Human-Autonomy Teaming

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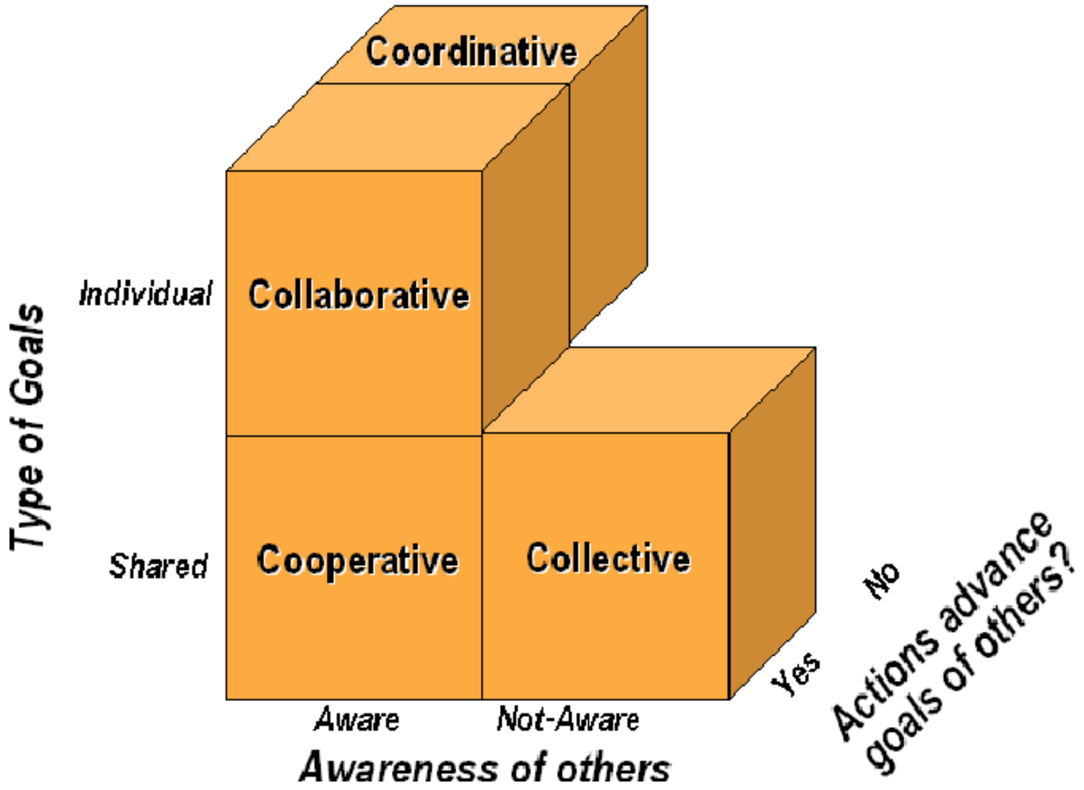
About Me

- Name: Meghan Saephan
- From: Stockton, CA
- Education:
  - B.S. MechE from UC Berkeley
  - M.S./Ph.D. MechE from Carnegie Mellon University
- Job: Computer Engineer at Ames Research Center
  - Human-machine interaction
  - Robotics
- Worked at NASA since 2014
  - Intern (4 summers)
  - Pathways Intern/Civil Servant (~5 years)

Multi-Agent Systems



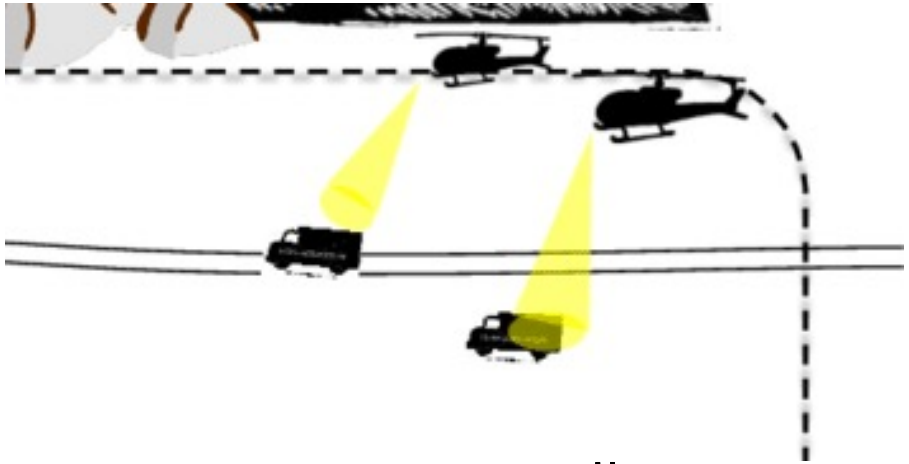
- Agents can be computers/software, robots/hardware, or a combination
  - Types of goals
  - Awareness
  - Advance goals of others
- Swarm
  - Many simple agents
  - Cooperate to reach emergent behavior
- Centralized or Decentralized

Onn, Tun hussein. "MULTI ROBOT TASK ALLOCATION USING MARKET BASED APPROACH FATIMAH BINTI YUSUF A project report submitted in partial fulfillment of the requirement for the award of the Master of Electrical Engineering." (2015).

