Upper E Traffic Management



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Airspace system should be ready when vehicles are ready



Airspace “System” should be ready when vehicles are ready

Innovation in aviation while respecting its safety tradition

Transition to UTM-inspired Airspace Traffic Management

Current ATM	UTM-inspired-ATM
All services are provided by FAA	Services are provided FAA and third-parties
Human address off-nominal situations and contingencies to ensure safety	Automation addressed off-nominal situations and contingencies to ensure scalability while maintaining
Very little interaction among users and third parties	Users collaborate/cooperate for efficiency, preferences for flights into constraints resources
• Human at the epi-center of information integration • Every data for every vehicle moves through FAA systems • Management by clearances • Each change is focused on domain-specific FAA	• Automation at the epi-center of information integration • New paradigm: Digital, connected ecosystems, outside applications • Movement towards management by exceptions

Research Needed: Architecture, data exchanges, service allocation/roles/responsibilities, rules of engagement, performance requirements for aircraft and airspace system technologies, automation for contingency management and disruption handling, machine learning environment and algorithms for continuous improvement, safety assurance/certification/acceptance approaches, and technology transfers.

Evolution of Airspace Operations and Safety

S-curves

+ Safety



Procedural

Estimate the current and planned a/c positions

+ Density



Radar

Know the current and estimate planned a/c positions

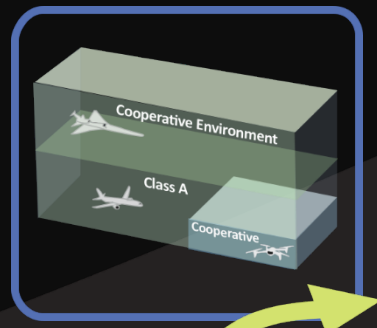
+ Efficiency and proactive planning



Trajectory

Know & exchange current and planned a/c positions

+ Service oriented architecture for tailored mission oriented services



Collaborative

Connected, performance-based, collaborative ATM

Introduces 3rd-party service providers

+ Complexity, scalability, and dynamic adaptation



Highly-Automated

ML/AI – based dynamic, robust performance and safety

Machine-to-machine interactions and humans collaborate

Digital Transformation of ATM

Human-centered safety monitoring, assessment and mitigation

Automated in-time safety monitoring and alerting services

Integrated predictive risk mitigation across domains

Automatically-assured adaptive in-time safety threat management

Epoch 1

Epoch 2

Epoch 3

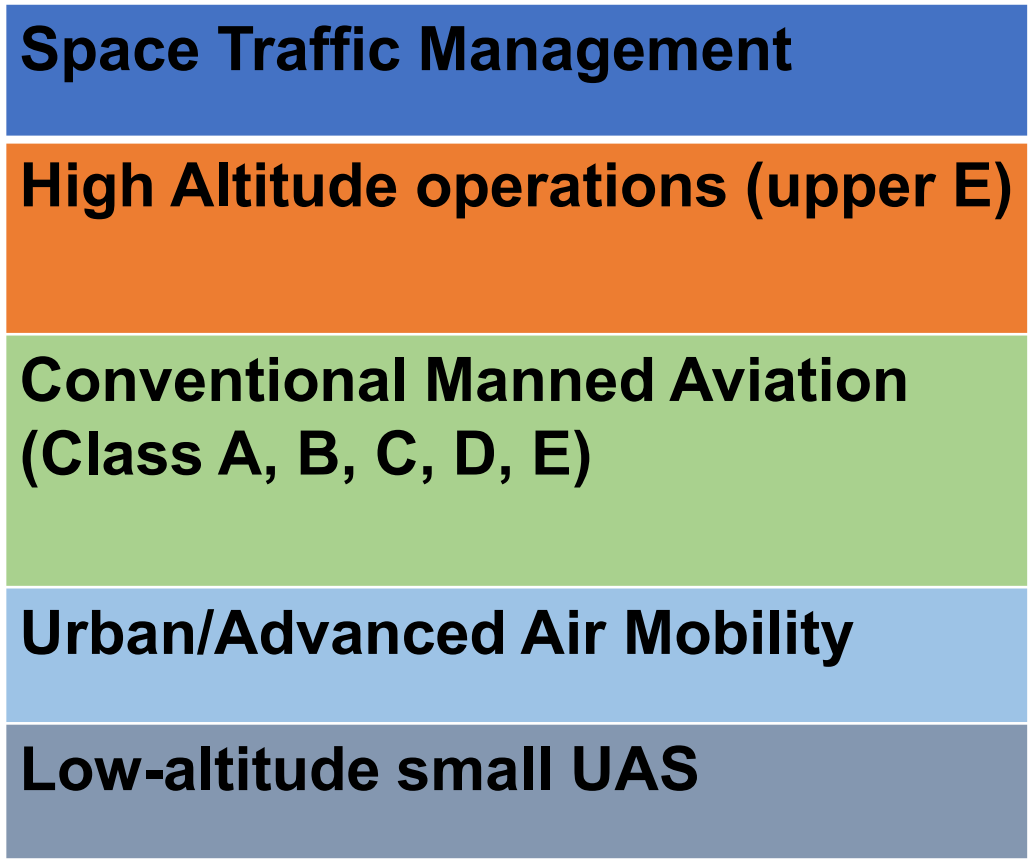
Epoch 4 (~2035)

