



TRANSFORMATIVE AERONAUTICS CONCEPTS PROGRAM (TACP)

Transformational Tools & Technologies Project

Revolutionary Aviation Mobility

November Workshop – NASA Ames – November 29-30, 2022

The background of the slide features a city skyline, likely San Francisco, with various skyscrapers. Overlaid on this are several futuristic elements: red dashed lines representing flight paths or communication links, a blue aircraft in the upper left, a white aircraft in the upper right, and a drone in the lower left. The text "Multi-Vehicle (m:N) Working Group" is prominently displayed in the center in a large, bold, black font.

Multi-Vehicle (m:N) Working Group

Collaboration with government, industry, and academia to reduce
m:N operation barriers.



Purpose and Goals for Workshop & Subgroups

- Goal: Identify technology and regulatory context of existing M:N ops and identify gaps and barriers to expansion to larger, more integrated ops in non-segregated airspace, then address gaps with R&D and Collaboration
- Product: M:N Roadmap for Safe Expansion of M:N Operations
 - How do we address the unique needs for each CONOP or Use Case?
 - What technical, regulatory, operational challenges must be solved?
- NASA Can Propose Ideas, but Industry Must Master Its Own Destiny
 - Assess Technical Maturity & Operational Readiness
 - Authorities Can't Certify Concepts – Need Mature Prototypes to Evaluate
- Is There Scalability From One “Epoch” or Use Case to Another?
 - Mature Capabilities in One Use May Not be Ready for Another
 - Regulatory and Technical Maturity May not Scale or Apply



Charge For M:N Subgroups



Your Charge, Should you Choose to Accept It

MISSION: IMPOSSIBLE

Your “Vision” Near Term and Long Term for your CONOP?

What does your mature use-case look like?

- For example – M:N Ratio, Role of Human, Ops Environment, Assumptions, Functions, Technologies, Capabilities, Timeline, etc.

What are your Use-Case Goals?

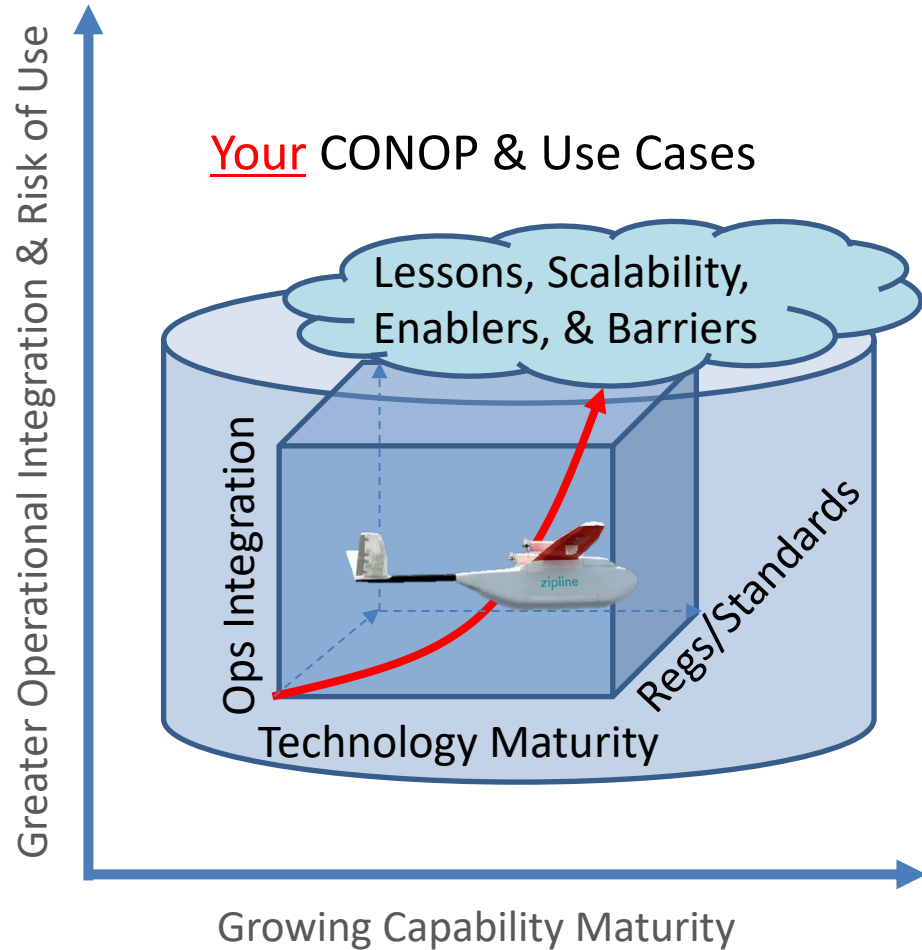
- Capabilities/Functions needed to enable your CONOP
- Technologies Enabling Functions – TRL – Prototype to Ops Maturity