Multi-Vehicle Applications

Forest Fire

Monitor Injured People



Persistent Surveillance

Infrastructure Inspection

Mission Operator

<u>Skilled Operators</u>

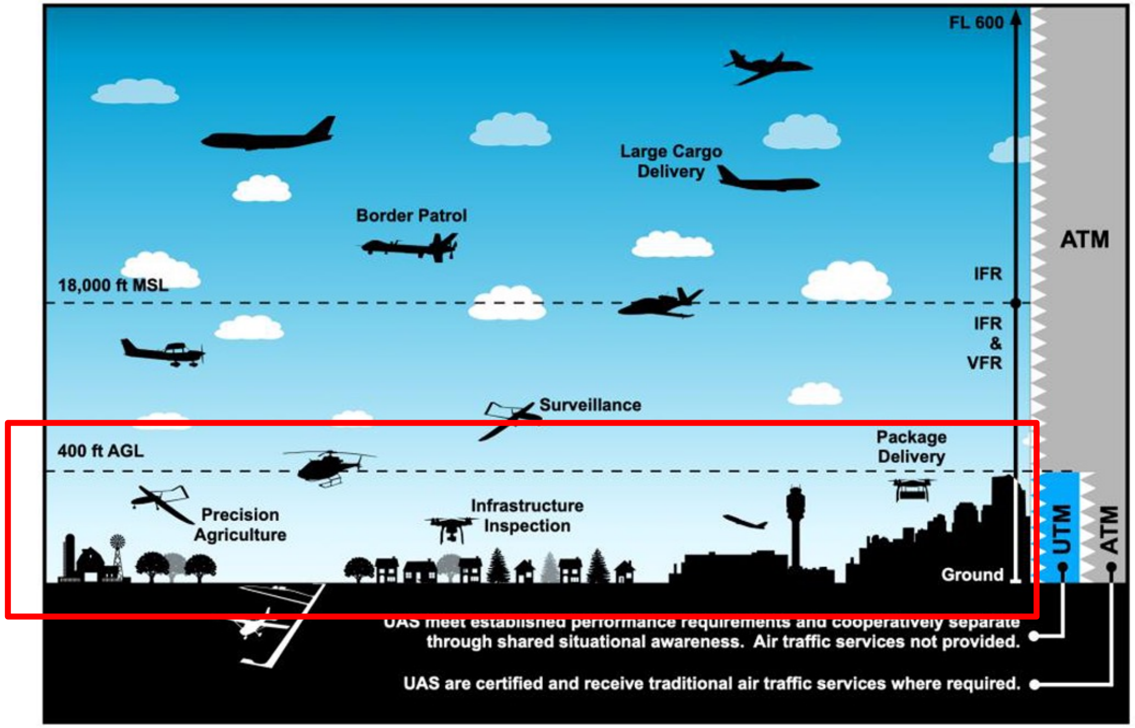
- Roboticists and pilots
- Comprehensive knowledge of vehicle and control behaviors
- Insight gained through experience

<u>Non-Expert Operators</u>

- Scientists
- Define missions, plan and manage from a high-level perspective
- Do not necessarily understand low level system architecture

Human-Machine Interaction

- Communication and information exchange methods between humans and machines
- Multiple modalities: keyboard/mouse, gesture, speech, multimodal
- Interaction methods and capabilities must enable humans to effectively interact with machines/automated systems without increasing workload on humans
  - Produce good system performance
  - Human is usually supervising agents – Supervisory control
- Human-Autonomy Teaming
  - Humans and agents work together to complete task(s)
  - Sometimes work in same environment



Future Envisioned Airspace

- Urban Air Mobility (UAM) aims to decrease congestion on roads
- Current work is exploring how Unmanned Aircraft Systems (UAS) Traffic Management (UTM) systems can be used for UAM operations

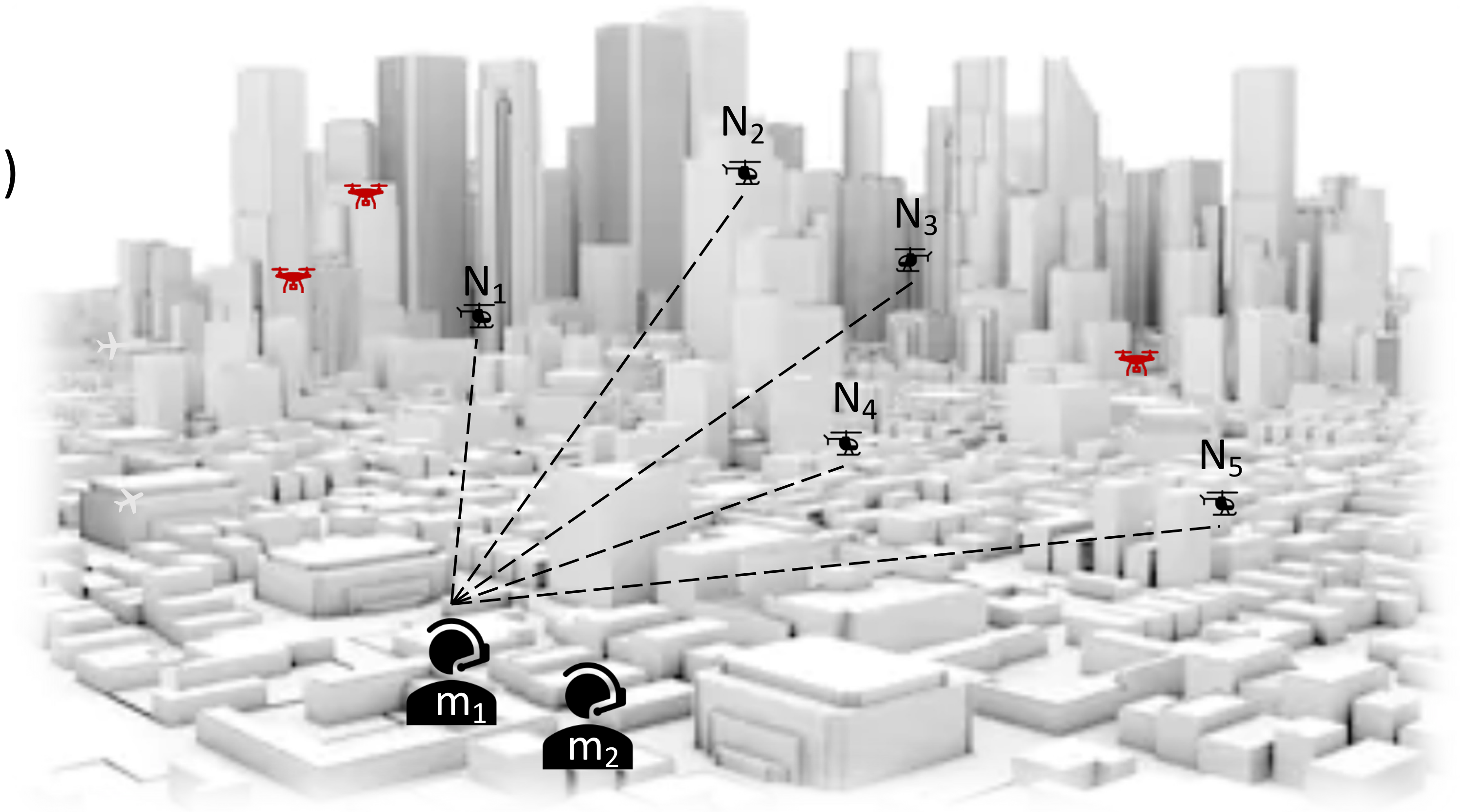
How can operators manage multiple Unmanned Aircraft Systems?