Epoch 5 (~2045)

Flexibility where possible and structure where absolutely necessary

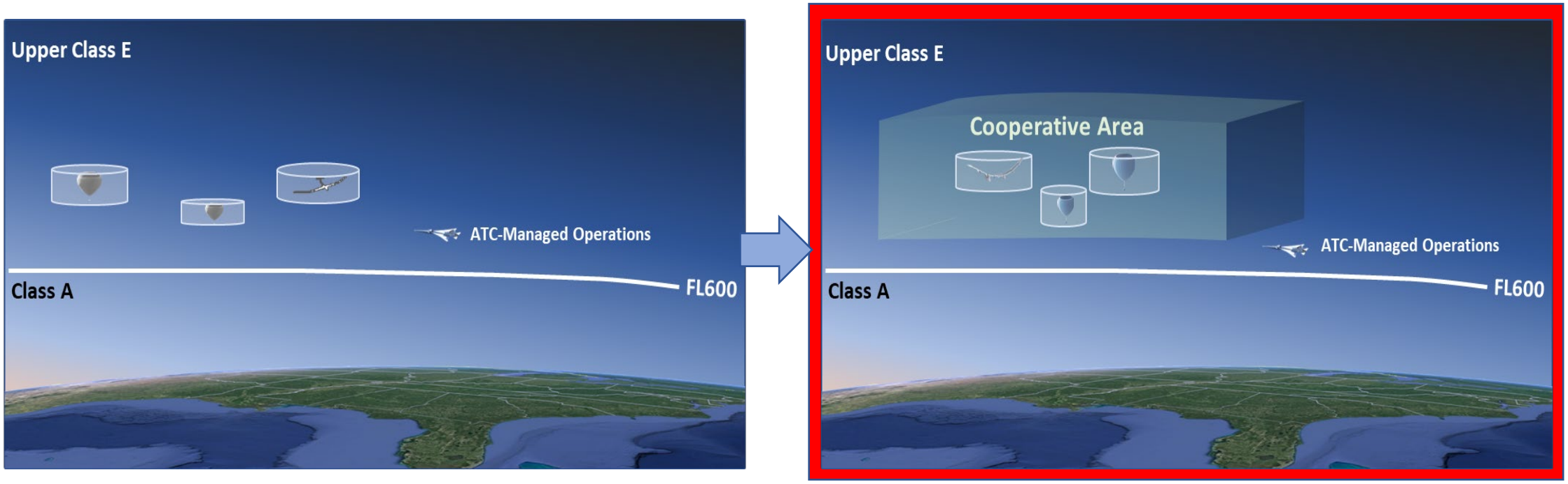
UTM-LIKE-ATM AIRSPACE OPERATIONS ENVIRONMENT

