Flight Demonstration of Unmanned Aircraft System (UAS) Traffic Management (UTM) at Technical Capability Level 3

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Presentation Outline

- Background
- UAS Traffic Management (UTM) Design
- High-Level Purpose of Technical Capability Level (TCL) 3 Demonstration
- TCL3 Flight Demonstration Highlights
- Summary

Background

- Millions of small Unmanned Aircraft Systems (UAS) to fly in U.S. airspace
- UAS Traffic Management (UTM): air traffic management ecosystem for small UAS in low altitude
- Other countries using the UTM architecture to integrate UAS


Hello
my name is
4444-8888-FEEDDEADBEEF
banana
banana

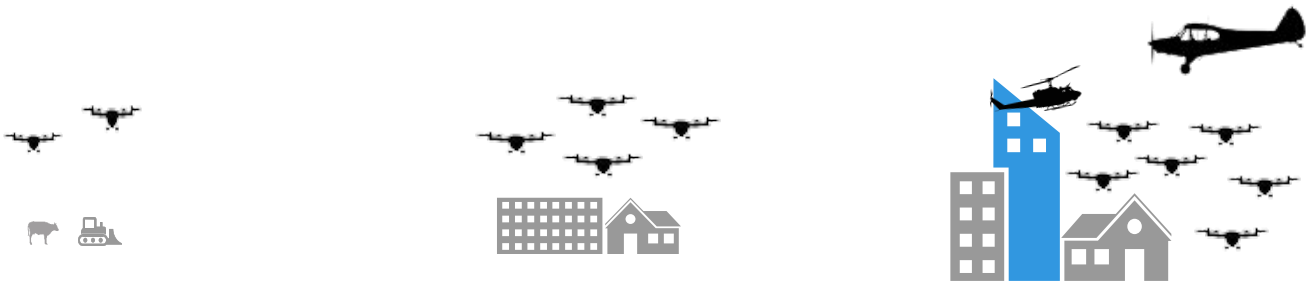
VS


Hello
?
cat

Technical Capability Levels (TCL) Progression for System Development and Testing

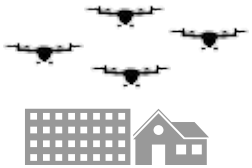
TCL1	TCL2
Remote Population	Sparse Population
Low Traffic Density	Low-Mod Traffic Density
Rural Applications	Rural / Industrial Applications
Multiple Visual Line of Sight (VLOS) Operations	Multiple Beyond Visual Line of Sight (BVLOS) Operations
Notification-based	
Completed 2015	**Completed 2017**

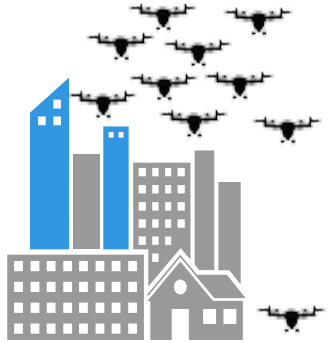
Technical Capability Levels (TCL) Progression for System Development and Testing



TCL1	TCL2	TCL 3
Remote Population	Sparse Population	Moderate Traffic Density
Low Traffic Density	Low-Mod Traffic Density	Suburban Applications
Rural Applications	Rural / Industrial Applications	Mixed Operations
Multiple Visual Line of Sight (VLOS) Operations	Multiple Beyond Visual Line of Sight (BVLOS) Operations	Vehicle to Vehicle Communication
Notification-based		Public Safety Operations
Completed 2015	**Completed 2017**	**Completed 2018**

