



Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Project

Project Overview and History

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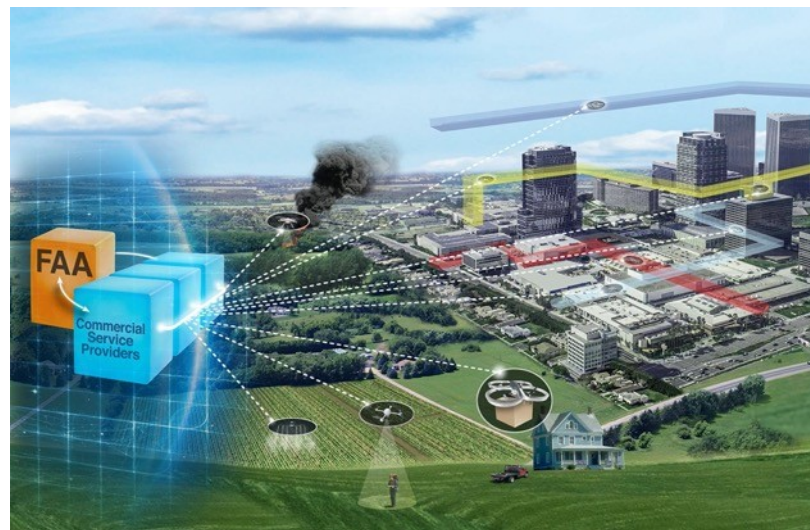
UTM Vision, Goals and Objectives

Vision

Define and safely enable future airspace operations (2025+) of small Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS)

Goals

- Allow diverse small UAS mix and airspace uses (e.g., package delivery, inspections, public safety and security)
- Safely enable scalability to accommodate future demand
- Accommodate a variety of business models (e.g., hub-and-spoke, point-to-point)
- Establish highly efficient, predictable, agile, safe, and affordable airspace operations system
- Maintain global competitiveness and domestic viability by innovation in technology and business models to manage airspace operations



Objectives

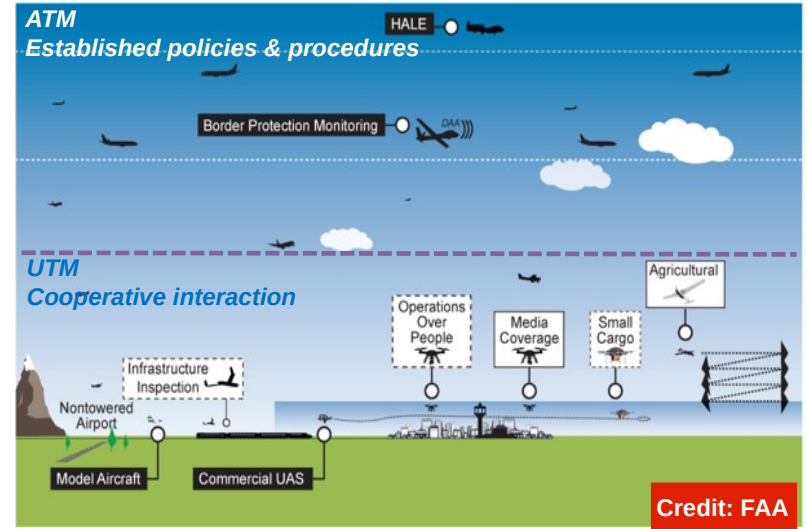
- Develop and validate airspace operations and integration requirements to enable safe, large-scale UAS operations
- Provide prototype (software) UTM system for further FAA testing and development



What is UTM?

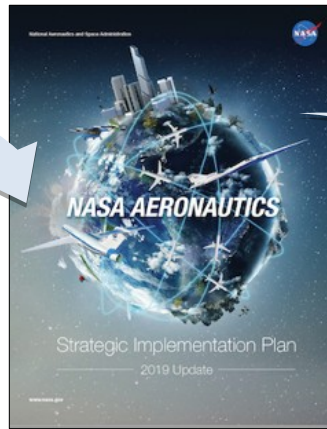


- UTM is an “air traffic management” ecosystem for uncontrolled airspace
- UTM utilizes industry’s ability to supply services under FAA’s regulatory authority where these services do not exist
- UTM development will ultimately enable the management of large scale, low-altitude UAS operations
 - Operational concept will address beyond visual line of sight UAS operations under 400 ft. AGL, Class G airspace
 - Roles/responsibilities of FAA and operators
 - Information architecture, data exchange protocols, software functions
 - System performance requirements





UTM Support of Agency Strategic Goals and Critical Commitment



- Safe, Efficient Growth in Global Operations**
 - Enable full NextGen and develop technologies to substantially reduce aircraft safety risks
- Innovation in Commercial Supersonic Aircraft**
 - Achieve a low-boom standard
- Ultra-Efficient Commercial Vehicles**
 - Pioneer technologies for big leaps in efficiency and environmental performance
- Transition to Alternative Propulsion and Energy**
 - Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology
- Real-Time System-Wide Safety Assurance**
 - Develop an integrated prototype of a real-time safety monitoring and assurance system