Multi-vehicle control = m:N

- Small group of humans (m) *manages* many highly automated air vehicles (N)
- Not flight vehicle control

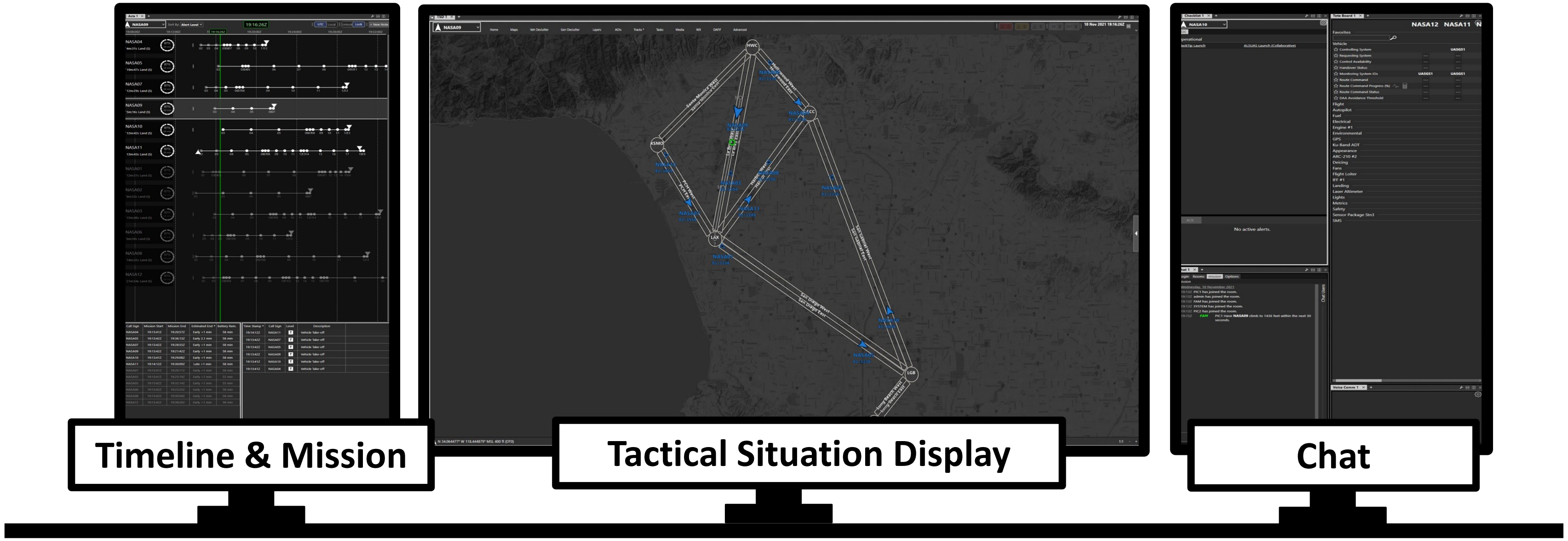
Enables desired future state

- Operations scalability
- Increasingly autonomous vehicles



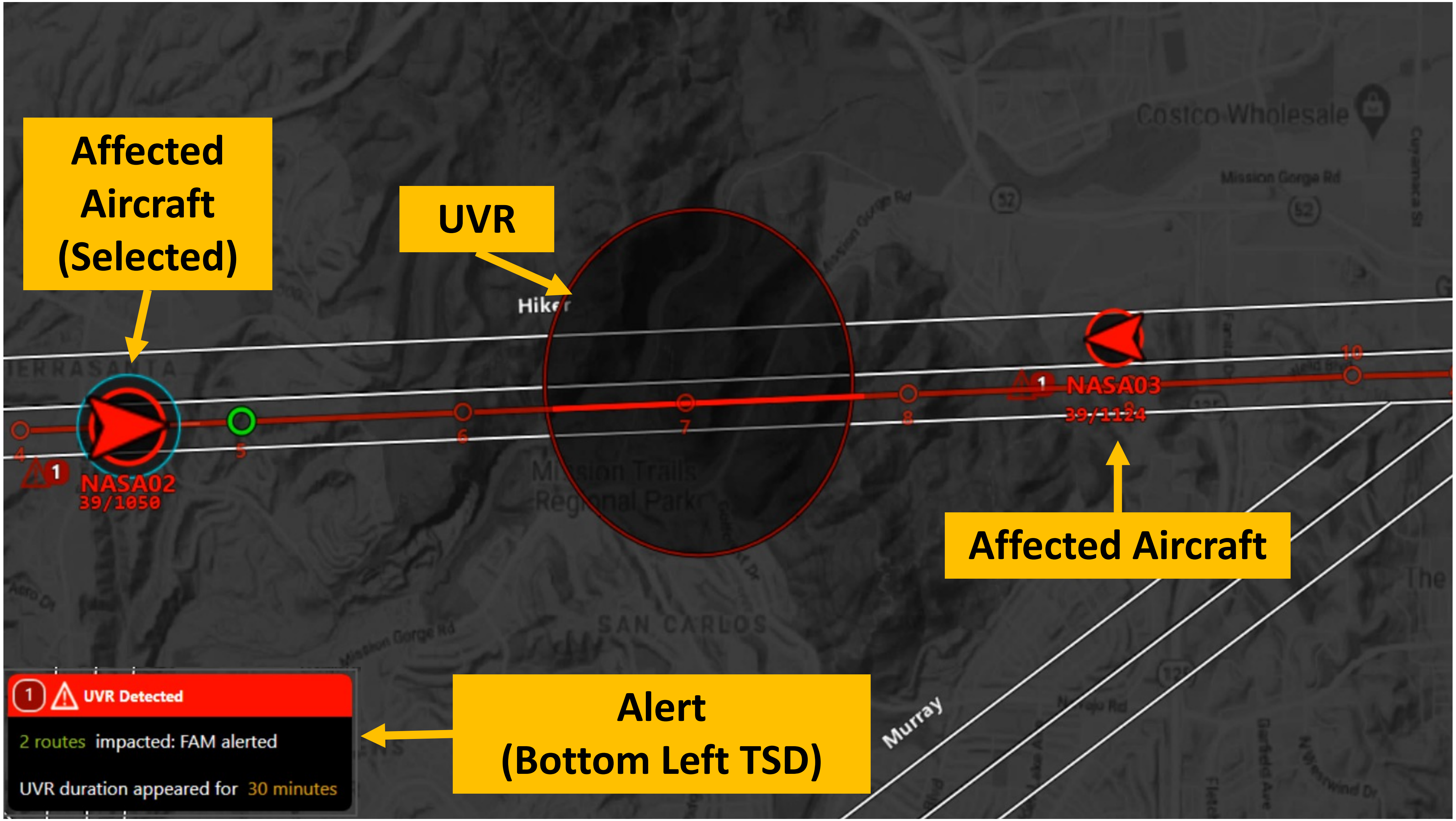
Applicable to range of use cases supporting of advanced air mobility vision