Technical Capability Levels (TCL) Progression for System Development and Testing





TCL1

Remote Population

Low Traffic Density

Rural Applications

Multiple Visual Line of Sight (VLOS) Operations

Notification-based

Completed 2015

TCL2

Sparse Population

Low-Mod Traffic Density

Rural / Industrial Applications

Multiple Beyond Visual Line of Sight (BVLOS) Operations

Completed 2017

TCL 3

Moderate Traffic Density

Suburban Applications

Mixed Operations

Vehicle to Vehicle Communication

Public Safety Operations

Completed 2018

TCL4

Dense Population

High Traffic Density

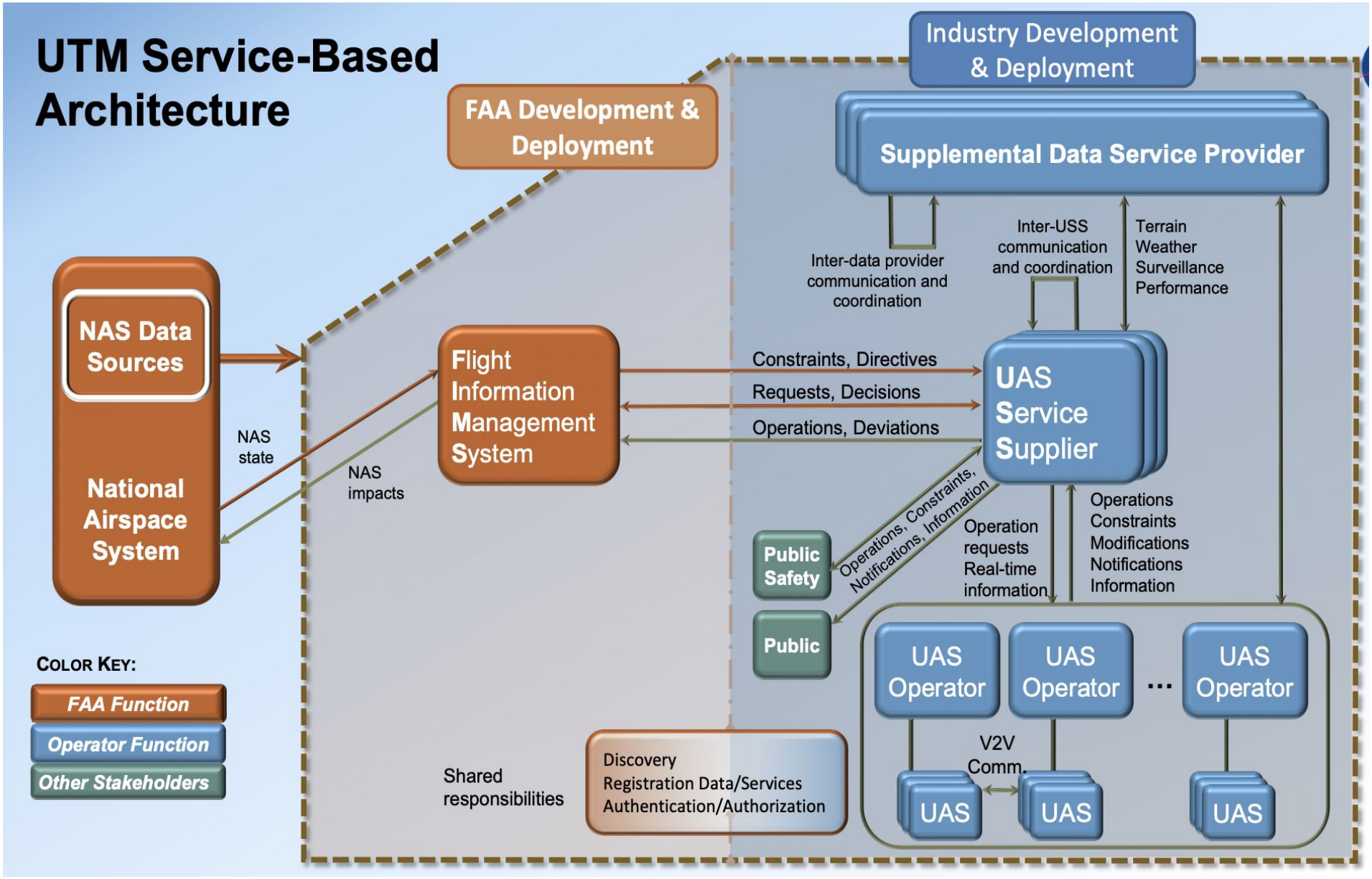
Urban Applications

Dense BVLOS Operations

