ACERO

Advanced Capabilities for Emergency Response Operations

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ACERO Project Objectives

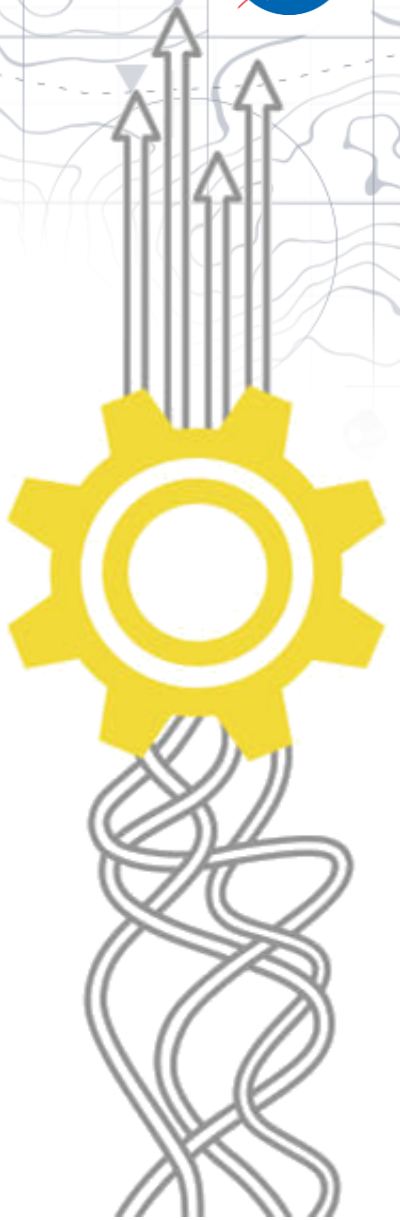
- Develop interagency Concept of Operations to ensure consistency of operational priorities, technology adoption, and programmatic alignment for national needs
- Develop and validate emerging airspace management technology to improve emergency responders' efficiency and safety during a disaster
- Develop and validate new mission capabilities using emerging aviation technologies that support 24-hour operations
- Leverage public, private, and philanthropic partnerships and cross-mission directorate technologies to develop and demonstrate prototype capabilities

Strategic Alignment

- NASA Alignment:
  - Agency Strategic Goal 3 - Catalyze Economic Growth and Drive Innovation to Address National Challenges
  - ARMD Strategic Implementation Plan
    - Mega-Driver 3 – Technology Convergence
    - Strategic Thrust 6 - Assured Autonomy for Aviation Transformation
  - NASA Wildland Fire Management Initiative - Collaboration between ARMD, SMD, and STMD

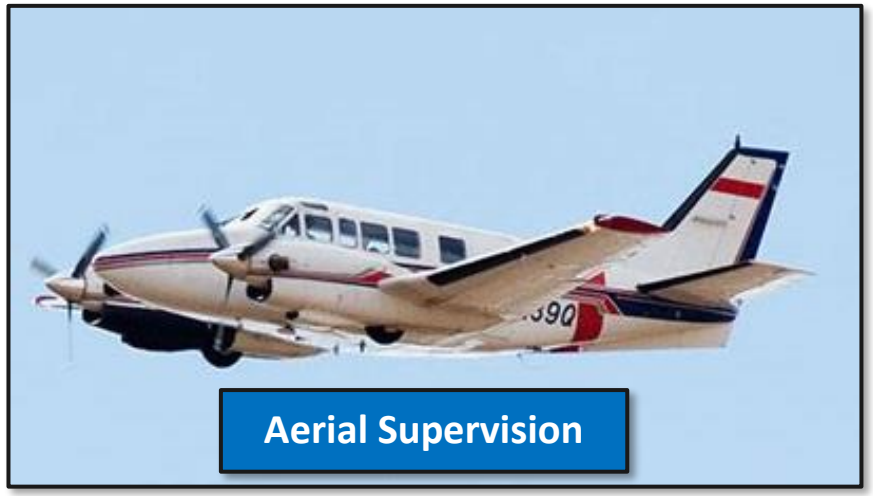
- Other Government Agency Alignment:
  - United States Forest Service (USFS) / Department of Interior (DOI) - Dingell Act
  - CAL FIRE - California Emergency Services Act