UTM

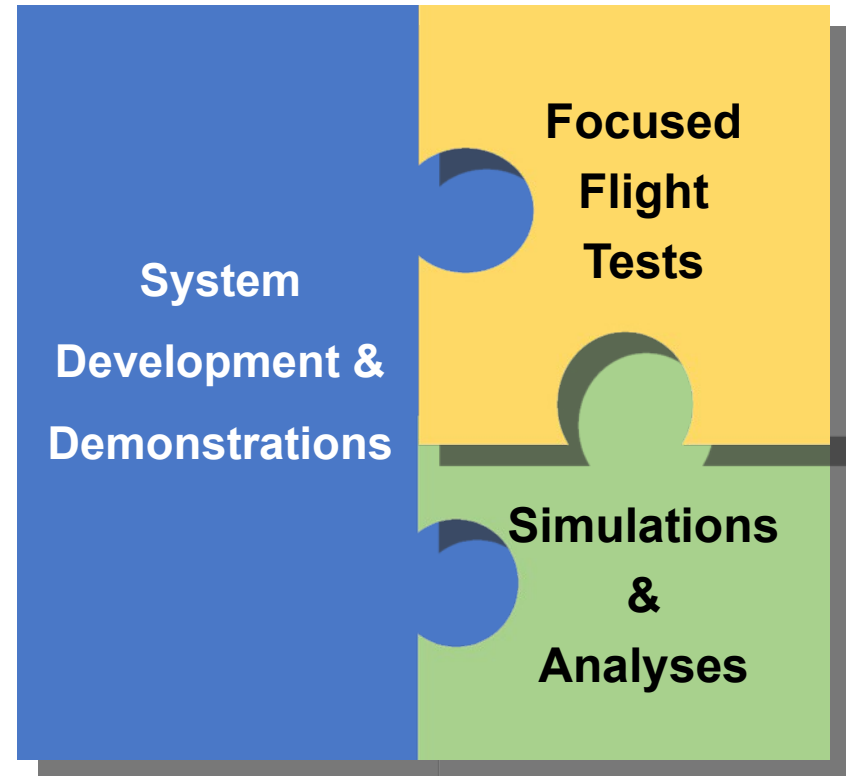
- Assured Autonomy for Aviation Transformation**
 - Develop high impact aviation autonomy applications

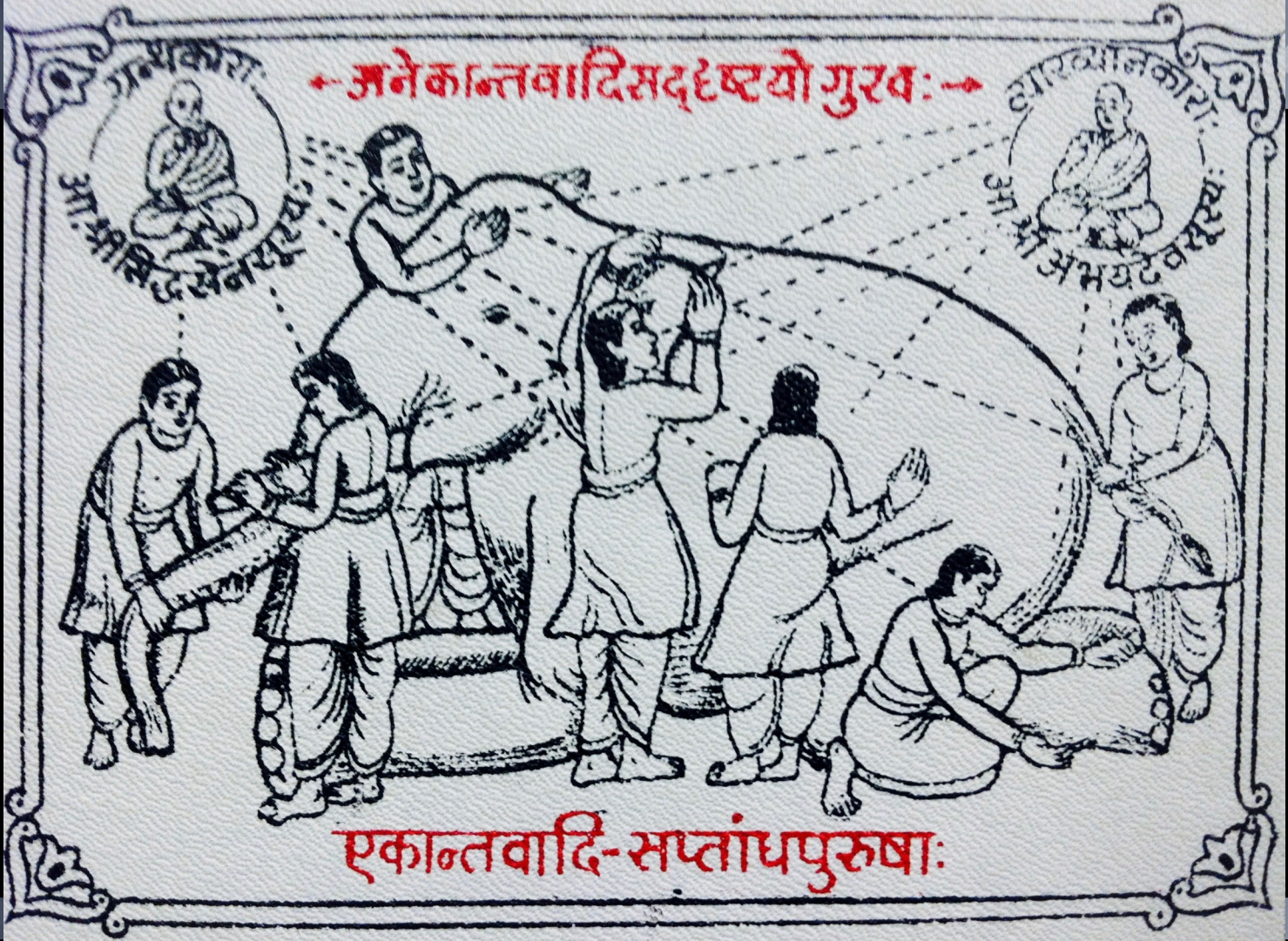
Strategic Thrust	Critical Commitment	Related Technical Challenge, same as TC
6. Assured Autonomy for Aviation Transformation	6.1 Demonstrate the feasibility of highly automated, low altitude UAS traffic management and deliver validated requirements to FAA and industry	AOSP12 – UAS Traffic Management



