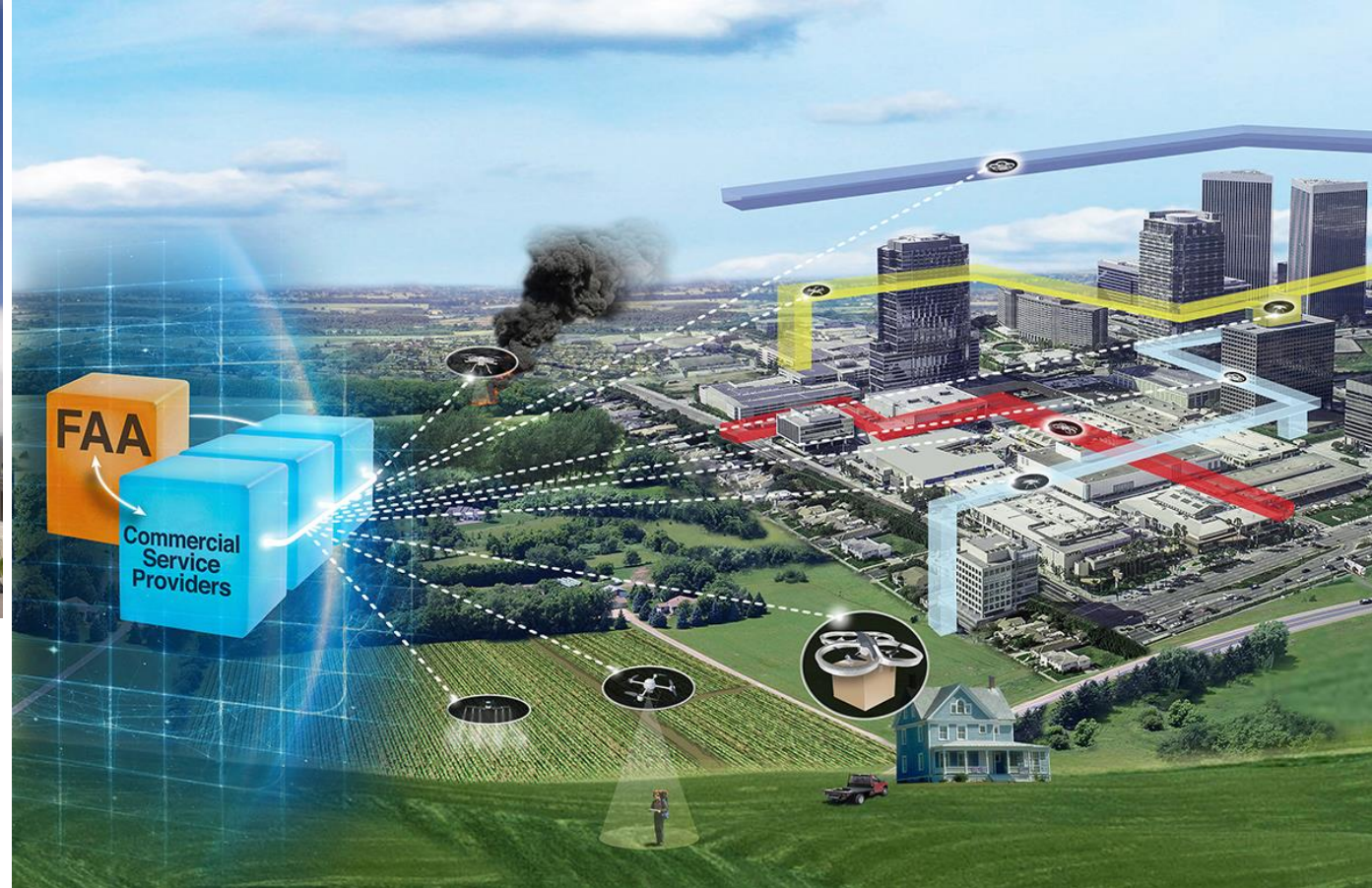
Background



- The US National Airspace System is extremely safe
- NASA has a rich history of contributions in Air Traffic Management
- New entrants are emerging
- NASA is on the leading edge of driving innovations in airspace management and integration of these new entrants



UAS Traffic Management (UTM)



- Many use cases and benefits of drones in our airspace
- How do we make sure they can all operate together safely?
- NASA pioneered an approach to UTM to enable future markets worldwide

Advanced Air Mobility (AAM)



- Advances in technology have made dynamic regional transport an achievable reality
- How do we integrate at scale?