m:N Human-in-the-Loop Studies

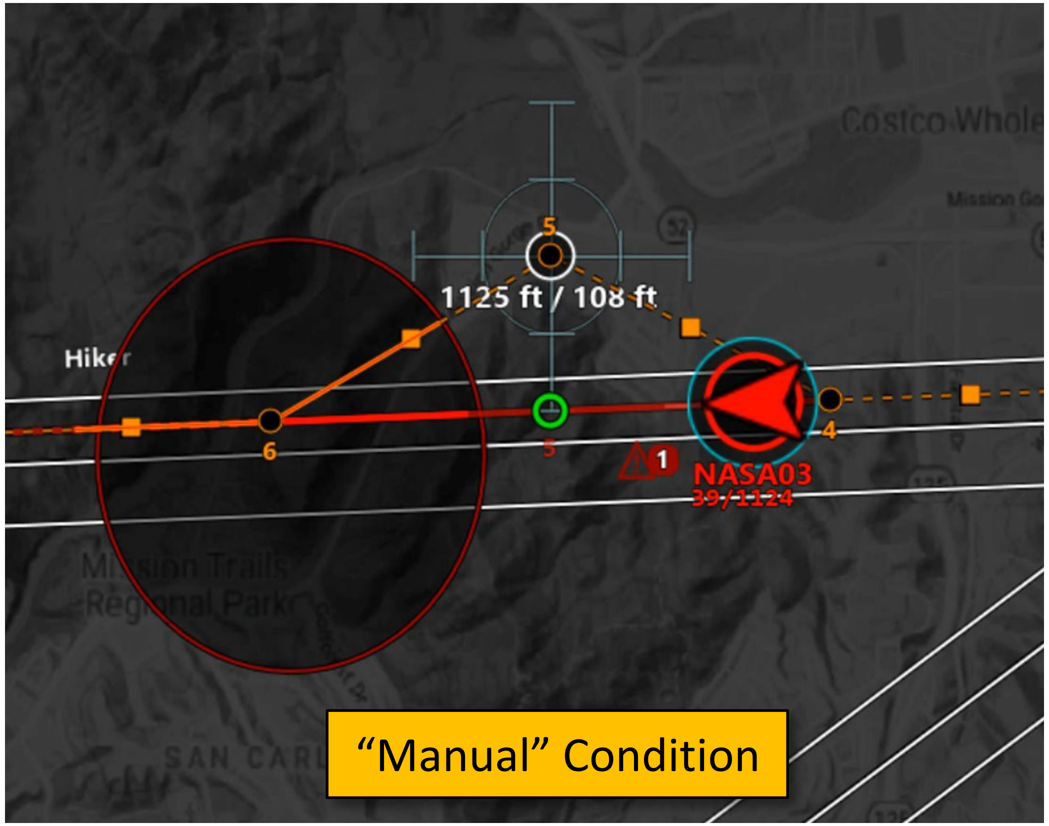


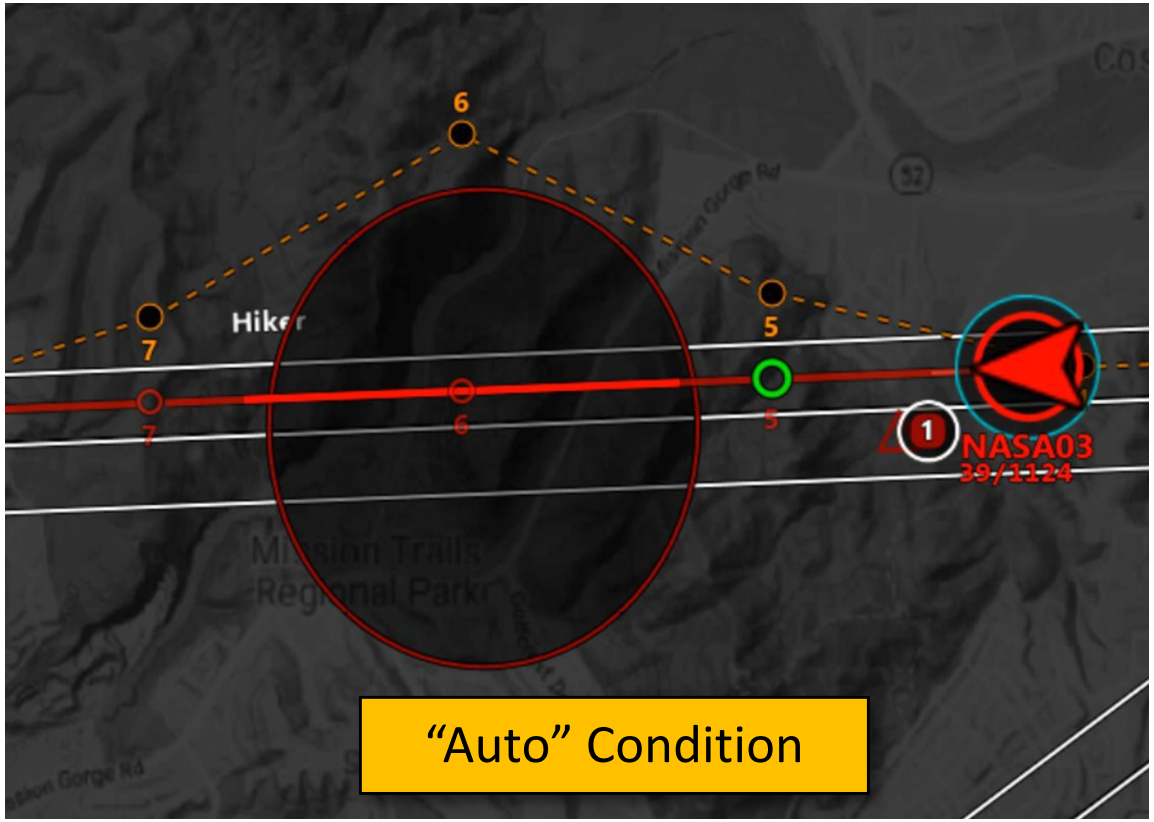
- Identify challenges for multi-operator, multi-vehicle operations
- Develop tools and capabilities for ground control stations used by multi-vehicle operators
- Explore impact of operational environments
- Collaborate with gov, industry, and academia