UTM Activity Areas

- **System Development & Demonstrations**
 - Develop UTM system to meet the operational concept and requirements of a service-based architecture
 - Test UTM functionality in field with many newcomers to small UAS (sUAS) operations
 - Accelerate industry development
- **Focused Flight Tests**
 - Performance characterization of specific challenge areas
- **Simulations & Analyses**
 - Evaluate the scalability and robustness of the concept



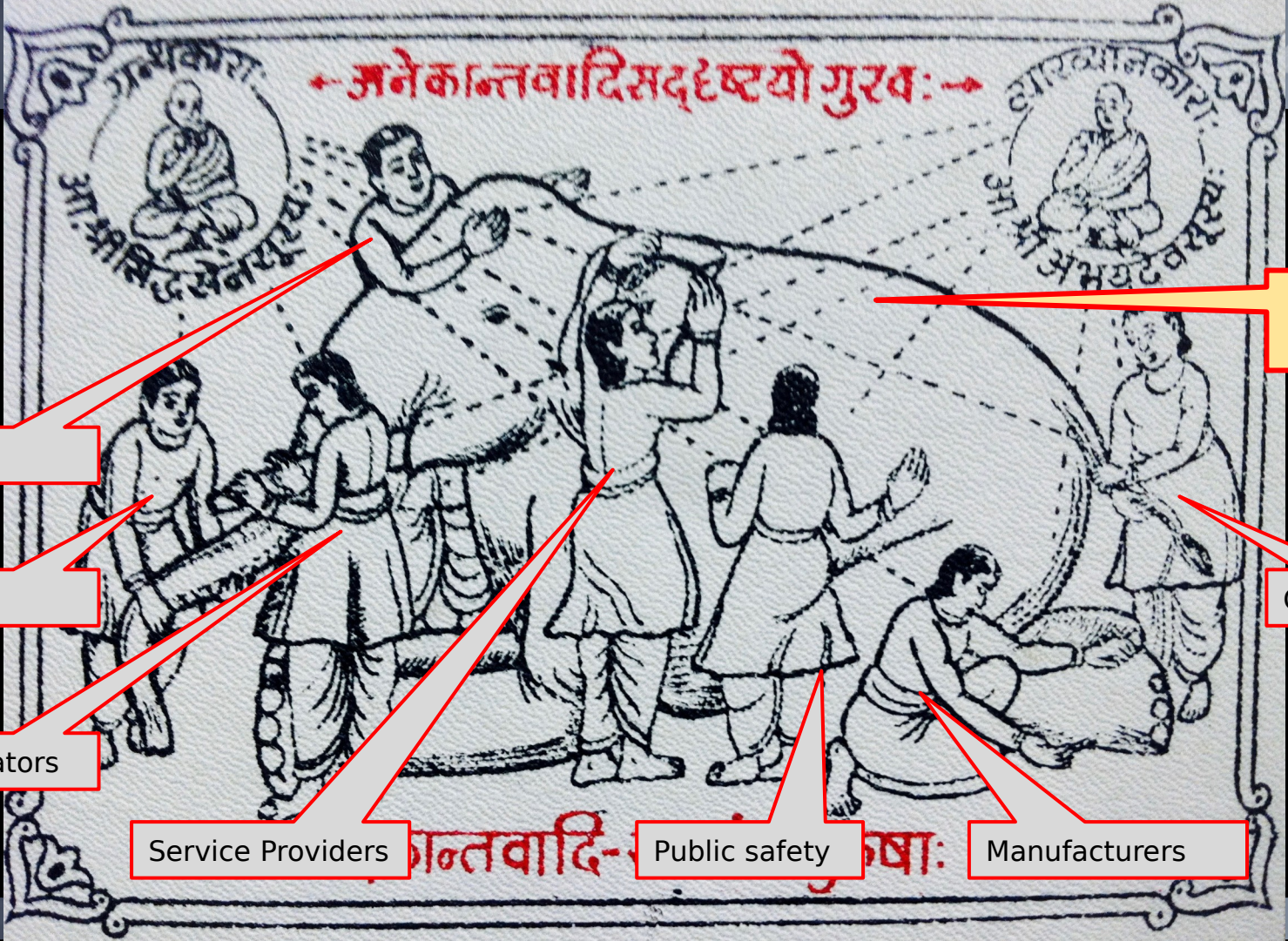


अनेकान्तवादिसदृष्टयौ गुरवः

एकान्तवादि-सप्तांधपुरुषाः

गणेशकाराः
श्री श्री सिद्धयन्त्रायः

द्वारव्याजकाराः
श्री श्री अभयद्वयस्यः



UTM

Public

Pilots

Regulators

Service Providers

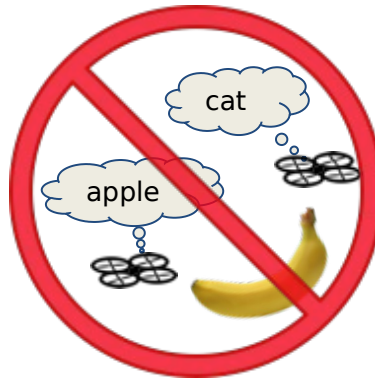
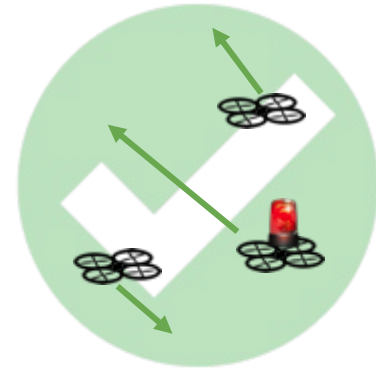
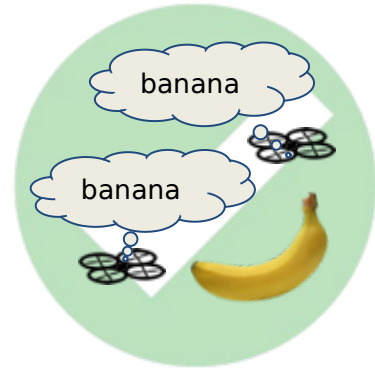
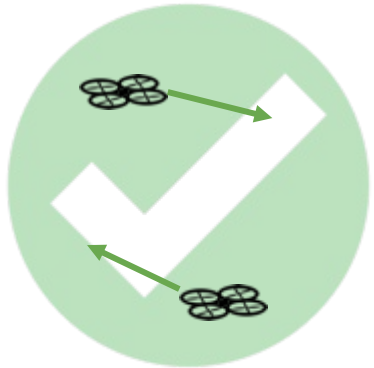
Public safety