AAM Missions



Airspace Operations and Safety Program (AOSP)

System Wide Safety (SWS)



Support transformation of the National Airspace System by identifying largest technical barriers to safety

Advanced Air Mobility (AAM)



Help safely develop air transportation system that moves people and cargo between places underserved by aviation

Air Traffic Management-eXploration (ATM-X)



Safely accommodate growing demand of new airspace entrants while improving traditional operations

ACERO



Develop, demonstrate, and transition emerging aviation technologies to identify, monitor, and suppress wildland fires

- To safely achieve scalability, a paradigm shift is envisioned that will involve a shift from onboard piloting to remote and potentially fully autonomous operations
- This shift will require advances in autonomy that will enable the aircraft to navigate, sense and avoid, and handle contingencies with limited to no human intervention



NASA Research in AAM: Air Traffic Management



- Current methods of air traffic management will likely limit scalability and place an undue burden on air traffic control personnel and infrastructure
- NASA is conducting research into the services, procedures, stakeholder roles and responsibilities, autonomy, and other aspects needed to manage AAM airspace



- Potential bottlenecks exist if operations in and around vertiports are not managed flexibly
- NASA is conducting research into the technologies, services, infrastructure, procedures, contingency management, and system interoperability to address airspace and resource management at the terminal areas of vertiports and vertiplexes



NASA Research in AAM: National Campaign Demonstrations

- A testing framework developed to provide a means to bring together the AAM research outcomes and technologies through a series of integrated simulations and flight demonstrations
- National Campaign brings together multiple partners from industry, NASA, FAA and other federal entities to demonstrate combined AAM capabilities and collect valuable data





AAM Missions



- Great deal of focus on public good aspect of airspace management and integration
- Some examples:
 - Disaster response
 - Wildfire Management
 - High-Altitude remote sensing
 - Medical transport
 - Search and Rescue
 - ...





JAXA and NASA Collaboration on Manned and Unmanned Aircraft Operation Integration in Disaster Response

Towards Integrated Disaster Response



- Aircraft are essential for efficient disaster response
- UAS usage has increased
- Currently, UAS and crewed vehicles cannot operate together
- Vehicle integration and coordination pose major challenges