Consider how to define your “Epoch”- Different Needs and Use Cases

Outcome: Roadmap for Transition from SUAS to AAM



Defining YOUR Epoch – What Does Success Look Like?

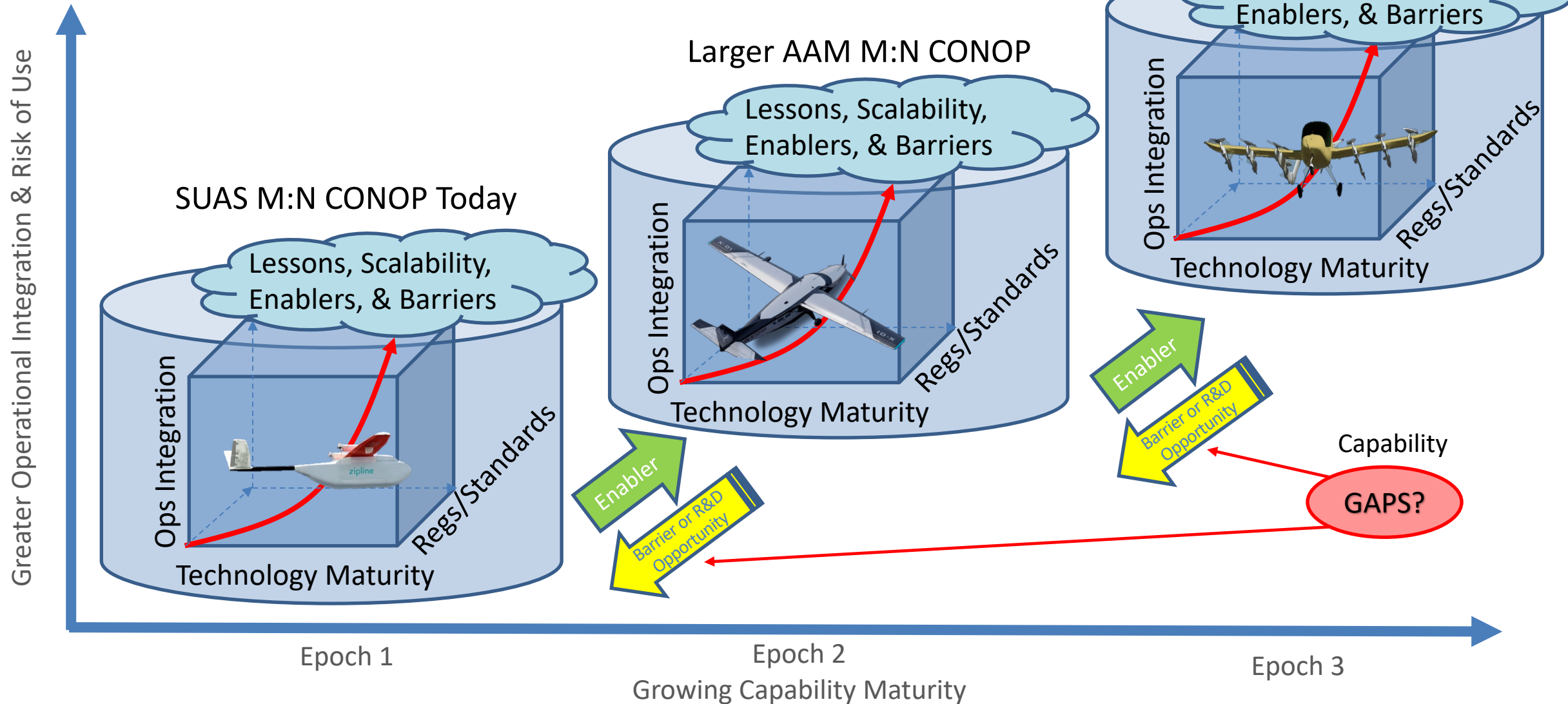


- How Would You Define “Success” Within Your Epoch – What Does Fully Developed Vision Look Like?
 - Level of Operational Integration & Airspace
 - Technological Maturity – Prototype or Operationally Proven?
 - Regulatory Maturity – What Rules Apply or are Excluded by Ops Limits?
- What Lessons Learned, Enablers, Barriers Might Be Scalable to Other Use Cases – Common Ground?