- Cooperative
- Intent-sharing
- Digital: data exchanges among operators
- Standardized application protocol interfaces
- Air/ground integrated
- Service-oriented architecture
- Role for third-parties



ETM Cooperative Separation

Schools of Thought



Collaborative innovation is key

Cooperative Areas
Overview

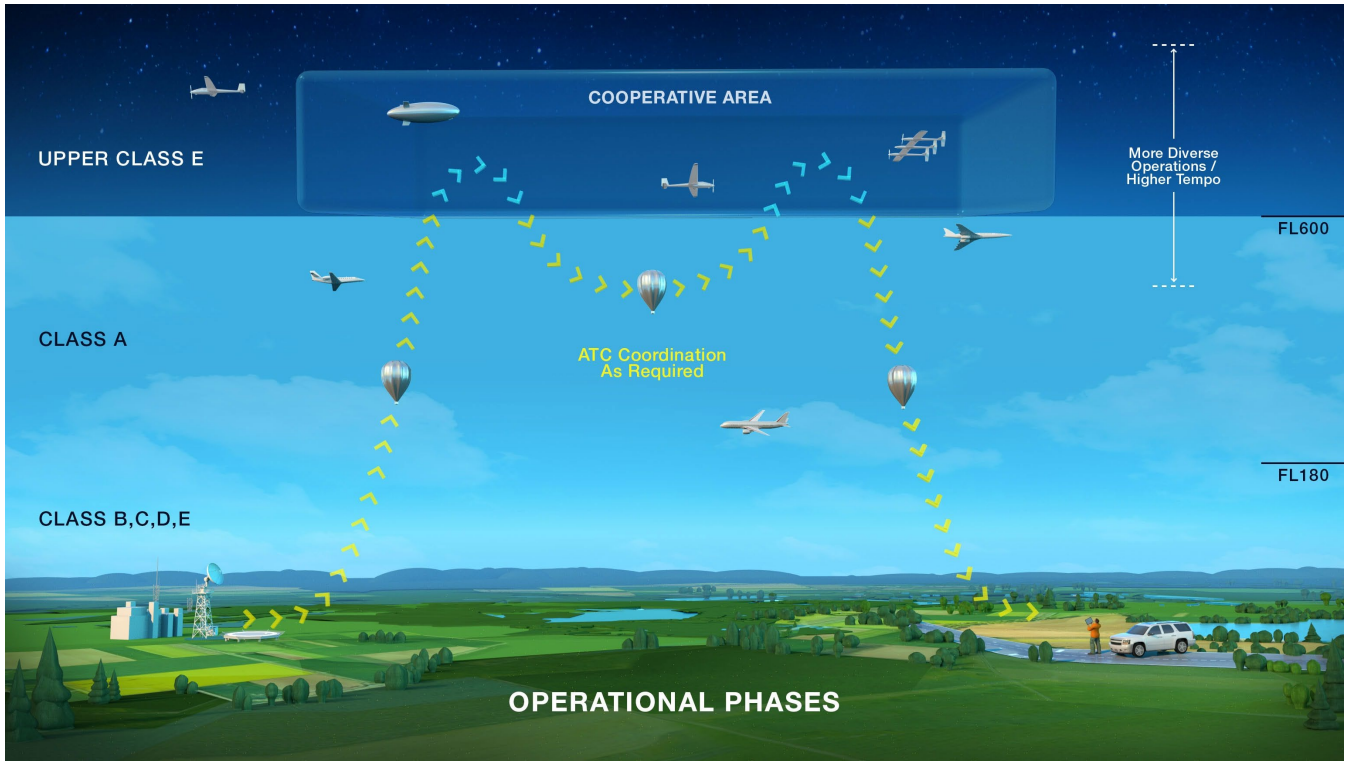


- The FAA designates volumes of airspace, referred to as ‘Cooperative Areas’, within which Operators manage their operations in accordance with Industry-developed, FAA-approved Cooperative Operating Practices (COPs)
- Operators do not receive Air Traffic Services (ATS) while operating in Cooperative Areas