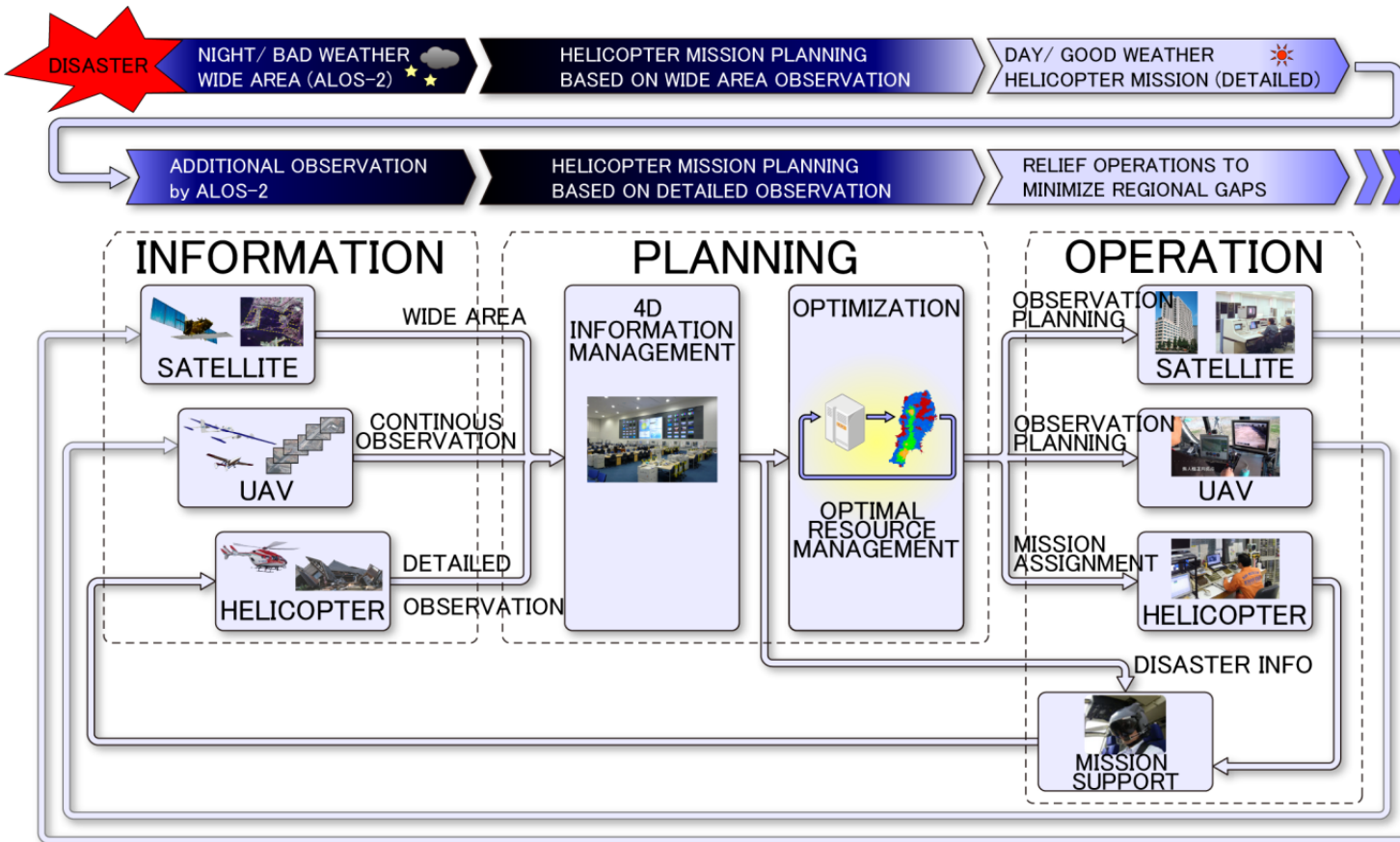


UAS: Unmanned Aircraft System

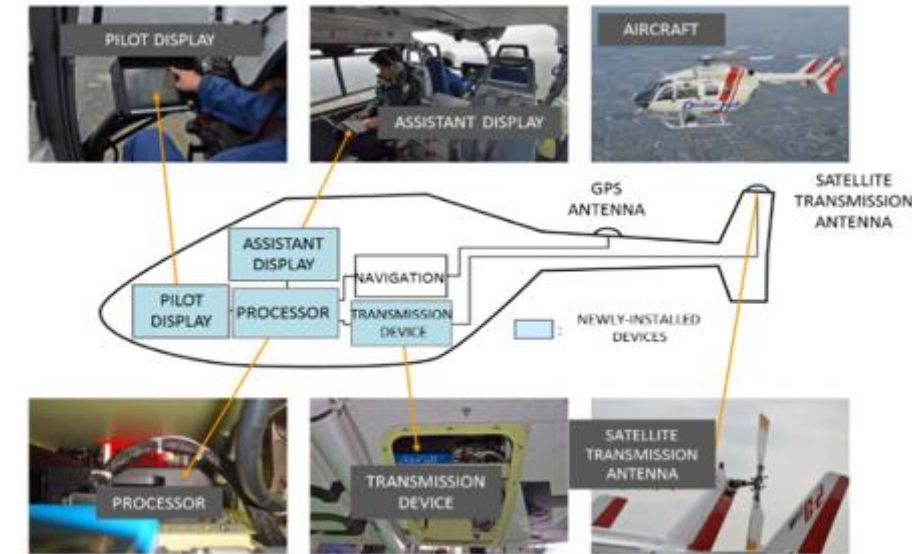
Goal: Use mission planning and traffic management technology to coordinate crewed aircraft and UAS

JAXA's Disaster Relief Aircraft Information Sharing Network (D-NET)

- Disaster response requires high levels of coordination and management of assets
- Current post-disaster operations: human-centered
- Technology advances → decision-support systems
- D-NET's goal: **safer** and **more efficient** disaster relief operations