Manufacturers

Operators

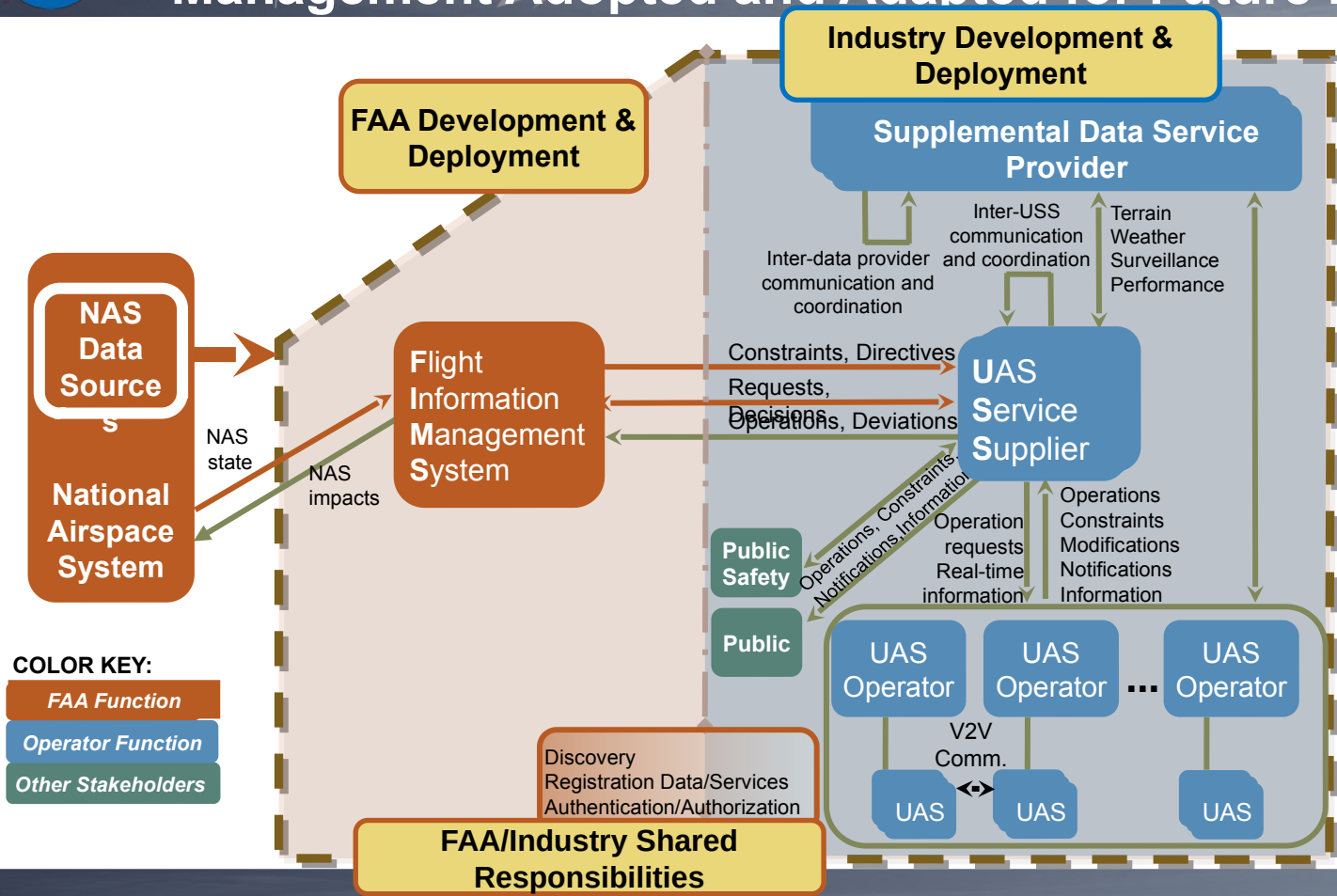


UTM Core Operating Principles





UTM Baseline Architecture and Information Flow Management Adopted and Adapted for Future NASA R&D



Flight Information Management System

- Enables airspace controls
- Facilitates requests
- Supports response in emergencies impacting NAS

UAS Service Supplier

- Federated Structure
- Cloud-based system
- Automated System
- Supports UAS with services (e.g. separation, weather, flight planning, contingency management, etc.)

Supplemental Data Service Provider

- Supplies supplemental data to USS and UAS Operator to support operations

UAS / UAS Operator

- Individual Operator
- Fleet Management
- On-board capabilities to support safe operations

COLOR KEY:

- FAA Function (Orange)
- Operator Function (Blue)
- Other Stakeholders (Green)



UTM Progression: Technical Capability Levels (TCL)