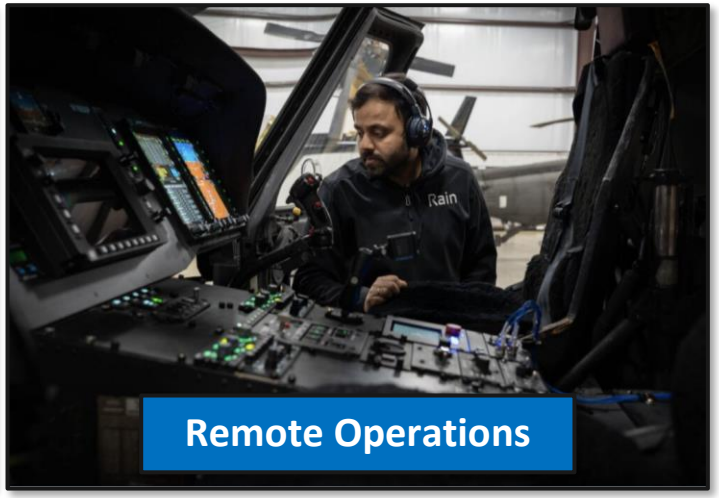
- Alignment with Independent Recommendations:
  - White House – “Modernizing Wildland Firefighting through Science and Technology” report by PCAST, February 2023.
  - Congress – “Wildland Fire Mitigation and Management Commission: Aviation Equipment Strategy Report” by WFMMC in January 2023
  - NASA Aeronautics Research and Technology Roundtable (ARTR)



Aviation Technologies in Managing Wildfires

- Aviation technologies are making an impact in wildfire operations





Challenges in Wildfire Aviation Operations

- Use of crewed assets for air tactics/support is limited to clear-visibility conditions
- Limited number of specialized workforce that can perform air tactics/support duties
- Existing airspace management techniques are mostly manual and high workload
- Simultaneous aerial operations is either prohibitive or limited
- Degraded communication environments limit information dissemination between personnel

NASA's leadership in Aviation Technologies

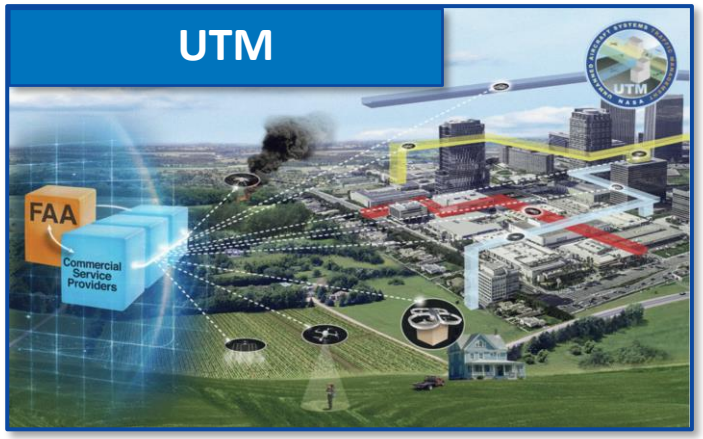
Decades of research excellence in aviation technologies

Operation Efficiency

New airspace management concepts

Safety

UTM



UAS Traffic Management (UTM) system to enable safe and scalable sUAS operations: collaboration, development, and field testing

STEReO:

UAS Pilot kit (UASP-kit): view of airspace, air traffic alerts, and wildfire operational maps; Validation testing at USFS in FY23

- **Experience in bringing community together to advance aviation technology**
- **Ability to collaborate with science, technology, and development experts to support holistic integration of new capabilities in wildfire management**

Enabling Wildfire Aviation Operations in Degraded Visual Environments

Technical Challenge

Develop and evaluate a prototype airspace management system that leverages advanced technology to enable safe and efficient remotely-piloted aerial firefighting operations, including suppression, in degraded visual environments.