Onboard D-NET mission support :
integrated/ fully-portable



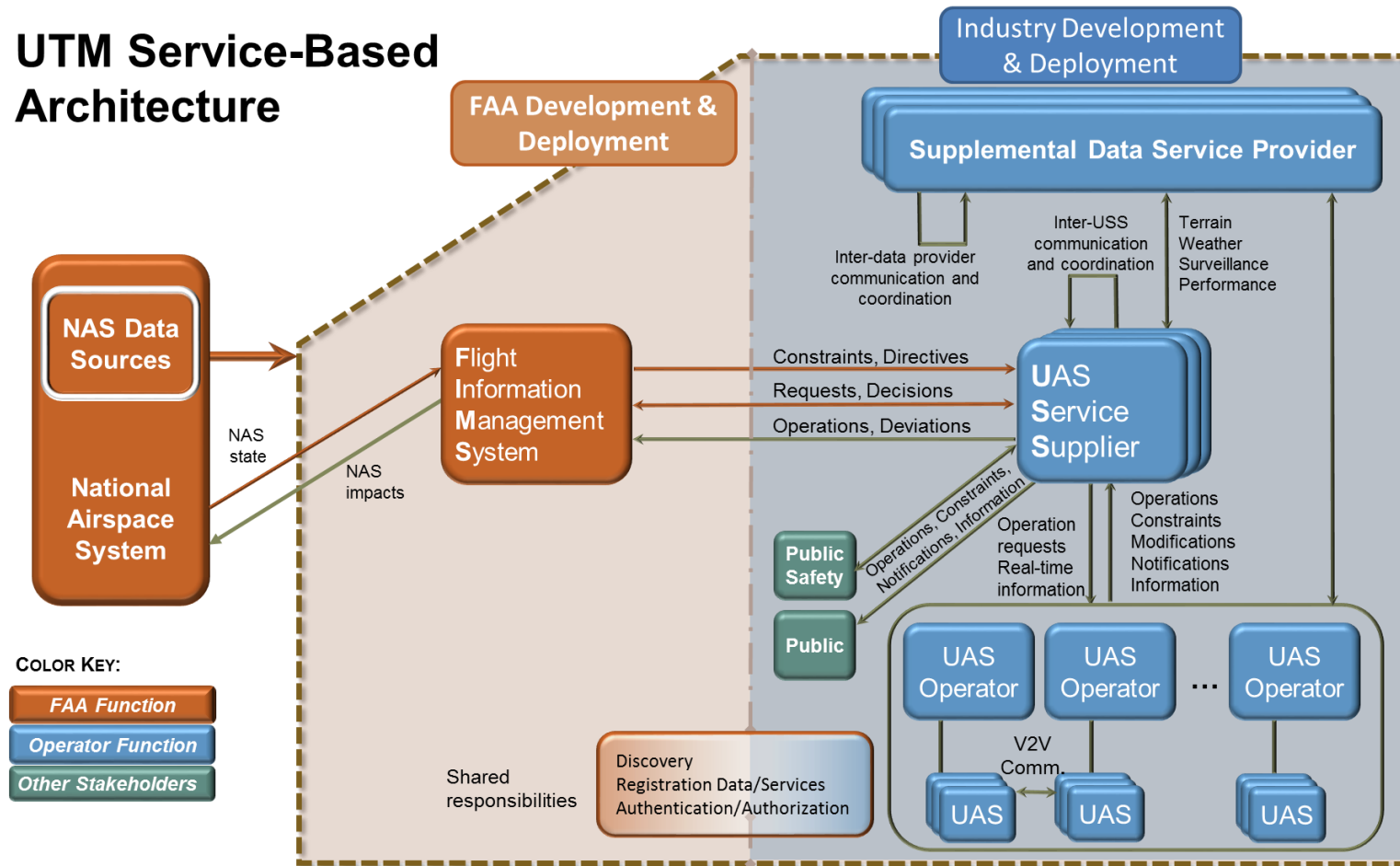
Ground D-NET Information Integration Subsystem (D-NET IP)



NASA's UAS Traffic Management



UTM Service-Based Architecture



Flight Information Management System

- Enables airspace controls, facilitates requests for an Air Navigation Service provider

UAS Service Supplier

- Federated Structure
- Cloud-based automated system
- Supports UAS with services (e.g. separation, weather, flight planning, contingency management,, etc.)