Risk-based development and test approach



TCL 1

Remote Population

Low Traffic Density

Rural Applications

Multiple VLOS Operations

Notification-based
Operations

TCL 2

Sparse Population

Low-Mod Traffic Density

Rural / Industrial Applications

Multiple BVLOS Operations

Tracking and Operational
Procedures

TCL 3

Moderate Population

Moderate Traffic Density

Suburban Applications

Mixed Operations

Vehicle to Vehicle Communication
Public Safety Operations

TCL 4

Dense Population

High Traffic Density

Urban Applications

Dense BVLOS Operations

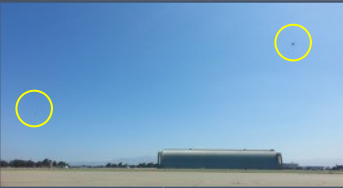
Large Scale Contingency
Management



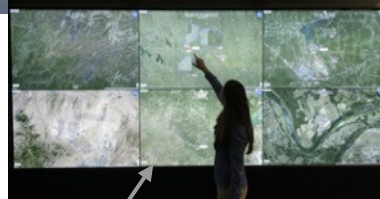
Project Timeline



Initial UTM Workshop with industry
Feb 2014



Integration with commercial partners
Nov 2014



National Campaign #1 at 6 FAA Test Sites
May 2016



RTT Plan signed by FAA+NASA
Jan 2017



TCL 3 Demo across 6 FAA Test Sites
May 2018



FY 2013
Internal seedling effort at NASA to investigate UTM

May 2014
Initial prototyping

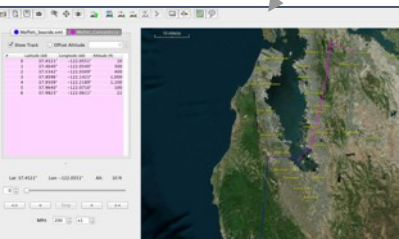
May 2015