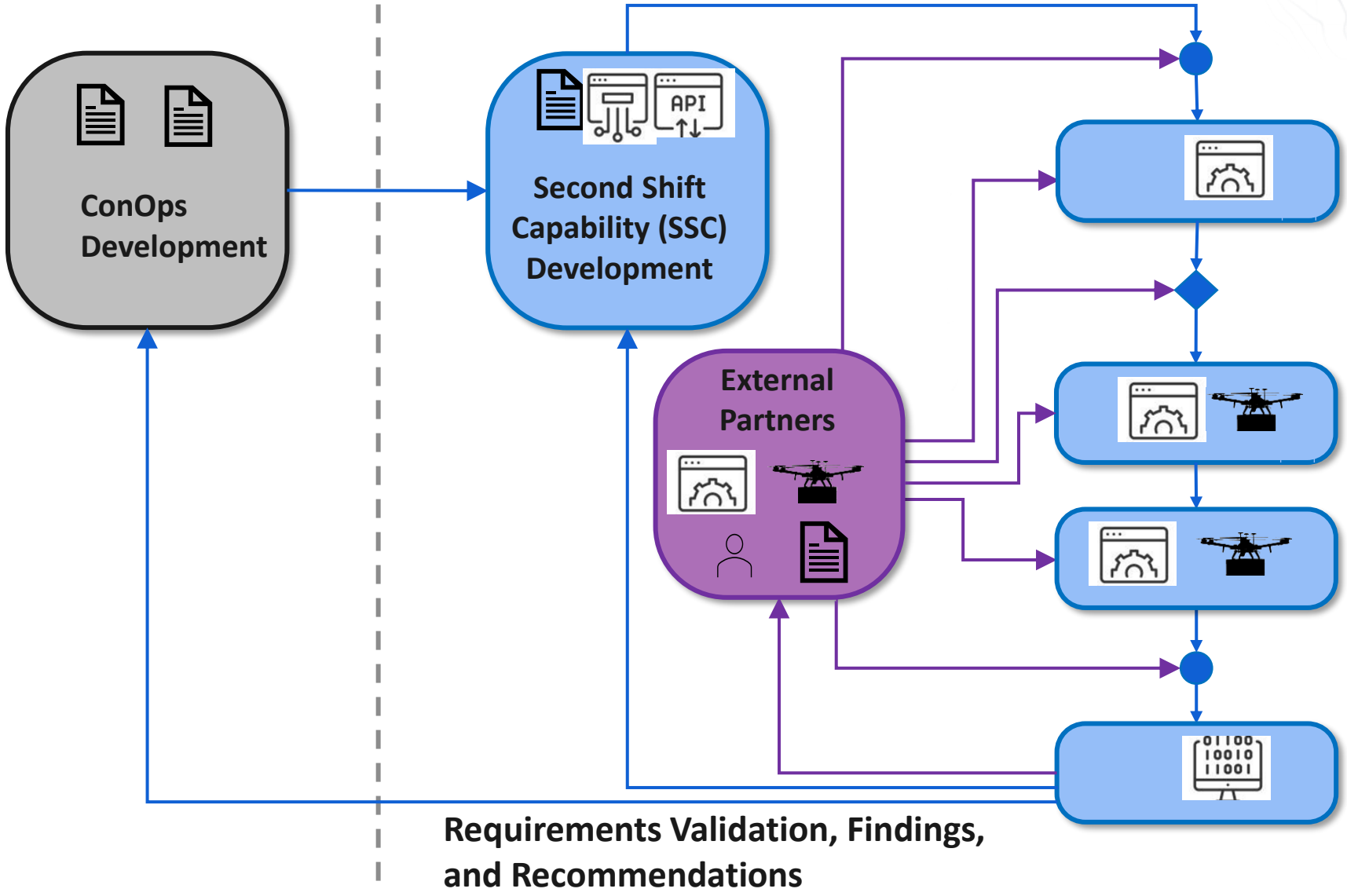
Development Approach

- Collaborate with partner agencies and industry to jointly develop prototypes that conform to requirements derived from the CONOPS
- Joint testing with stakeholder partners to evaluate feasibility, performance, and/or usability of prototype technologies

Exit Criteria

- A Second Shift reference prototype that conforms to requirements derived from Inter-agency CONOPS
- A technology transfer to key stakeholders that includes airspace management and autonomy system requirements and procedures for remotely piloted suppression operations in degraded visual conditions
- Joint development and testing with industry to support technology transfer