Supplemental Data Service Provider

- Supplies supplemental data to USS and UAS Operator to support operations

UAS / UAS Operator

- Individual Operator
- Fleet Management
- On-board capabilities to support safe operations

D-NET / UTM Testing Summary



Objectives

- Demonstrate the performance of NASA's UTM system in disaster relief operations through integration with JAXA's D-NET system to enable the effective use of UAS in support of response efforts
- Inform international standards and interoperability as part of global harmonization in UTM and AAM

Accomplishments

2018

- Joint publication presented at AIAA Aviation in June 2018
- Connectivity established between JAXA UTM client and D-NET system
- JAXA simulations of UTM operations conducted in August
- Large-scale disaster drill held October 12 in Japan. UTM researchers, D-NET researchers and operators, and JAXA flight crews participated and demonstrated UTM/D-NET integration

2019

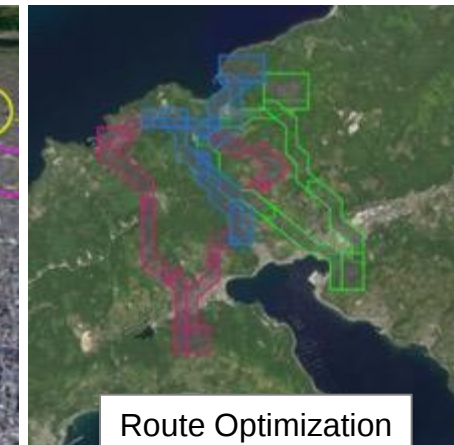
- Updated UTM systems used in collaboration with TCL4
- Developed route optimization algorithm for planning and asset allocation
- Conducted UTM/D-NET-connected live flight tests of manned helicopter on mock SAR mission in urban Tokyo area (Dec 2019)



Disaster Drill Ehime, Japan



Live flight of manned JAXA helicopter

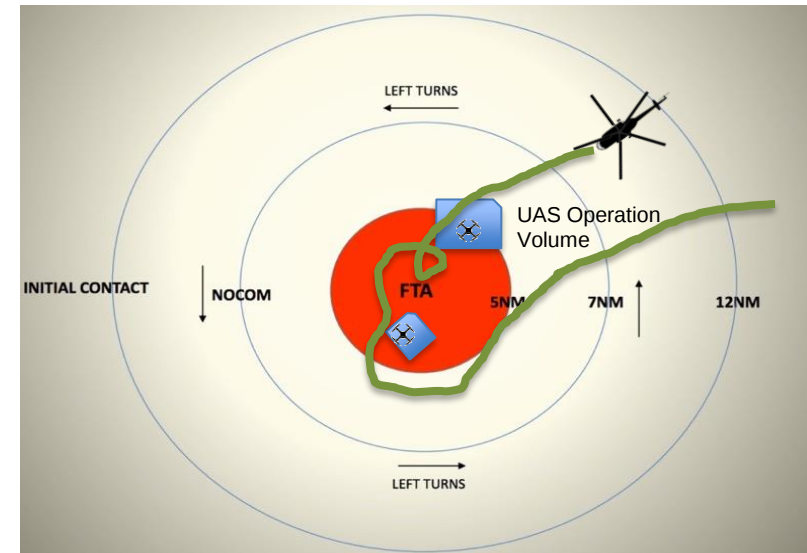
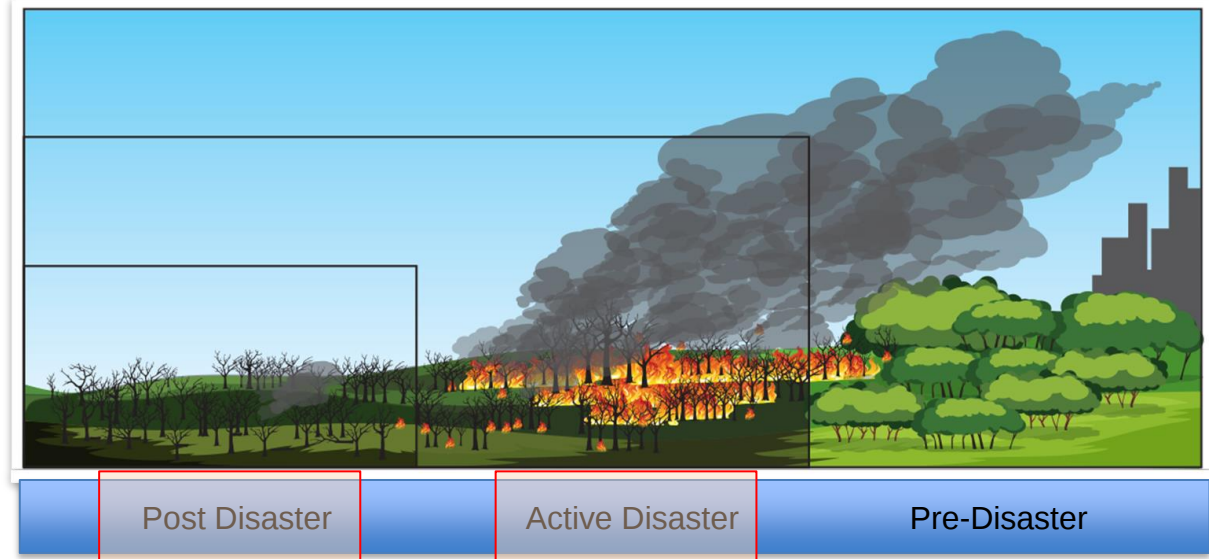