Roadmap for M:N Should Connect Epochs

Consider Technical & Regulatory Maturity + Aircraft/Ops





Supporting Slides for Panel/Discussions At Workshop



Notional M:N Capability Maturity Model

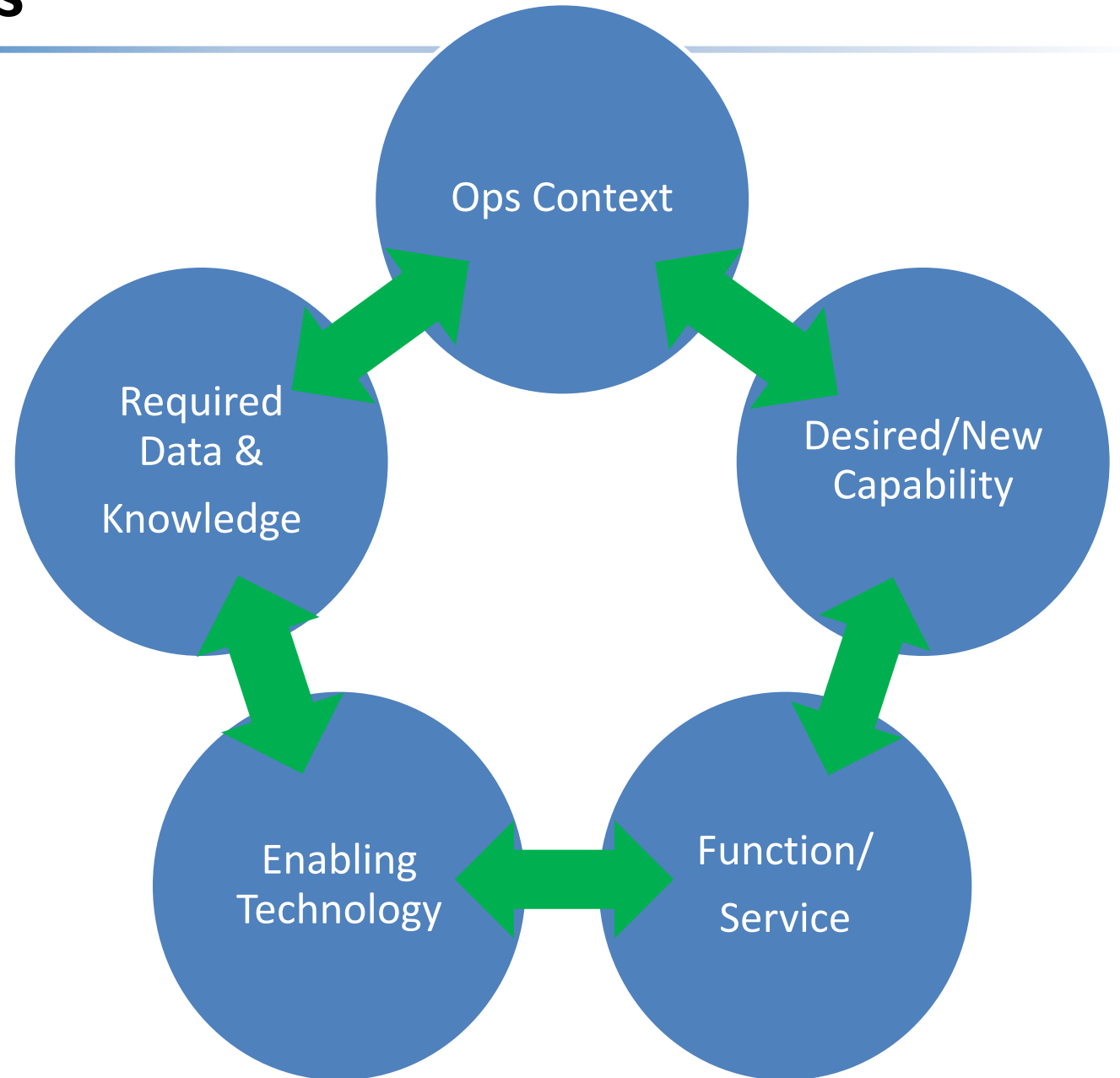


- Capability – a new Ability, Level of Expertise, Level of Proficiency
- Function/Service – Task, Role, and/or Intent of a System to Enable a Capability
- Technology – Equipment & Elements to Implement a Function/Service
- Data/Sensors – Information Sources Required by a Technology to Achieve and Maintain its Function in Support of a Capability
- Cannot Reach a Capability without assessing maturity, integrity, reliability, availability, etc. of data sources & technology to implement an intended function in support of a new capability
 - Must have a clear maturation path from data/sensors, to core technology, to intended function, to mature capability for civil use in specific context



Applied CMM Process

- Identify Specific Ops Context
- Define Desired, New Capability
- Evaluate Functions/Services
Required to Enable the Capability in
Intended Ops Context
- Determine What Technologies
Already Enable the Functions
Needed, or Could Evolve to Provide
the Function
- Evaluate Technology to Determine
Required Data (System) &
Knowledge (for Human Involved)
- Determine If Maturity Can Be
Expanded for New, More Complex
Ops Context





Capability Maturity Model (Simple Example)

Capability	Function/Service	Technology	Data
Airspace Management	Conflict Detection and Avoidance	Sense and Avoid/DAA, Surveillance, Data Sharing, Trajectory Mgmt	GPS Position, Timing, Sharing Intent Trajectory/Plan/Conflict Avoidance
Aircraft Flight Path Management	4D Automated Flight Path Control	Digital Flight Controls, Contingency Management Procedures	Aircraft State, Progress Along Intended Trajectory, Sharing Data with ATC
