Multi-Vehicle Control Working Group
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m:N operations

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 advanced air mobility vision
m:N across ARMD

Transformational Tools and Technologies (T^3)
• Progressive human-in-the-loop demos for m:N operation with Joby Aviation
• Foundational human-autonomy teaming research

System-Wide Safety (SWS)
• m:N ConOps development
• Proposed technical challenge includes human-autonomy teaming for wildfire response

Advanced Air Mobility (AAM)
• m:N for high density vertiport operations including ConOps development and BVLOS safety case
m:N across ARMD

Project Legend
- Advanced Air Mobility (AAM)
- System-Wide Safety (SWS)
- Air Traffic Management Exploration (ATM-X)
- Revolutionary Vertical Lift Technology (RVLT)
- Flight Demonstrations and Capabilities (FDC)
- Transformational Tools and Technologies (T^3)
- AAM Mission Integration Office (AMIO)
**T^3 Revolutionary Aviation Mobility subproject**

- Supports ARMD mission programs by providing a pipeline of solutions and knowledge for **foundational challenges in enabling an advanced air mobility market**

- Enables increasingly autonomous transportation in the **UML-4+ timeframe**

**OBJECTIVES**

- Enable scalable operations to achieve the full vision and potential of AAM through development of targeted tools and techniques critical for autonomous m:N fleet management [Draft TC] {AS}

- Explore and develop airspace management and operations architectures and tools in expectation of increased heterogeneous air traffic {AS, CNS, MDAO}

- Develop modeling, performance, and control tools & techniques for advanced urban capable aircraft {Controls, MDAO}

- Explore and demonstrate approaches for scaled vehicle production {M&S}
Multi-disciplinary support

**Human Autonomy Teaming**
- Distribution of roles & responsibilities
- Safe, effective teaming strategies
- Foundational research tools
- Human-in-the-loop simulation

**Perception**
- Vehicle knowledge of surroundings, self, and health through sensing and information processing
- Gap analysis and trade studies of capabilities enabling UML 4+
- Research-enabling data collection

**Intelligent Contingency Management**
- Intelligent machine decisions for unforeseen events with uncertain, incomplete, and unreliable info
- Assuring non-deterministic ICM algorithms

**Collective Autonomous Mobility**
- Explore architectures to accommodate heterogeneous autonomous operations in the same airspace
- Examine the dynamic relationship among services, operators, and agents

**Communication, Navigation, and Surveillance**
- Autonomous spectrum allocation
- Self-optimizing phased array antennas to mitigate interference

**Resilient Autonomy**
- Inform future certification requirements and strategies for highly autonomous aircraft
- Project specific certification plans for general aviation and UAS
m:N proposed technical challenge

**m:N Fleet Management**

For efforts through FY26, $6M/year

Enable scalable operations to achieve the full vision and potential of advanced air mobility through development of targeted tools and techniques critical for m:N operation of autonomous fleets

**Supporting capabilities**

**Human-Autonomy Teaming:**
Develop tools and techniques to enable a small number of humans (m) to manage many autonomous vehicles (N) across disparate scenarios and dynamic relationships

**Autonomous vehicle technology:**
Develop a capability description of a UML 4+ autonomous vehicle through characterization of realistic Intelligent Contingency Management and Perception functions

**Exit criteria**

- **Demonstration** of m:N operations with a realistically autonomous fleet in 2+ disparate scenarios

- Complementary artifacts:
  - Realistic autonomous vehicle characterization
  - Human-autonomy teaming framework
  - Publicly available research tool
Questions?