Cooperative Areas
Entering and Exiting

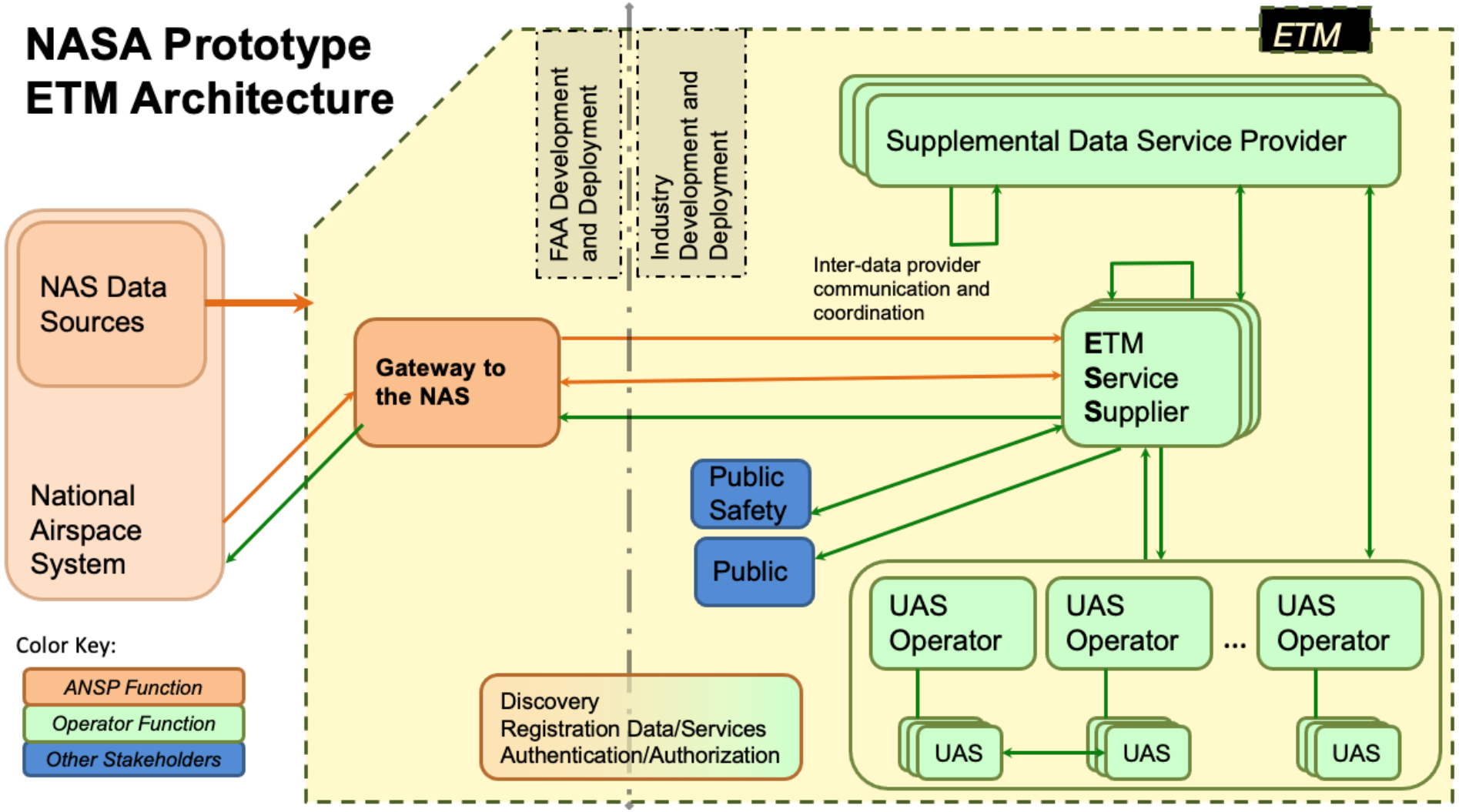
Operators entering and exiting Cooperative Areas must transfer services accordingly