Screenshot of Active UVR & Affected Vehicles



Screenshot of Reroute with Terrain Conflict

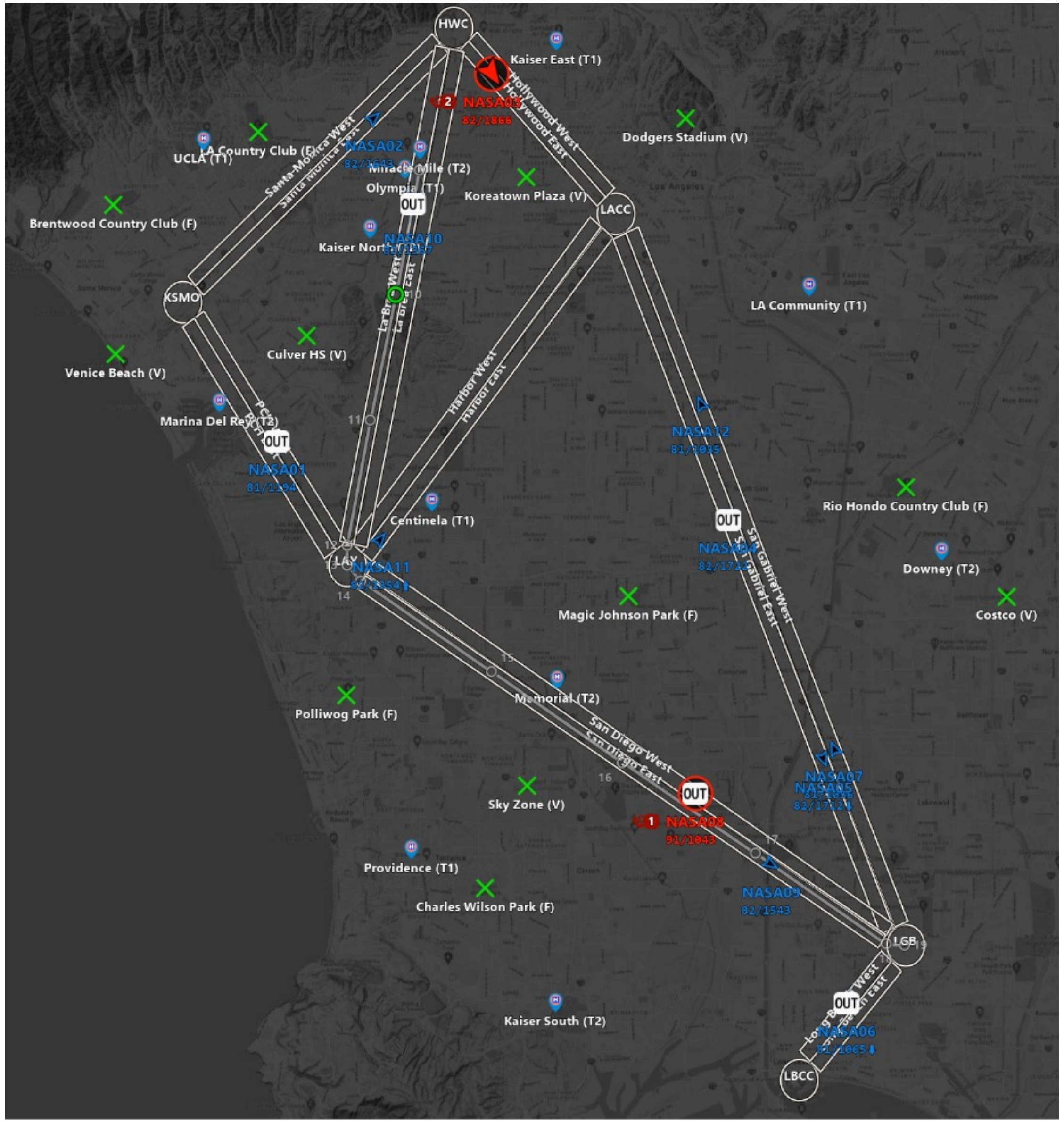




Workload Management

Pilot Task: divert emergency aircraft to appropriate landing sites (hospitals, helipads, open fields)

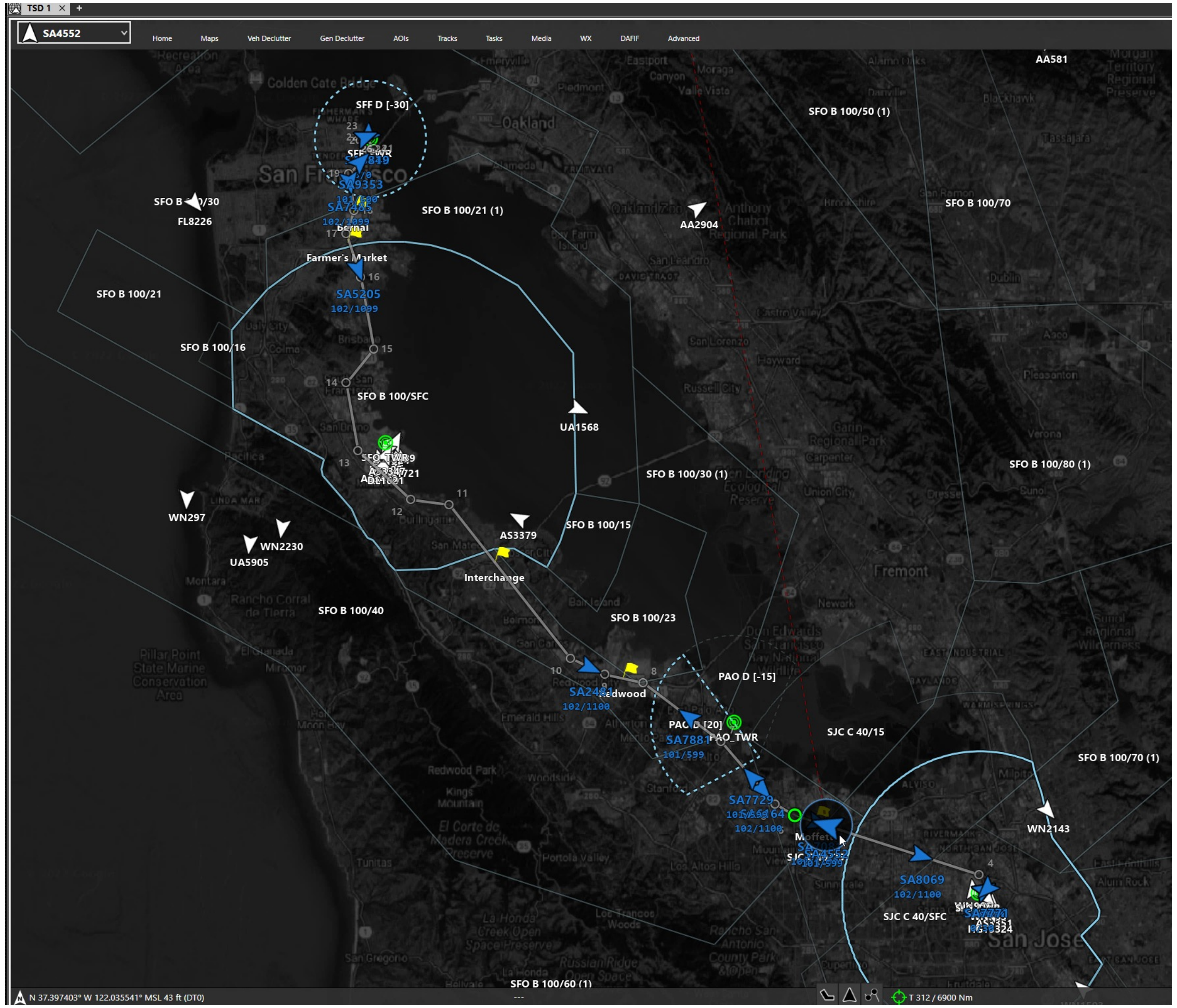
Goal: collect data on remote operators' use of the handoff capability in an m:N Urban Air Mobility (UAM) context. The primary focus of the current study was how participants manage **unplanned handoffs** – i.e., did handoffs occur when one or more vehicles in their fleet experienced an emergency?