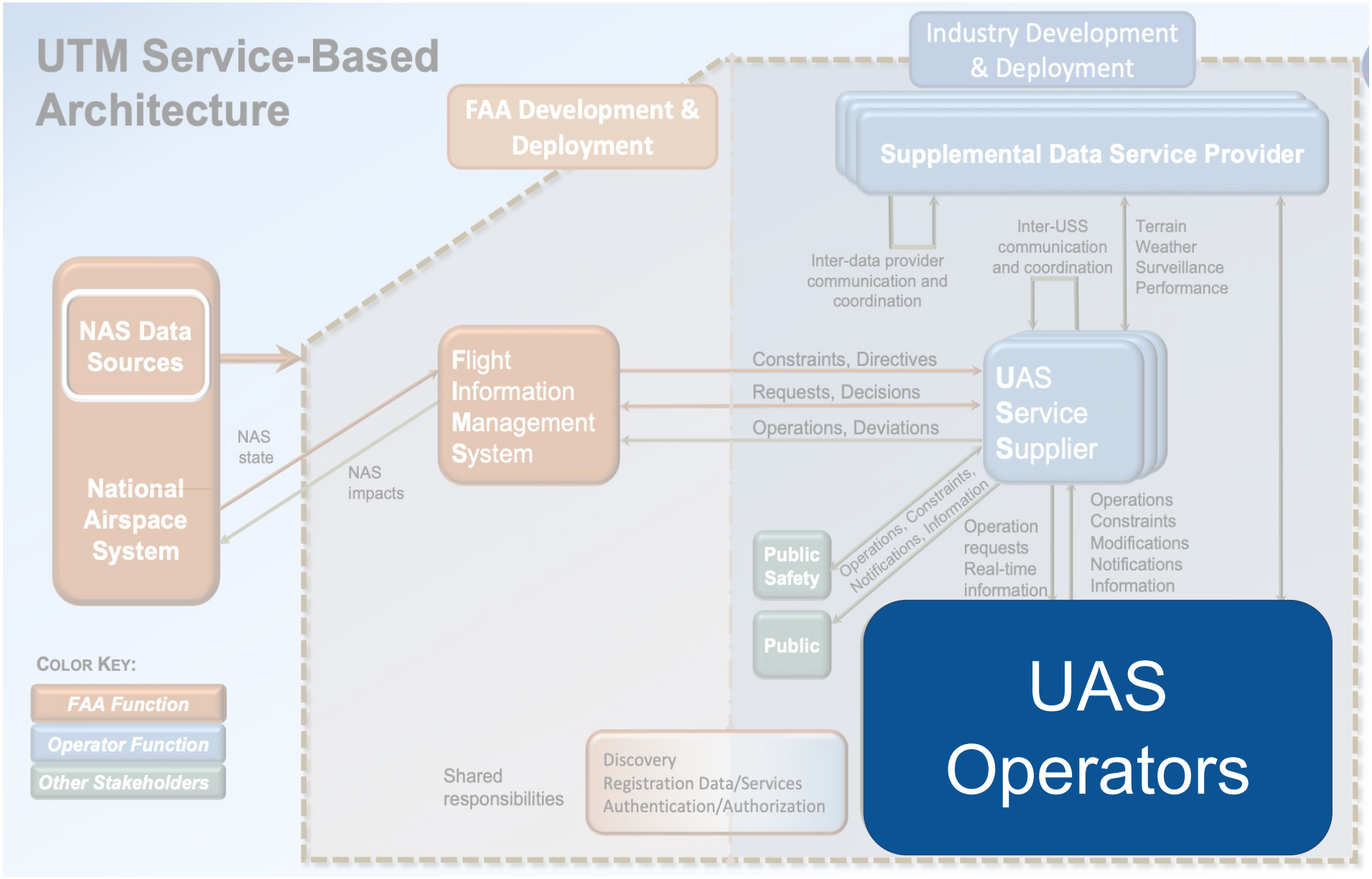
Large Scale Contingency Management

2019

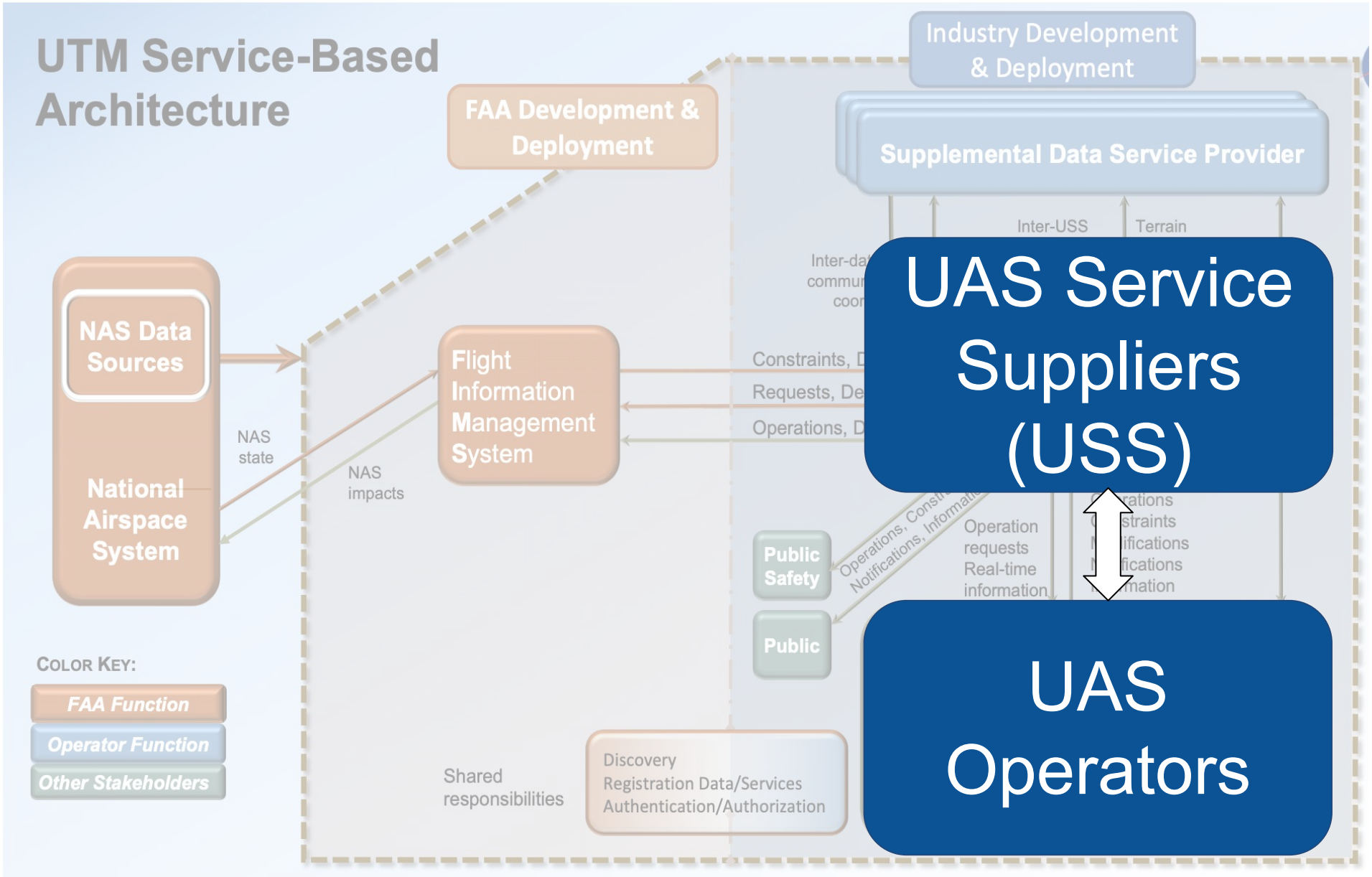
UTM Architecture



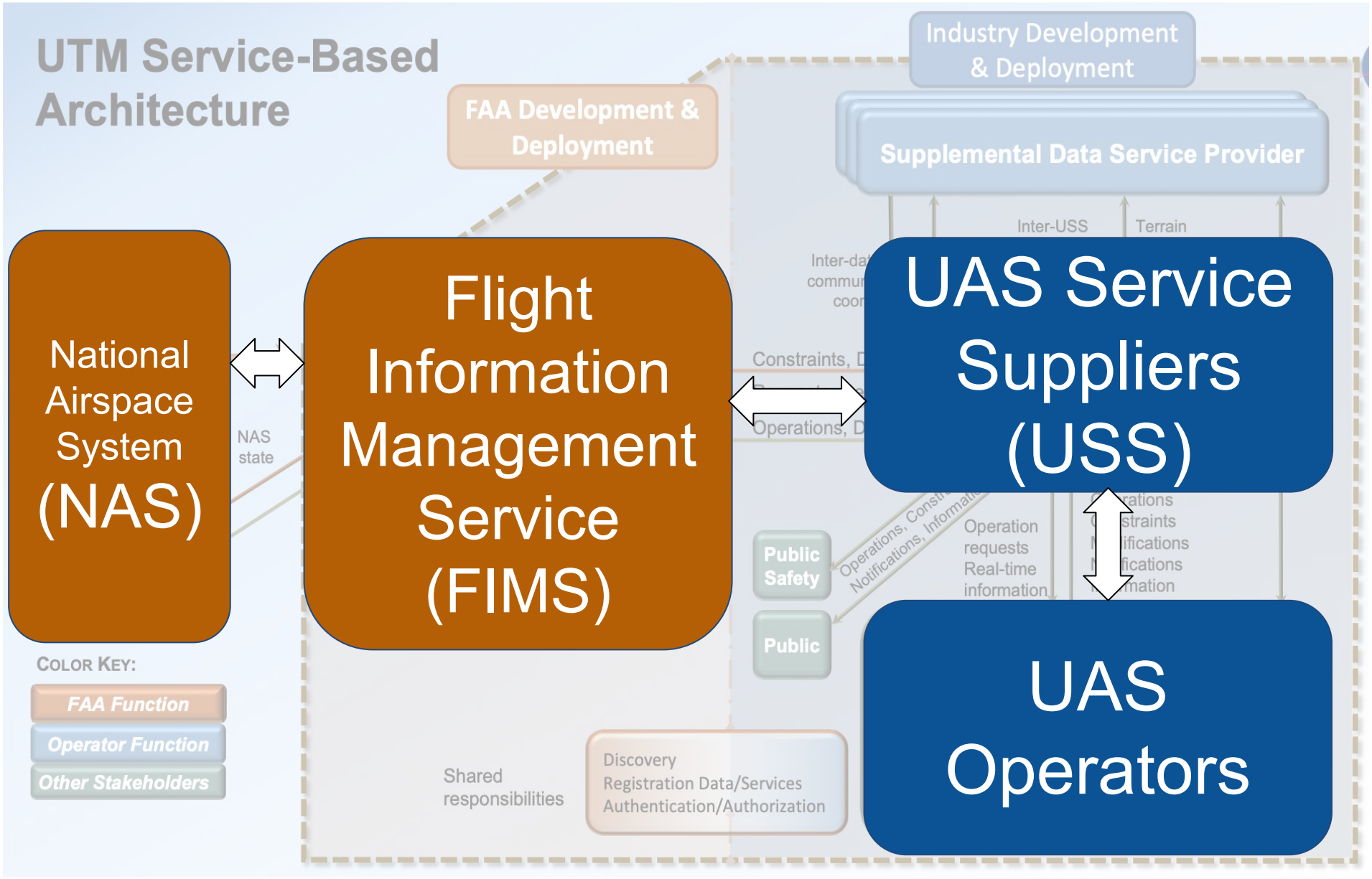
UTM Architecture



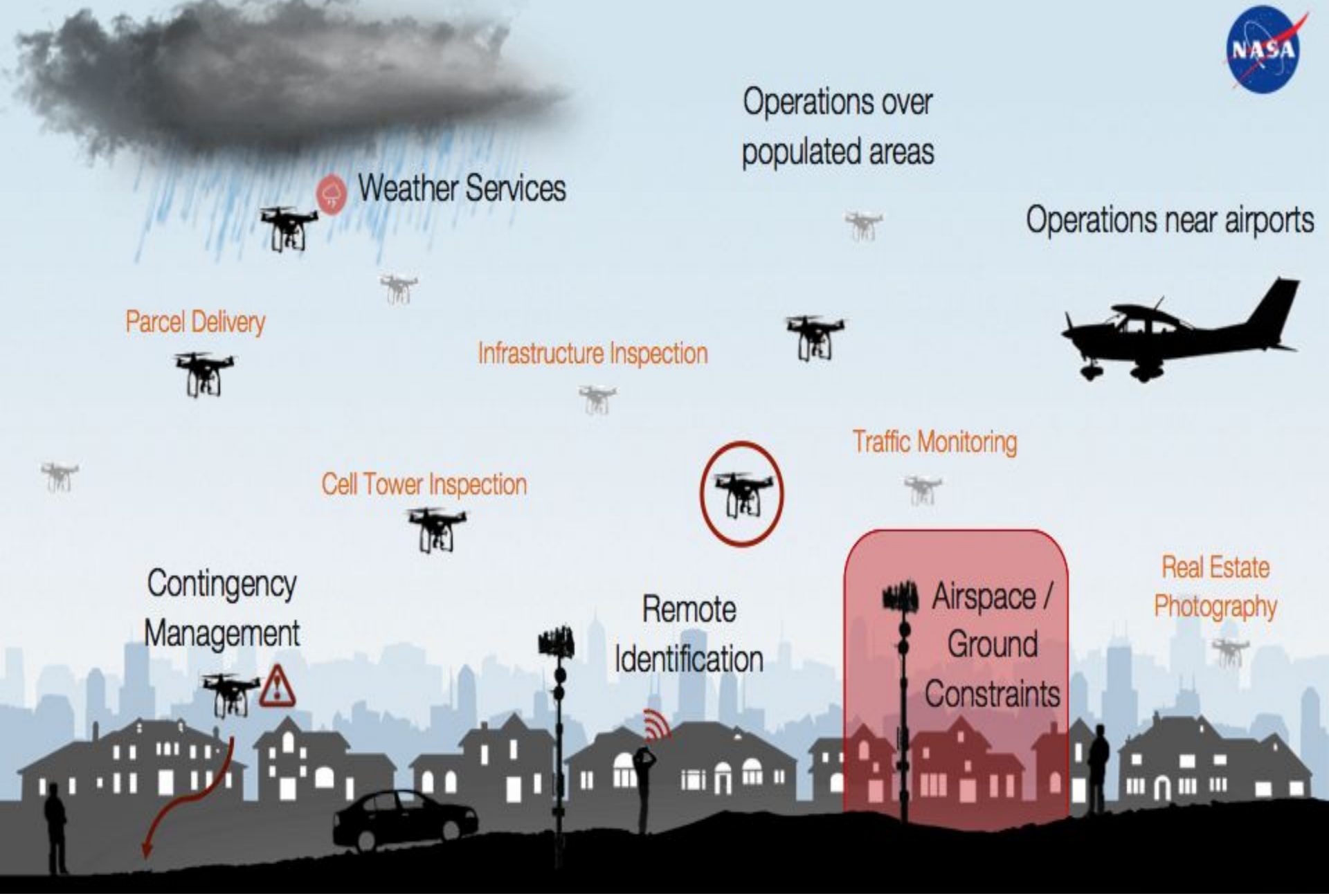
UTM Architecture



UTM Architecture



TCL3 Flight Demonstration