- Operators/vehicles entering Cooperative Areas from the ATCE transition to cooperative traffic management and services in accordance with established procedures
- Operators/vehicles exiting Cooperative Areas into the ATCE transition to air traffic services in accordance with established procedures
- May have coordinated entry and exit points into and out of the Cooperative Area



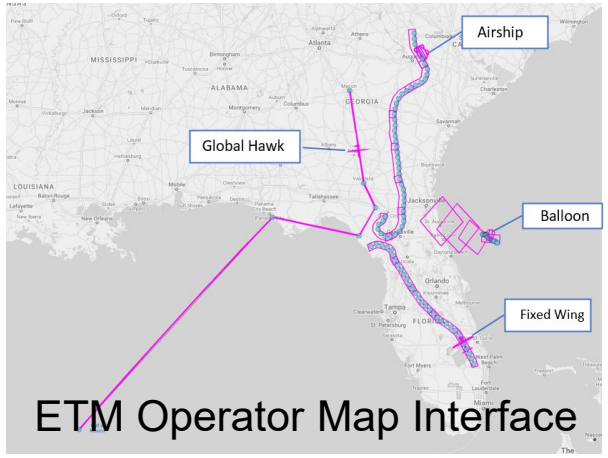
Our resources are only limited by our ability to collaborate