Route Optimization

Next Steps



- Renewed collaboration
- Use Cases:
 - Active Wildfire Response
 - UAS logistics transitioning in and out of a Temporary Flight Restriction (TFR)
 - UAS aerial surveillance in a TFR
 - Post Hurricane/Earthquake Recovery
- Goal:
 - Further research how conventional aircraft and UAS can safely integrate for disaster response operations
 - Provide recommendations to standards development organizations to support considerations for unmanned-manned interactions and disaster-response operations
- Planned Activities:
 - CONOPS / Use Case Development (FY22)
 - Joint Simulation (FY23)



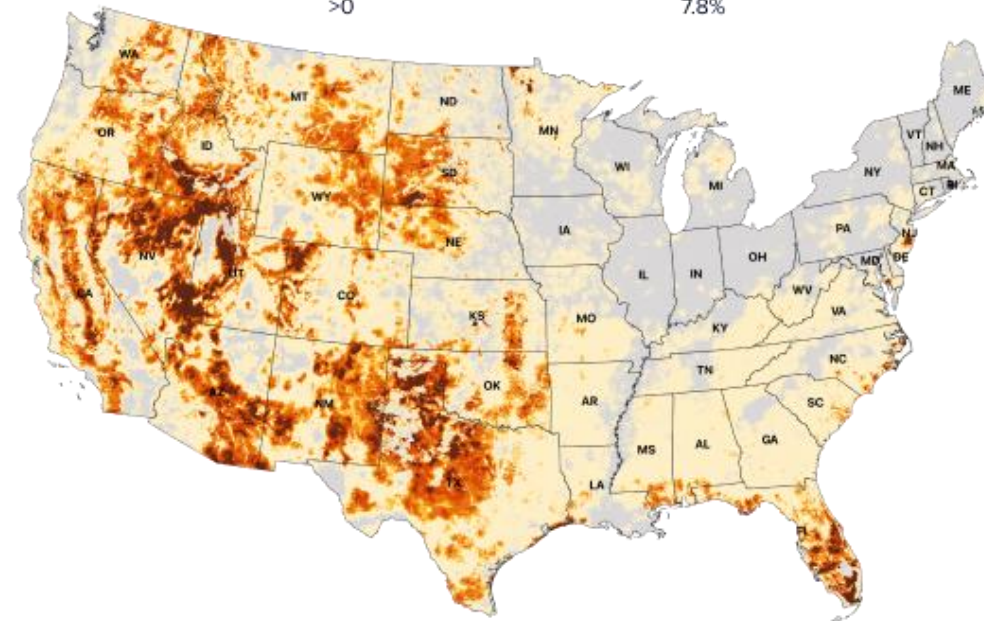


Advance Capabilities for Emergency Response Operations (ACERO)

Wildland Fire Impacts



2022 National Wildfire Probability



Credit: 5th National Climate Risk Assessment, First Street Foundation

- **Increased Severity**

- 2015, 2017, and 2020 each had over 10M acres burned
- In 2021: 58k Fires and 7.1M acres burned

- **Increased Costs**

- 10-year average: \$2.3B Suppression & \$8.4B Total
- 5-year average: \$2.8B Suppression & \$16.8B Total
- In 2021: \$4.3B Suppression & \$11.2B Total

- **Increased Risk**

- 1 in 6 homes in the US at risk over the next 30 years
- Wildfires affect Climate (e.g., CO₂, black/brown carbon)
- Wildfires affect Air Quality

<https://fas.org/sgp/crs/misc/IF10244.pdf>
<https://www.nifc.gov/fire-information/statistics>
<https://www.ncei.noaa.gov/access/billions/>