First live flights under UTM

Aug 2015
TCL 1 Demo

Oct 2016
TCL 2 Demo, NV Test Site

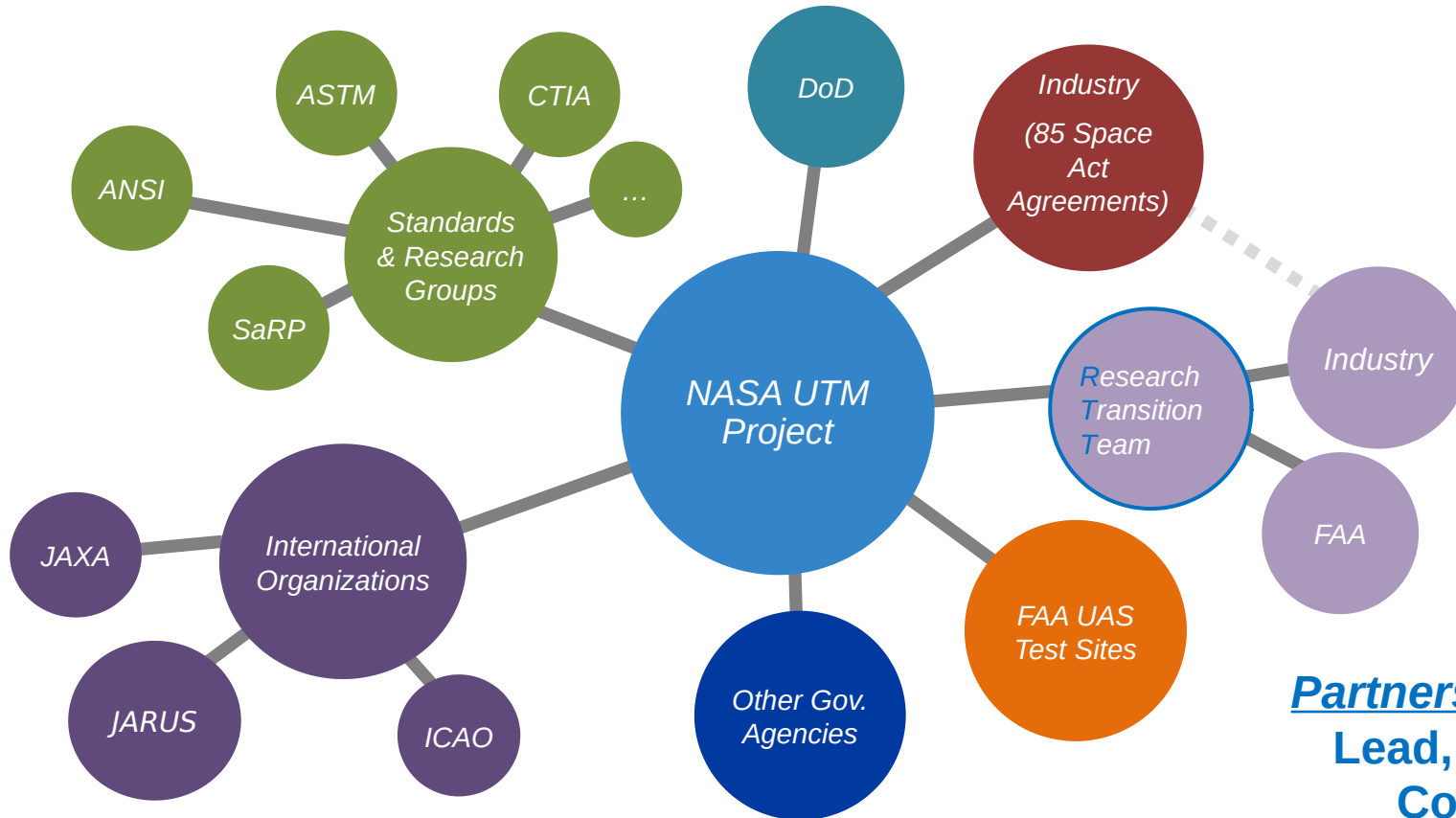
May 2017
National Campaign #2 at 6 FAA Test Sites

Summer 2019
TCL 4 Demo NV+TX





UTM Partnership



Partnership Strategy
Lead, Leverage & Collaborate



Acceptance of TCLs and UTM



- FAA and Community acceptance of NASA-UTM is demonstrated by:
 - *FAA UTM Pilot Program use of NASA-UTM federated architecture and commercial service providers partnered with NASA*
 - *FAA Low Altitude Authorization and Notification Capability (LAANC) operational system utilizes NASA-UTM construct*
 - *FAA UTM ConOps, rulemaking, and national implementation plan informed by NASA-UTM*
 - *Growing market of UAS Service Suppliers (UTM graduates): AirMap, AiRXOS, Amazon, etc.*
 - *Domestic and international standards groups adopting NASA-UTM and adding further definition*
 - *DHS/DoD adopting NASA-UTM construct and adapting for their missions*

“The FAA is already deploying a preliminary version of UTM ... it’s the wave of the future and we are using UTM to lead that way.”

