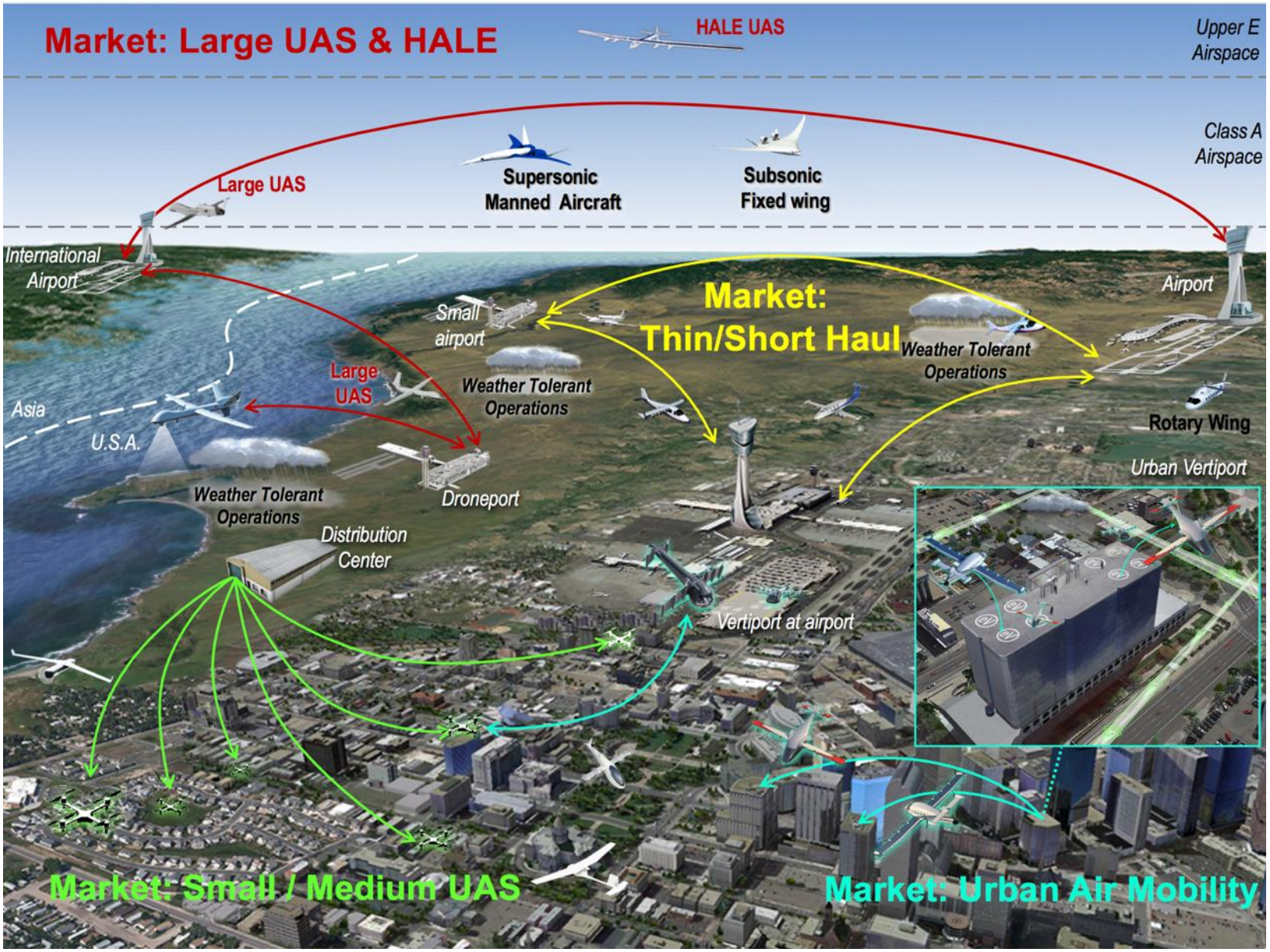
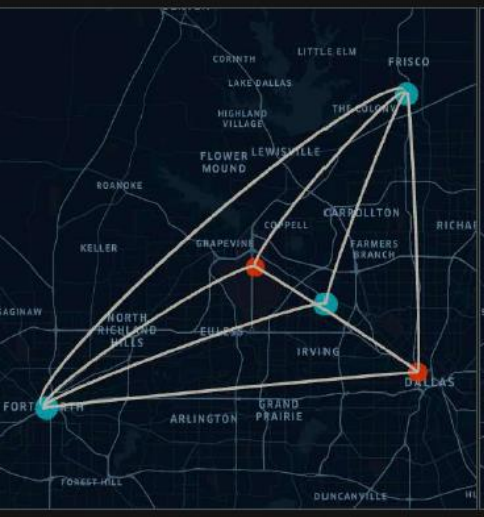
UAV Panel
-
PHM Conference 2018