Initial ETM System Architecture

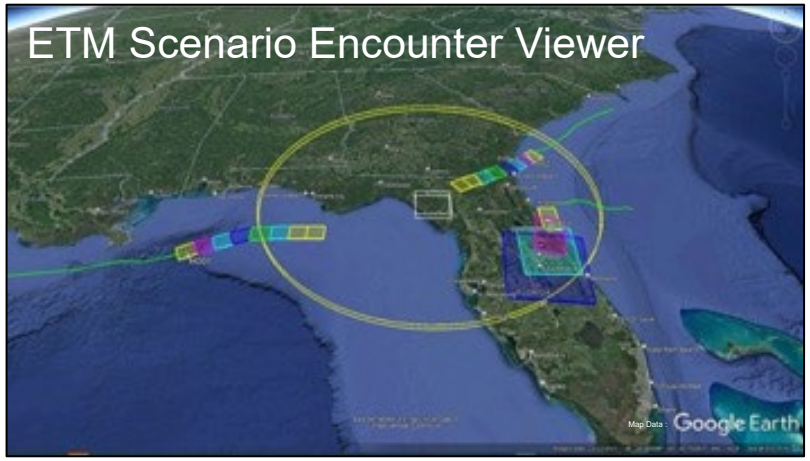


UTM construct is adopted for a prototype NASA Research ETM system

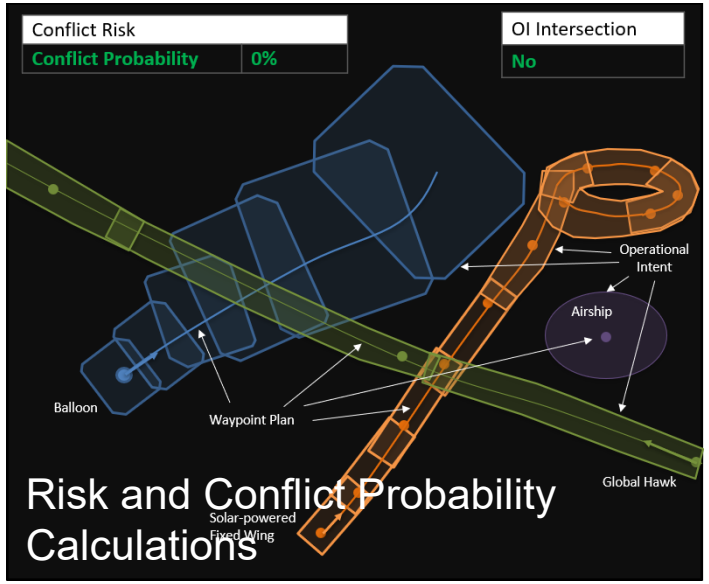
Simulation Development



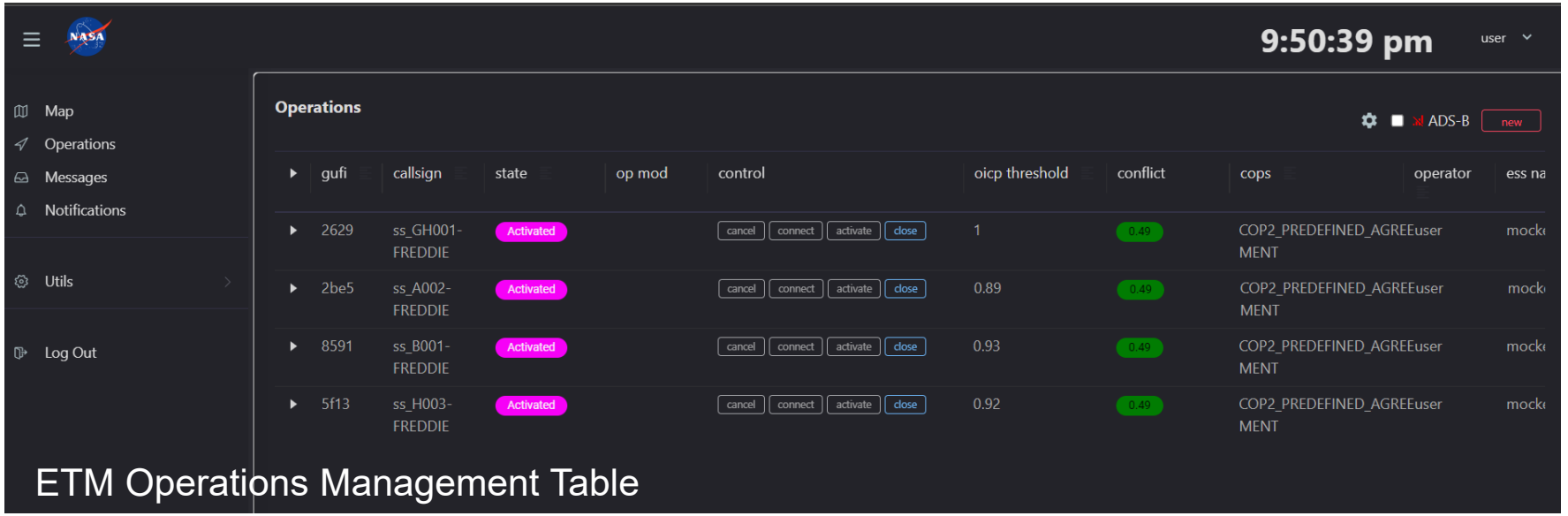
ETM Operator Map Interface



- ETM test architecture implemented
- NASA software and interfaces in development and testing
- Internal simulations underway
- APIs slated for future release
- Partners onboarding



Risk and Conflict Probability Calculations



ETM Operations Management Table

Importance of ETM

- UTM for small UAS started in 2013, ETM original white paper was in 2017
- UTM principles are now used towards advanced air mobility and ETM
- A clear adoption of those will prove the importance of modernization through third party services and cooperative operations
- Enables economic value of upper E for societal good
- Look forward to continued collaboration with you all

Questions and Feedback?

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