Technical Approach



TCL Kickoff and Identify Partnerships

Mission Concept and System Requirements Review

Establish Partnerships

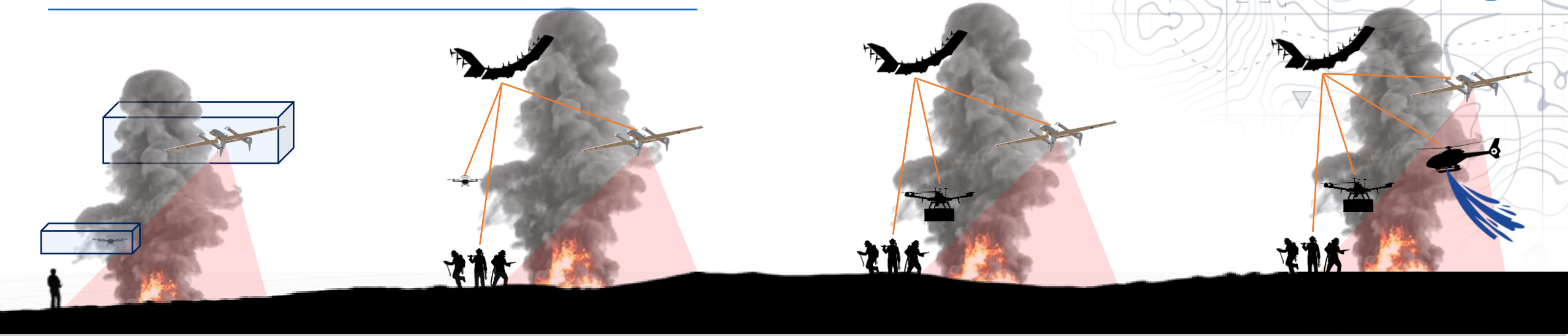
Technical Architecture and Flight Readiness Reviews

Buildup and Shakedown Testing

Demonstration and Data Collection

Results Dissemination

Degraded Visual Environments: Technical Capability Levels



TCL 1 (FY25)

- **Capability:** Incident Monitoring
- **Technology:** UTM-in-a-box
- **Enablers:**
  - Local Information Sharing
  - Airspace Management and Aircraft Deconfliction
- **Impact:** Locally shared situation awareness

TCL 2 (FY27)

- **Capability:** Information Sharing
- **Technology**: Communications Architecture and Aerial Comms Solution for UTM-in-a-box
- **Enablers:**
  - Extended Information Sharing
  - Mission Planning
- **Impact:** Reliable and interoperable mobile communications

TCL 3 (FY28)

- **Capability:** Logistics
- **Technology:** Hazard Detection & Avoidance, Mission Planning, & xTM interoperability
- **Enablers:**
  - Mission Tasking
  - Aircraft Transit through NAS
- **Impact:** UAS mission that can transition to and from an incident

TCL 4 (FY30)

- **Capability:** Suppression
- **Technology:** Suppression Mission Autonomy
- **Enablers:**
  - Suppressant Delivery & Monitoring
  - Re-tasking & Re-loading
- **Impact**: End-to-End Suppression Operation with remotely piloted aircraft

TCL demonstrations test increasingly complex missions needed for suppression in degraded visual environments

Technical Capability Level Progression

Aircraft:

- Mesh Network (TCL 1):
- Mobile Network (TCL 2):
- Hazard Perception & Avoidance (TCL 3)
- Suppression Autonomy (TCL 4)
- Thermal Camera
- Comms Payload
- Equipment Payload
- Suppressant