Kai Goebel
NASA Ames Research Center
kai.goebel@nasa.gov

Emerging Aviation Markets



Proposed Crawl, Walk, Run Build-Up



2020

Demonstration flights

Experimental flights

Establish community & user acceptance

Reduced payload and/or range

Modular energy storage solution

2023

Commercial flights

All-electric on day 1

60-mile range

Commercial pilot + 4 pax

Fleets with several manufacturers across 3+ cities

2025

Early scaled operations

5+ cities

300-500 aircraft per city

60,000+ passenger trips per day per city

2030-2035

Fully-Scaled Operations

12+ cities

1000+ aircraft per city

100,000+ passenger flights per day per city

No pilot in vehicle (5 pax per flight)

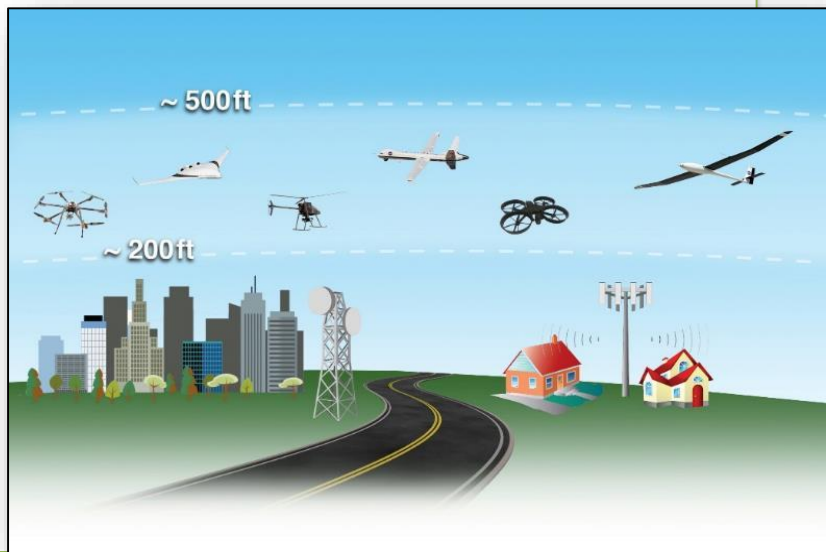
Airspace Operations Requirements

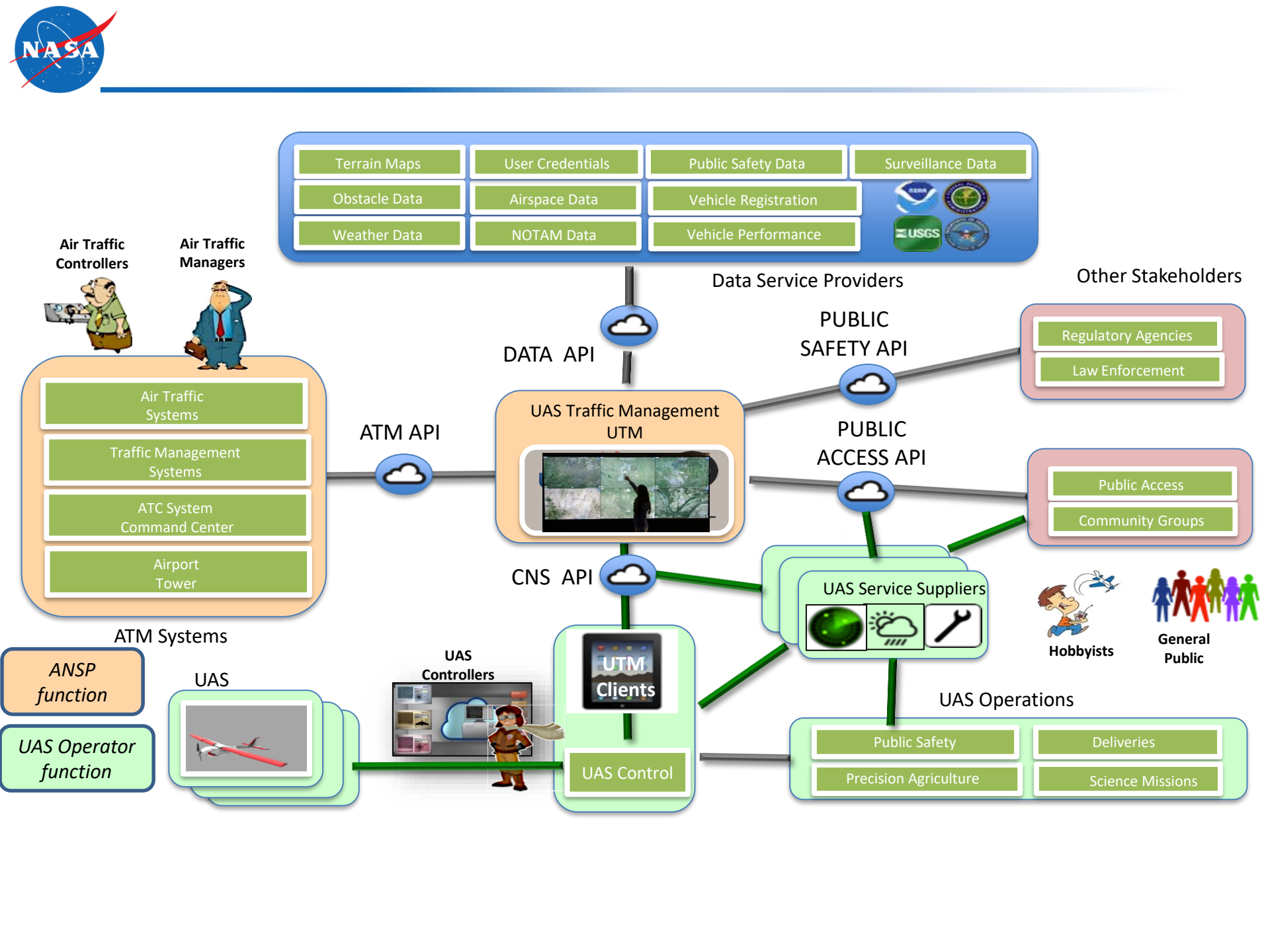
- Air-ground integrated concept of operations
- Roles/responsibilities
- Federated, networked, and interoperable data exchange
- Information architecture
- Airspace configuration (static and dynamic geo-fencing)
- Weather and wind (actual and predicted)
- Demand/capacity imbalance management
- 3D maps
- Track and locate (cell, ADS-B, satellite, psudo-lites)
- Conflict (V2V, sense and avoid) and hazard avoidance
- Last and first 50 feet operation
- Contingency management

UAS Traffic Management (UTM)

Research Platform that

(1) Gives situational awareness of all airspace constraints and info about other operations to UAS operators, support service suppliers, and regulators
(2) Allows to exchange data among UAS operators as well as regulator
(3) Allows UAS operators to submit flight plans to execute a specific mission in low-altitude airspace, and