– Steve Bradford, Chief Scientist for Architecture, NextGen, FAA



How the Project met the Critical Commitment

Demonstrate the feasibility of highly automated, low altitude UAS traffic management and deliver validated requirements to the FAA and industry

- How we demonstrated *the feasibility of highly automated, low altitude UAS traffic management*
 - *Workshops and working groups develop use cases and scenarios*
 - *Collaboratively develop data interfaces and protocols to support use cases*
 - *Demonstrate use cases via collaborative simulations and flight tests*
 - *Incorporate industry leaders in flight tests to nurture their development and show state of art*
- How we *delivered validated requirements to the FAA and industry*
 - *Technical Memos and internal documentation provided in Tech Transfers to FAA and publicly (examples)*
 - *USS Specification (NASA/TM-2019-220376)*
 - *USS Framework for Authentication and Authorization (NASA/TM-2019-220364)*
 - *Strategic Deconfliction: System Requirements*
 - *UAS Service Supplier Checkout (NASA/TM-2019-220456)*
 - *Automated Management of sUAS Comm and Nav Contingency (AIAA 2020)*
 - *Field-tested Application Programming Interfaces published via GitHub*
 - *Supporting analysis of test results via TM and conferences*



UTM Influence



FAA UTM RTT
 FIMS Prototype
 USS Checkout Process
 TCL 1-4 CONOPS and Use Cases
International
 UTM Annex for JARUS SORA
 UTM Architecture for ICAO
 C&N Requirements for
 GUTMA/3GPP

National
 Airspace
 System

FAA Development &
 Deployment

Flight
 Information
 Management
 System

DOD / DHS
 Federal USS Prototype

ASTM WK6540 UAS Remote
 ID
 TCL Remote ID Results
 Discovery Specification

IEEE P1920.2 V2V for UAS
 TCL V2V Results
 Conflict Management Model

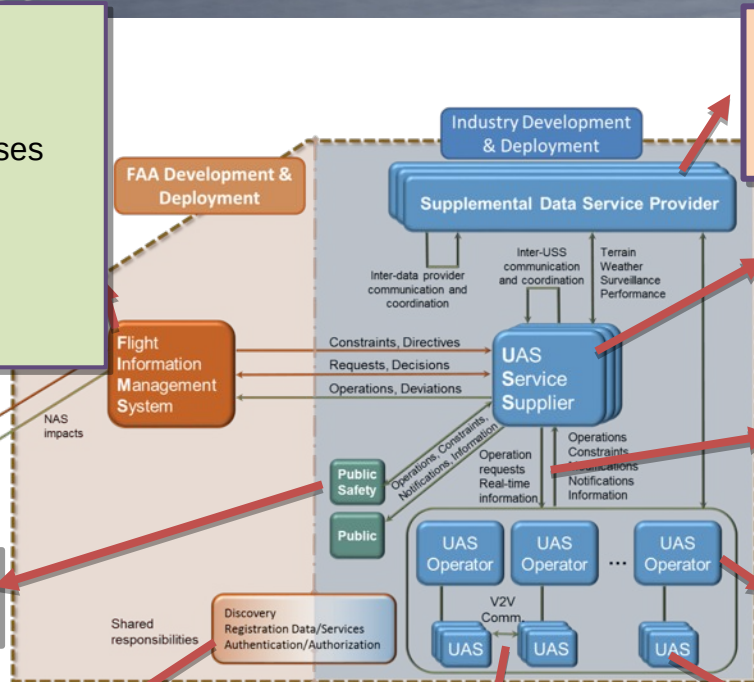
ASTM WK69690 Ground Surveillance
 UTM Surveillance API
 TCL DAA Results
 Conflict Management Model

ASTM WK63418 UTM Services
 USS Specification
 Authorization & Authentication

CTIA UAS Working Group
 TCL C&N Results
 UTM C&N Model and
 Requirements

Unmanned Aircraft Safety Team
 Off-Nominal Reporting
 UTM Hazards Analysis

ASTM WK62669 Detect & Avoid
 TCL DAA Results
 Conflict Management Model





International Impact of UTM

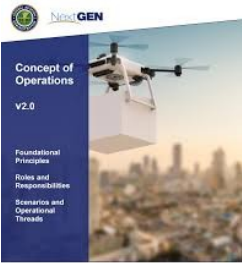
UTM has directly influenced the regulation and policy, concepts and architectures, and standards across the world for implementing UAS traffic management

FAA - "UTM Conops v2.0"

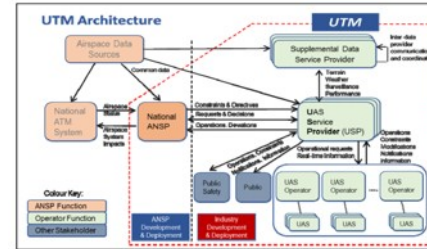
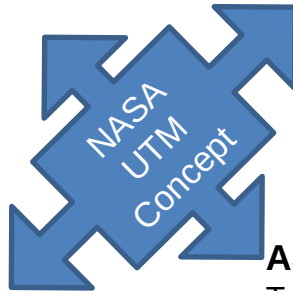
EASA - "High Level regulatory framework for the U-space"