Operational Integration	Flight Planning/Approval	Automated Flight Plan Filing, Deconfliction	Intended Path/Timing Relative to Others
Capability Assessment by Detailed Analysis			
Is Capability Mature Now?	Is Intended Function to Enable the Capability the Same (Use Case), or are there Changes in Assumptions, Boundary Conditions by Use Case?	Is Technology Mature, Including Assumed Role of Human and Automation for Specific Use Case? Scalable To New Use Case?	Is Data to Feed Technology At the Needed Level of Integrity, Accuracy, Availability, Security, etc. for Use Case? Is it Scalable to Other Use Cases?



Potential Process Steps

- Process:
 - A. Identify existing M:N capabilities that are being regularly demonstrated successfully/safely by ops like Zipline's and other SUAS M:N operators.
 - B. Identify the functions that make those capabilities real/executable
 - C. Identify the technologies that make those functions possible
 - D. Identify the data sources and their level of integrity/reliability/validation that drive those technologies
 - From this identified Capability Maturity analysis, evaluate the regulations and ops procedure that are applicable to each layer A to D
 - Discuss/evaluate whether the MOC to the applicable regulations can be scalable, and what barriers to scalability exist.
- Outcomes:
 - Inform a path to UAM maturity from the AAM results
 - Areas where NASA can partner with industry to move technology maturity, ops concepts, and other sources of gaps to a higher TRL level.
 - Identify experiments where NASA can collect data on PNT technology, Conflict management concepts, and other core enablers to allow expansion from segregated to integrated ops.
 - Identify a process and roadmap to allow repeatable, methodical expansion from existing ops to AAM for regional cargo with larger M:N aircraft