Shared Operating Picture

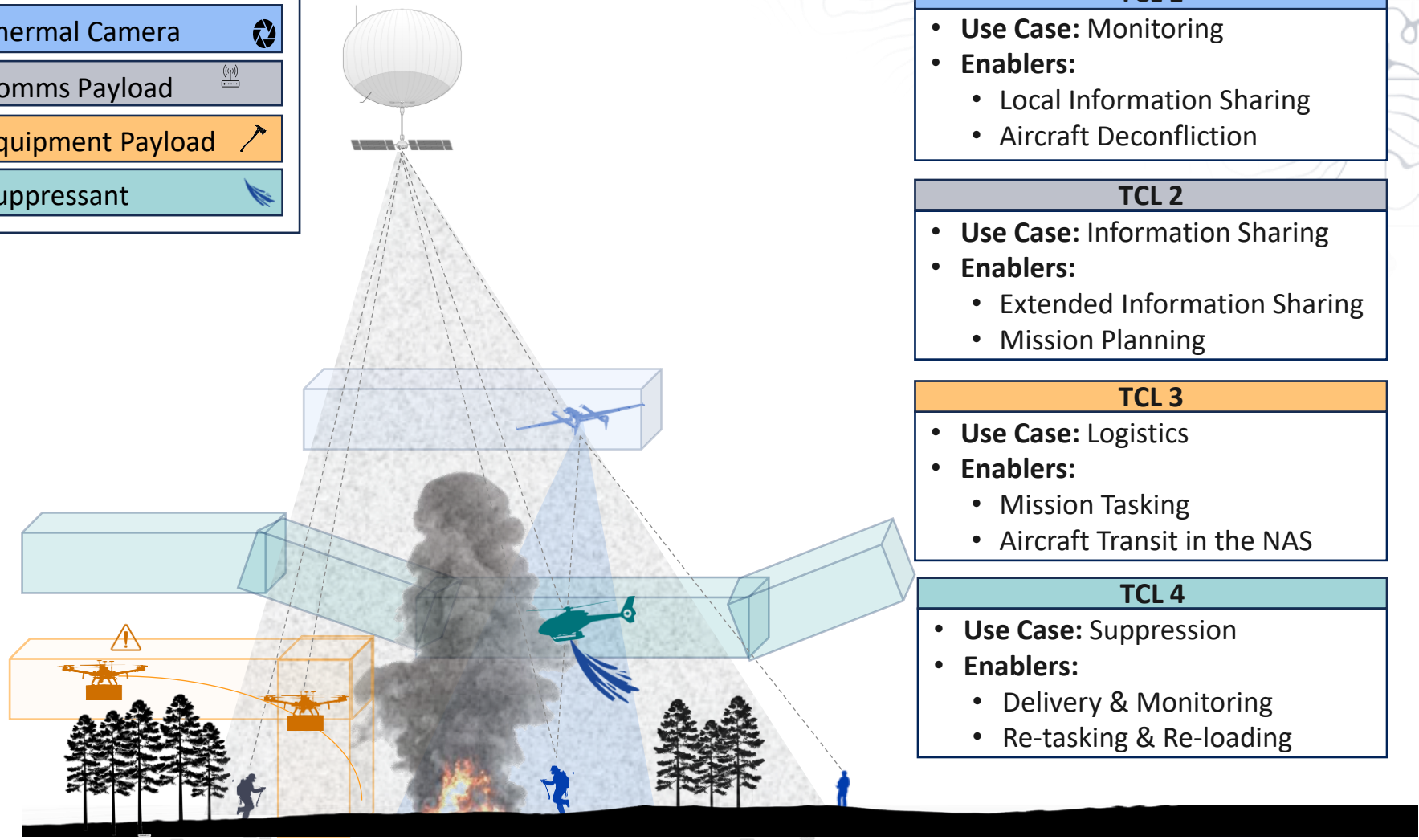
- Remote Pilot
- Hand Crew
- Air Tactical Group Supervisor
- Other Users

Ground Control Station:

- Mesh Network (TLC 1):
- Mobile Network (TCL 2):

UTM-in-a-box:

- Fire Data Processing (TCL 1)
- Strategic Deconfliction (TCL 1)
- Comms &Connectivity (TCL 2)
- xTM Interoperability (TCL 3)
- Dynamic Mission Planning (TCL 4)



TCL 1

- **Use Case:** Monitoring
- **Enablers:**
  - Local Information Sharing
  - Aircraft Deconfliction

TCL 2

- **Use Case:** Information Sharing
- **Enablers:**
  - Extended Information Sharing
  - Mission Planning

TCL 3

- **Use Case:** Logistics
- **Enablers:**
  - Mission Tasking
  - Aircraft Transit in the NAS

TCL 4

- **Use Case:** Suppression
- **Enablers:**
  - Delivery & Monitoring
  - Re-tasking & Re-loading

Connections to Projects outside ARMD

NASA Science Mission Directorate (SMD)

- The FireSense Program focuses on the measurement of (i) pre-fire fuels conditions, (ii) active fire dynamics, (iii) post fire impacts and threats, and (iv) air quality impacts and forecasting.
- The Disasters Program projects apply Earth observing data to support decisions across the disaster cycle.

Space Technology Mission Directorate (STMD)

- Small Business Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs.
- Flight Opportunities Program: flight testing of stratospheric platforms to support monitoring and communication mission for wildland fire.
- Capabilities for technology tracking, prizes, challenges, and crowdsourcing competitions.

Coordination & Collaboration

- Bi-monthly memo for the Wildland Fire Management Initiative
- weekly meeting
- quarterly F2F meeting
- Provided topics to STMD
- Provided support in planning for Flight Opportunities Program

Key External Partnerships

Government Agencies

Close collaboration with different agencies to coordinate the development of technologies; Cooperation to inform rulemaking and alignment across activities.

Industry

Work closely with industry and leverage their capabilities to accelerate the technology integration.

Standards

Dedicated engagement with standards organizations to ensure progress and impact.

International Organization

Collaborate with international organizations to preserve US leadership and enhance the competitive position of US companies.