Communication Modality Exploration

Pilot Task: coordinate flight activity for multiple, simultaneous flights in a hypothetical airtaxi service. Pilots were required to request departure, arrival, and transition clearances as well as comply with ATC instructions

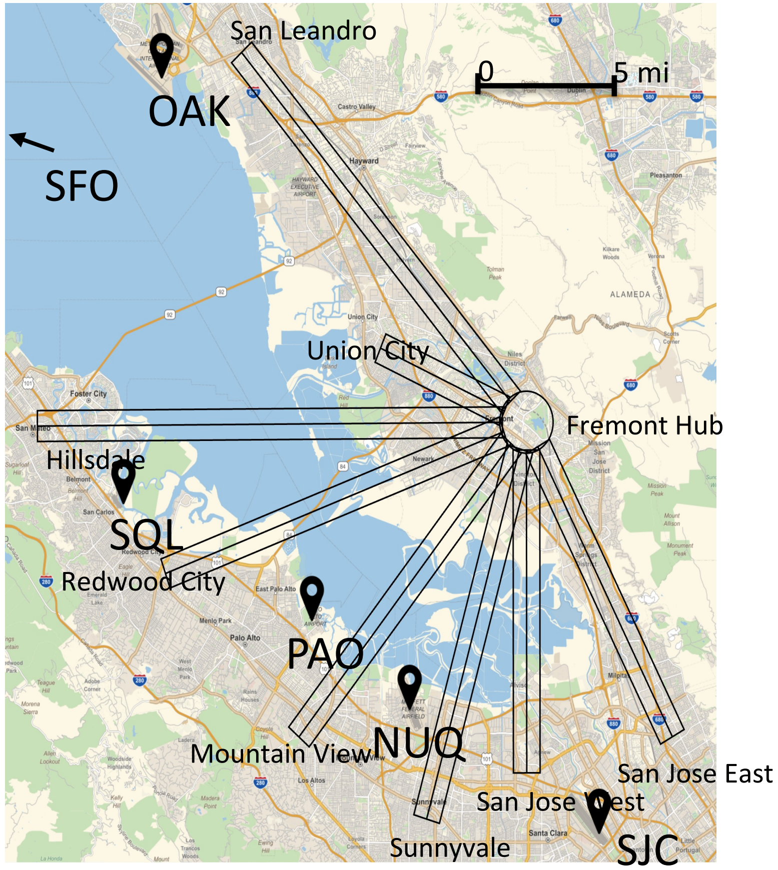
Goal: determine effects of communication system and vehicle load on pilot coordination with ATC



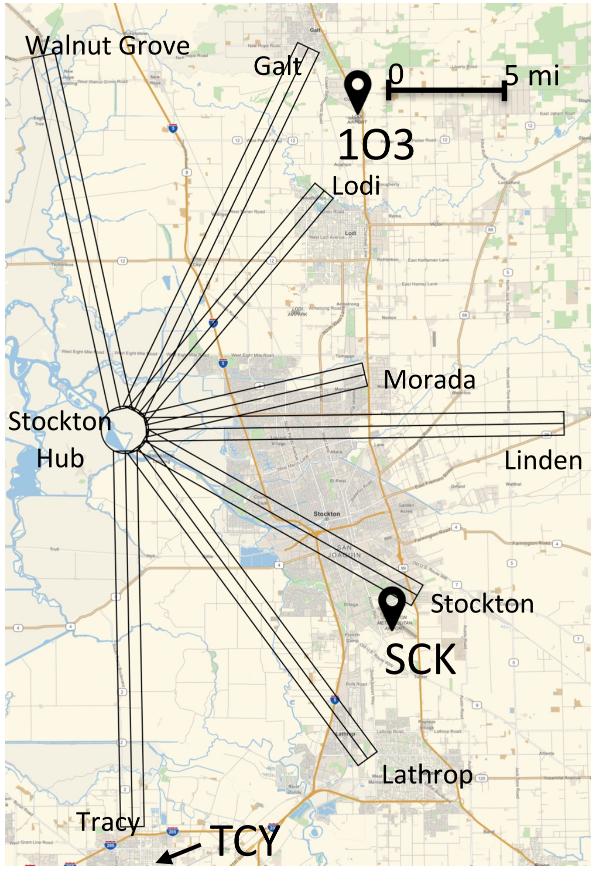
Pilot Task: Manage fleet of vehicles tasked with delivering packages

Goals:

- Test and evaluate various GCS configurations for sUAS operators managing highly automated fleets of vehicles
- Examine the effects of GCS configuration on sUAS operator performance