(4) Determines how to safely enable such single or multiple UAS operations either within visual line of sight or beyond visual line of sight
(5) Integrates airspace and vehicle operations




Terrain Maps
User Credentials
Public Safety Data
Surveillance Data
Obstacle Data
Airspace Data
Vehicle Registration
Weather Data
NOTAM Data
Vehicle Performance
USGS
Air Traffic Controllers
Air Traffic Managers
Data Service Providers
Other Stakeholders
DATA API
PUBLIC SAFETY API
Regulatory Agencies
Law Enforcement
Air Traffic Systems
Traffic Management Systems
ATC System Command Center
Airport Tower
ATM API
UAS Traffic Management UTM
PUBLIC ACCESS API
Public Access
Community Groups
CNS API
UAS Service Suppliers
Hobbyists
General Public
ATM Systems
ANSP function
UAS
UAS Controllers
UTM Clients
UAS Operations
UAS Operator function
UAS Control
Public Safety
Deliveries
Precision Agriculture
Science Missions

Vehicle Technology Challenges

- Low Size, Weight, Power, and cost – Sense and avoid
  - Detection of obstacles such as wires as well as other moving objects
- Tracking: Cell phone, ADS-B, Satellite, pseudo-lite
- Reliable control system
- Safe landing under failure or safety under malfunction
- Long endurance (45 min current battery life)
- Cyber secure/spoof free vehicles
- Graceful landing in case of failure with low kinetic energy – safe flying around people
- Ultra-low noise vehicles
- Operations under GPS-free or degraded conditions
- Last/first 50 feet safe autonomous operation

System Wide Safety Strategic Thrust

- **Continuous System-wide Safety Awareness (Monitor)**

  Technical approaches and required architecture to support comprehensive safety monitoring through acquisition, integration and assurance of sensitive data from heterogeneous sources.