Connections to Other ARMD Projects

- Airspace management insights
- Resilient comms insights
- UAS for Hurricane Relief & Recovery

System Wide Safety (SWS)

- UTM BVLOS: standards, safety case development
- Remotely piloted (or remotely supervised) operations, aircraft autonomy.
- Advancement of xTM concept and xTM-ATS interactions

Air Traffic Management – eXploration (ATM-X)

- VTOL Analysis for Emergency Response Applications
- Flight quality to support mission planning in wildfire environment

Revolutionary Vertical Lift Technologies(RVLT)

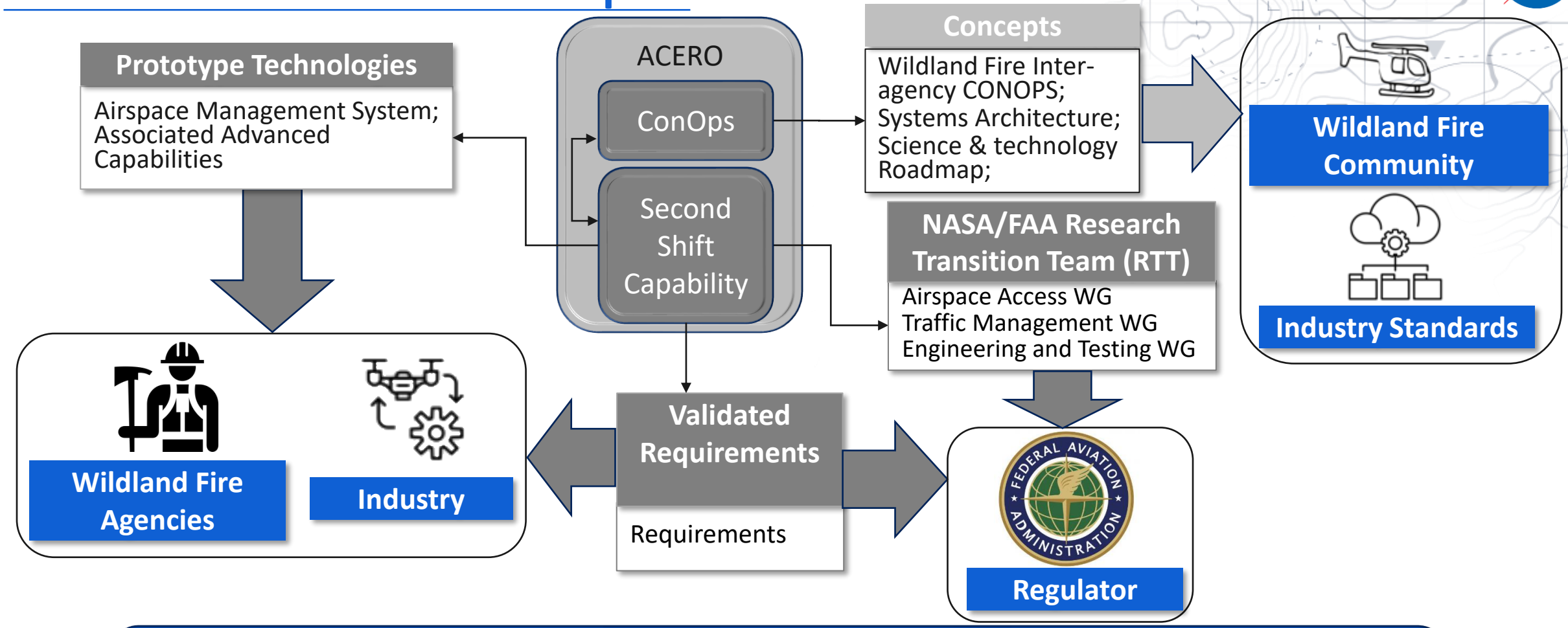
- Strategic Planning
- Tactical Deconfliction
- UAM-ATS interactions

Air Mobility Pathfinders (AMP)

- m:N UAS operations
- Wind modeling for wildland fire area

Transformational Tools and Technologies (TTT)

Deliverables and Impact



Impact on the State-of-the-art

- Validated requirements for portable and scalable airspace management system
- Enable safe and efficient 24-hr BVLOS operations with mixed crewed and uncrewed aerial vehicles
- Unlock potential applications of uncrewed aerial systems in wildfire operations

ACERO Summary

- Enable safe and efficient 24-hour aerial firefighting operations in degraded visual environments with interoperability considerations
- Development a prototype airspace management system incorporating advanced technologies for wildland fire management
- Conduct a progression of operational evaluations to validate requirements for aerial logistics and suppression operations in degraded visual environments for wildland firefighting
- Transfer prototype implementations, lessons learned, and validated requirements to key stakeholder agencies, industry partners, and standards development organizations

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Thank you