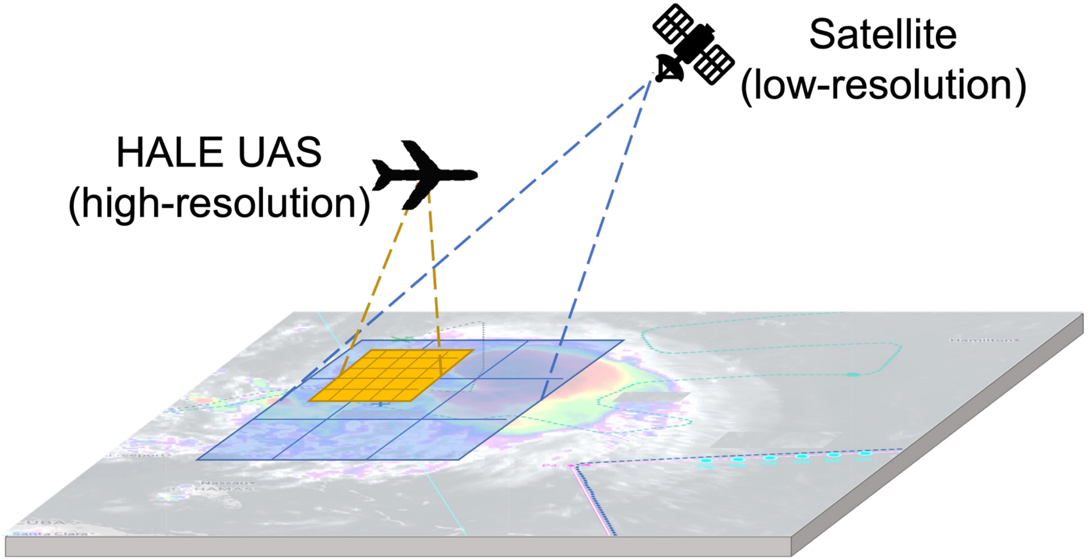


SF Bay Area



Central Valley

Intelligent Long Endurance Observing System (ILEOS)



- Current satellites and fine-pointing aircraft do not provide sufficient spatio-temporal resolution to observe stochastic, ephemeral events between observations

- HALE UAS provide mechanism for collecting higher spatio-temporal data
  - Operate for months and loiter over targets

ILEOS will provide a science activity planning system to enable NOS
  - Fuse coarse-grained sensor data to target and plan HALE UAS flights

Objectives

- Optimize fine-grained spatio-temporal resolution data collection of Earth observations, such as GHG-relevant gases

Novel automated target generation technology

- Incorporates *coarse-grained satellite data* and near real-time environmental (e.g., wind, weather, airspace constraints) data to generate high-value fine-grained resolution data collection plans.

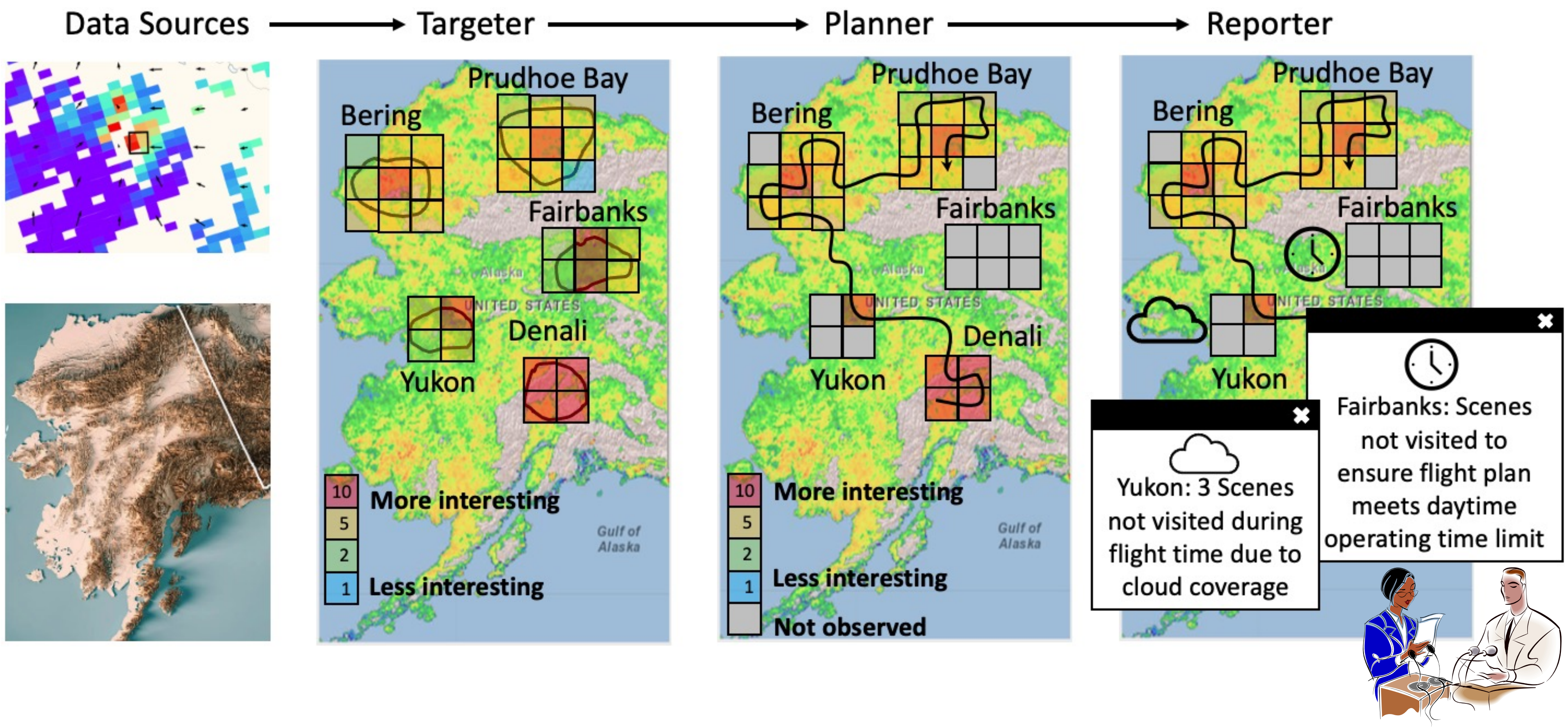
State-of-the-art automated planning and scheduling algorithms

- Designed for human operators; *plan explanation and data provenance features* will ensure science mission planners understand all key choices made while generating targets and plans.

Innovative techniques for user control and review of decision making

IMPACT: Reduced cost for Earth observations in environments ranging from arctic to urban to offshore (some previously inaccessible), continuous observations not possible for current field/in-situ campaigns, improved science outcomes

Full ILEOS Pipeline



Thank You

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