ICAO - "UTM - A Common Framework with Core Principles"

JARUS - "SORA v2.0 Annex H- UTM Services"



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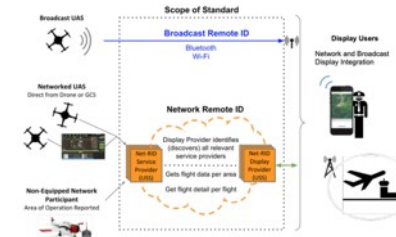


GUTMA - "Map of Global UTM Implementations"



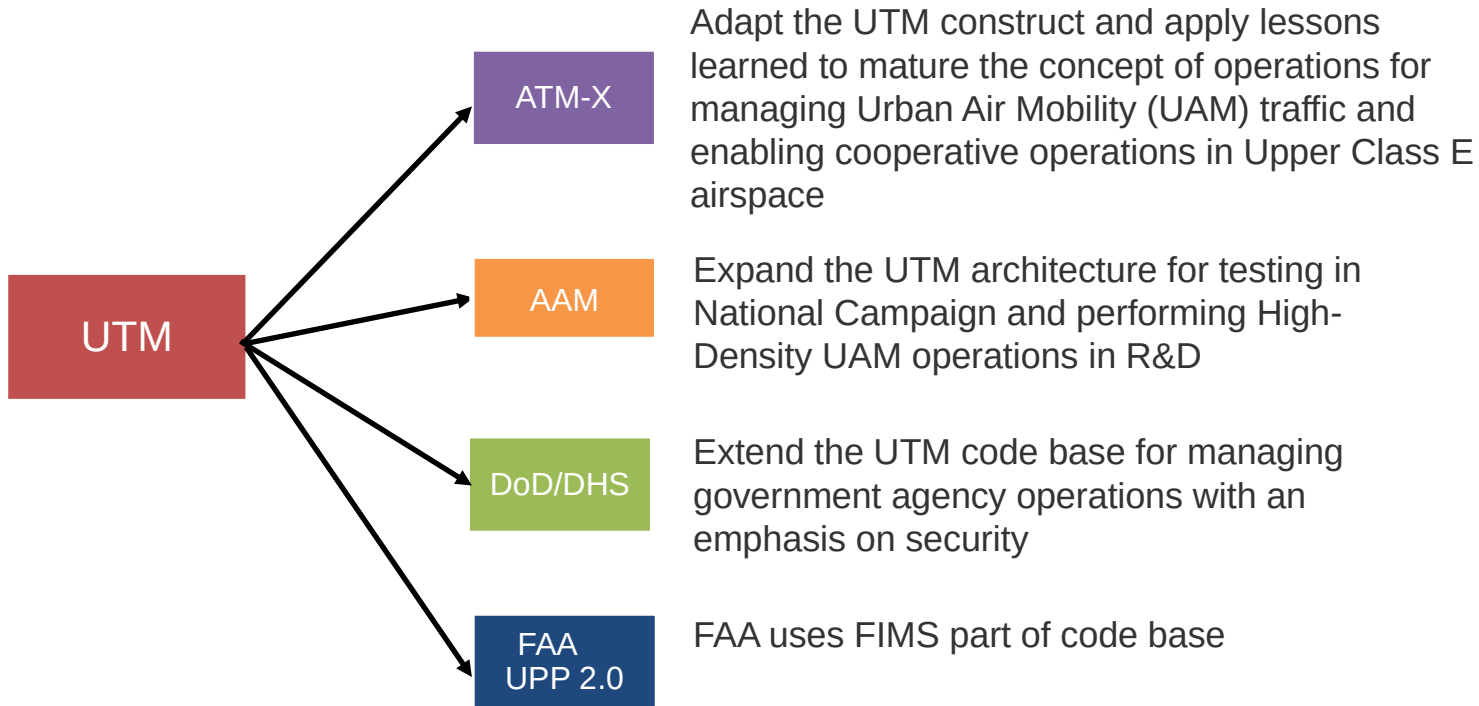
ASTM - "New Specification for Service provided under UAS Traffic Management"

ISO - "Requirements for UTM services and service providers"





UTM Project Ends but UTM Construct Continues



The UTM concept has been very successful in evolving to new applications and spring boarding projects



The UTM Journey from 2015 to 2020

- *In 2015, the small UAS industry was just beginning to accelerate with no clear concept of how this new traffic would be safely managed*
- *Through partnerships with FAA, industry, and academia, a concept was created and UTM was developed to meet stakeholder's needs*
- *A prototype UTM system of federated services was tested through a series of increasingly complex events in realistic environments to prove the concept*
- *Industry has created business models around providing UTM services and is taking leadership in standards development*
- *The FAA is embarking on the UTM implementation program that will unleash, in a disciplined way, a multi-billion-dollar industry*
- *Now in 2020, the UTM concept is the springboard for managing UAS in all airspace domains and will influence the future NAS transformation*