- **Safety Risk Identification and Evaluation (Assess)**

  Assured tools that improve the accuracy of real-time detection, diagnosis and prediction of hazardous states and the impact of these states on system safety.

- **Coordinated Prevention, Mitigation and Recovery (Mitigate)**

  Trusted methods for dynamic, multi-agent planning, evaluation, and execution of real-time risk mitigating response to hazardous events.

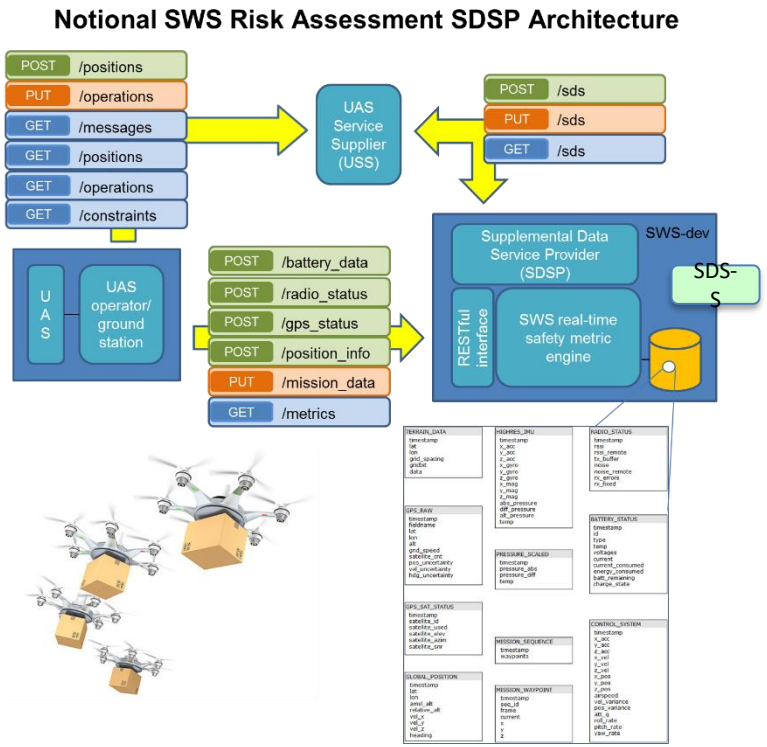
- **Experimentation, Demonstration and Assessment**

  Experimentation, demonstration, benefits analysis and transition of new RSSA technologies within all elements of the airspace.

In-Time Safety Monitoring Service

Objectives:

- Apply PHM principles to safety within the UAM domain.
  - Identify relevant in-time risk assessment metrics
  - On-vehicle subsystems considered
    - Electrical powertrain
    - Positioning sensors
    - Communications equipment
- Integrate such a safety framework with the UTM architecture
  - Consider safety assessment a “service” within that architecture
- Conduct flight test to demonstrate feasibility of approach
  - Collect data and publish where possible
  - Flight test planned for Fall 2018
  - Plan to participate in UTM campaign