2021 Estimated Costs and Duration

Dixie Fire:	\$637M (over 3 months)
Beckwourth Complex:	\$542M (over 2 months)
Caldor Fire:	\$271M (over 2 months)
Monument:	\$163M (over 2 months)
Bootleg:	\$100M (over 1 month)

Wildfires contribute to climate change and climate change increases likelihood of wildfires

Current State-of-the-Art

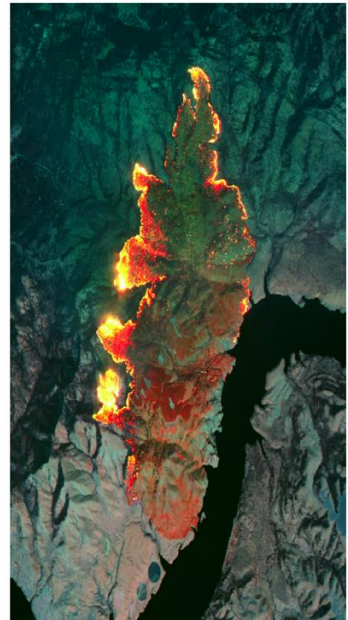


NASA, in collaboration with the US Forest Service, conducted a workshop to understand the state-of-the-art, needs, and opportunities to improve wildfire management

- Focused on pre-fire fighting, during fire fighting, and post fire needs
- Identify the needs and challenges of stakeholders at various decision cycles from planning, prediction, detection, tracking, mitigation, suppression, and post-fire remedial efforts
- 154 attendees from other government organizations, academia, industry, and NASA