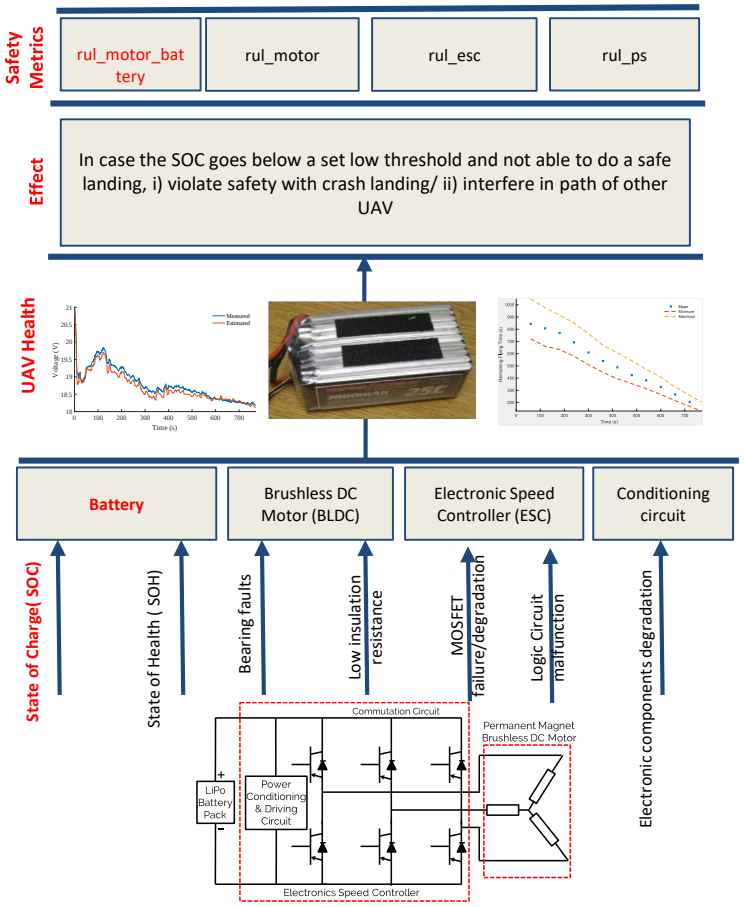
Electric Powertrain Health (EPT)

Objective:

- Predict effect of UAV system health on airspace safety in-time for decision-making

Approach:

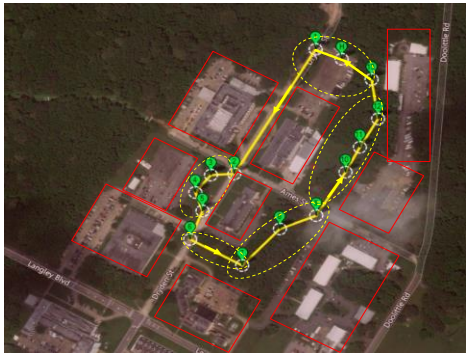
- Leverage health management framework to predict faults in sub-systems of UAV electric powertrain
- Identify components within sub-systems that may affect its operation and airspace safety
    - Understand propagation timing of fault
        - Some faults progress over a single flight (fast),
            - battery state of charge (SOC)
            - Motor faults (some)
        - Some faults progress over several fights (slow),
            - battery state of health (SOH)
            - electronic speed controllers (ESC)
            - power conditioning circuits (PCC)
- Select type of sensors and determined needed data rates required for vehicle based on identified faults
- Model components, simulate, lab tests, flight tests



Baseline Capability Testing

Objective: (1) Test and evaluate baseline architecture and selected functional elements; (2) Collect data to support future development of envisioned capabilities

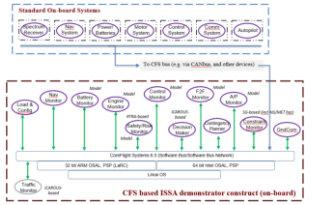
Status:
- Precursor tests conducted;
- Verification tests in fall



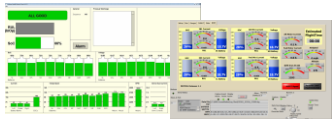
Onboard ISSA-enabling Technologies

UAS Operator Station

Ground Infrastructure and ISSA-enabling Information Services (within UTM ecosystem)

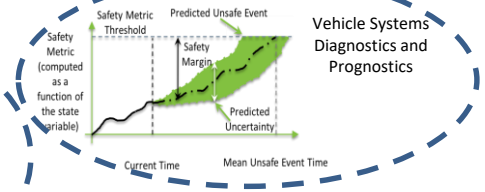


On-board safety monitoring and contingency management algorithms

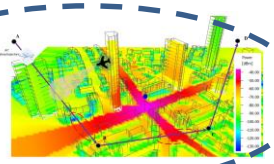


Interfaces for safety and mission awareness

Airspace Safety Margins Monitoring



Vehicle Systems Diagnostics and Prognostics



Environment Forecasting and Alerting

Interaction with relevant ISSA monitoring services

- Exercise use case scenarios for requirements discovery
- Test interfaces with remote ground systems and info services

Drivers:
- Consistency with UTM infrastructure
- Integrates relevant past research
- Begins spiral RDT&E for ISSA application to Emerging Ops domain