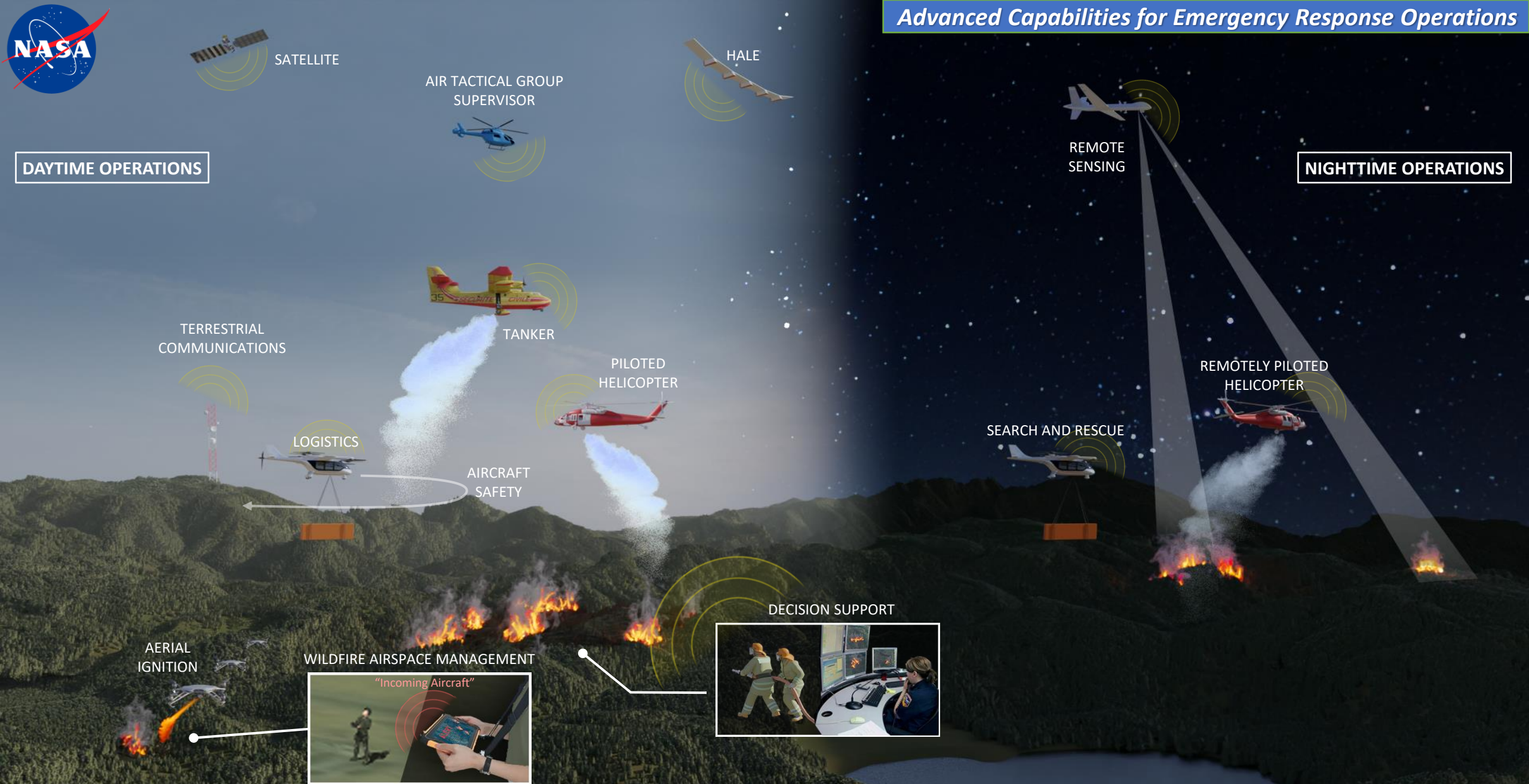
Main Findings

- Lack of persistent surveillance for fire detection and tracking
- Lack of persistent communications
- Lack of persistent aerial operations particularly under poor visibility
- Lack of airspace technologies to enable multiple types of aircraft operating simultaneously
- Lower aircraft safety record than other areas of aviation
- Lack of adequate coordination among multiple government agencies
- Need a clear plan to mature research for operational use in the field



- Workshop report available at https://nari.arc.nasa.gov/sites/default/files/attachments/NASA%20ARMD%20WILDFIRE%20MANAGEMENT%20WORKSHOP_6.1.2021_v13.pdf

Findings offer insights where research and development could make a significant impact

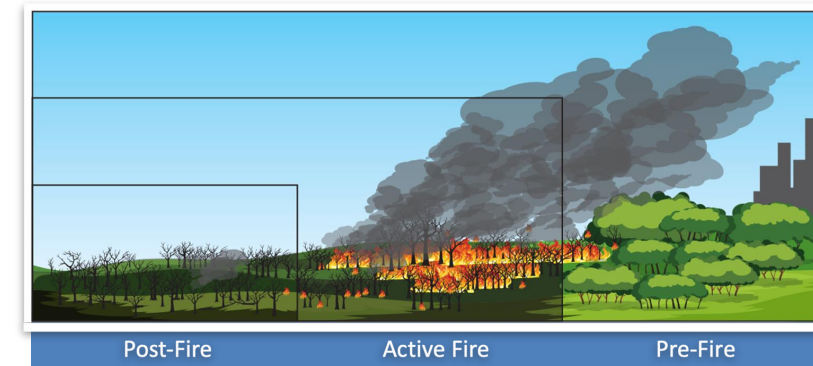


GOAL: Develop, demonstrate, and transition to operations, emerging aviation technologies to identify, monitor, and suppress wildland fires, as a means to enhance safety, improve efficiency, and prevent economic loss.

ACERO Objectives



- ❑ Demonstrate emerging airspace management technology to improve emergency responder's effectiveness and safety during a disaster
- ❑ Develop and demonstrate new mission capabilities using emerging aviation technologies that provide resilient and interoperable communication, navigation, surveillance, and mission support to extend disaster response operations
- ❑ Integrate NASA Science Mission Directorate Earth Science sensing capability and flight assets, with NASA ARMD airspace and vehicle operations capabilities to enable expanded and scalable aircraft operations
- ❑ Leverage public-private partnerships to develop and test prototype capabilities



ACERO aims to benefit society through the modernization of disaster response operations

Summary



- NASA is engaged in multiple areas of research, in collaboration with government and industry, to enable Advanced Air Mobility (AAM)
- Focused AAM research activities include: aircraft autonomy, airspace management, vertiports & infrastructure, and national campaign flight demonstrations
- AAM missions of focus include regional passenger/cargo, consumer goods and enterprises, urban passenger transport, and public good
- Public good an increasingly important AAM mission of interest
 - NASA and JAXA have a successful, ongoing collaboration to address the challenges of manned/unmanned integration in disaster response situations
 - NASA's ACERO Project will develop, demonstrate, and transition to operations, emerging aviation technologies to the wildland fire community



Questions?

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