TCL3 Operations Environment

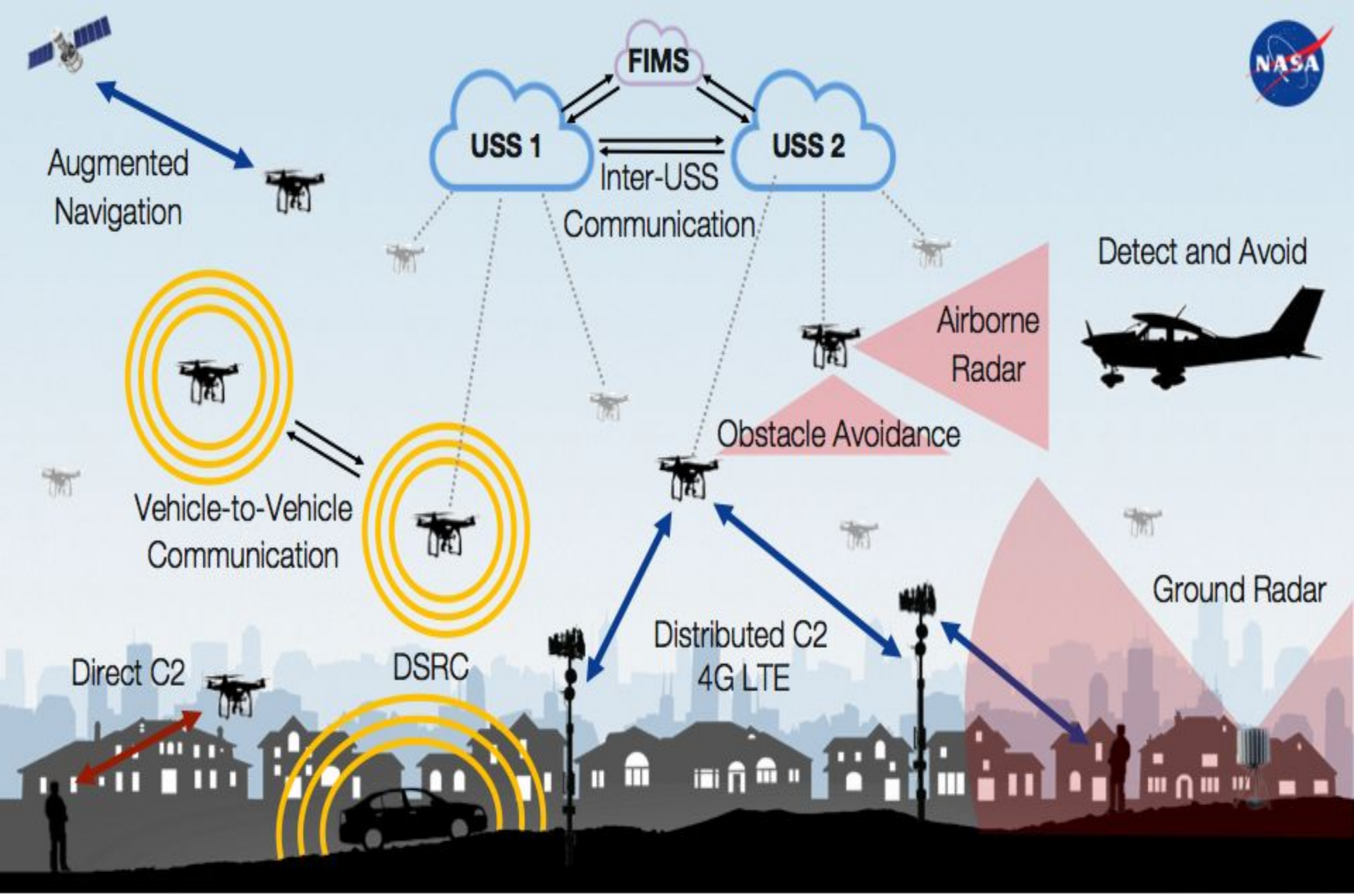
High-Level Purpose of TCL3 Demonstration

Demonstrate, evaluate, and refine the functional designs, technology prototypes, and UTM Concepts of Operation

- Across a wide range of operating locations
- With a wide range of UAS platforms and USS implementations
- Utilizing service based architecture
  - Operator-USS
  - USS-USS
  - USS-FIMS

High-Level Purpose of TCL3 Demonstration

- Accelerate UAS stakeholder development of UTM components
- Objectives pertinent to the work of the NASA-FAA Research Transition Team (RTT) Working Groups
  - Communication and Navigation (C&N)
  - Sense and Avoid (SAA)
  - Data and Information Exchange (DAT)
  - Concept Use Cases (CON)



Technology for TCL3 Demonstration

*DSRC- Dedicated short range communication *C2- Command and Control

Flight Demonstration Highlights

6 FAA UAS Test Sites

7 Ranges

Flight Window

March 6 – May 30, 2018

4

Test Types

C&N

SAA

DAT

CON

Participating Entities

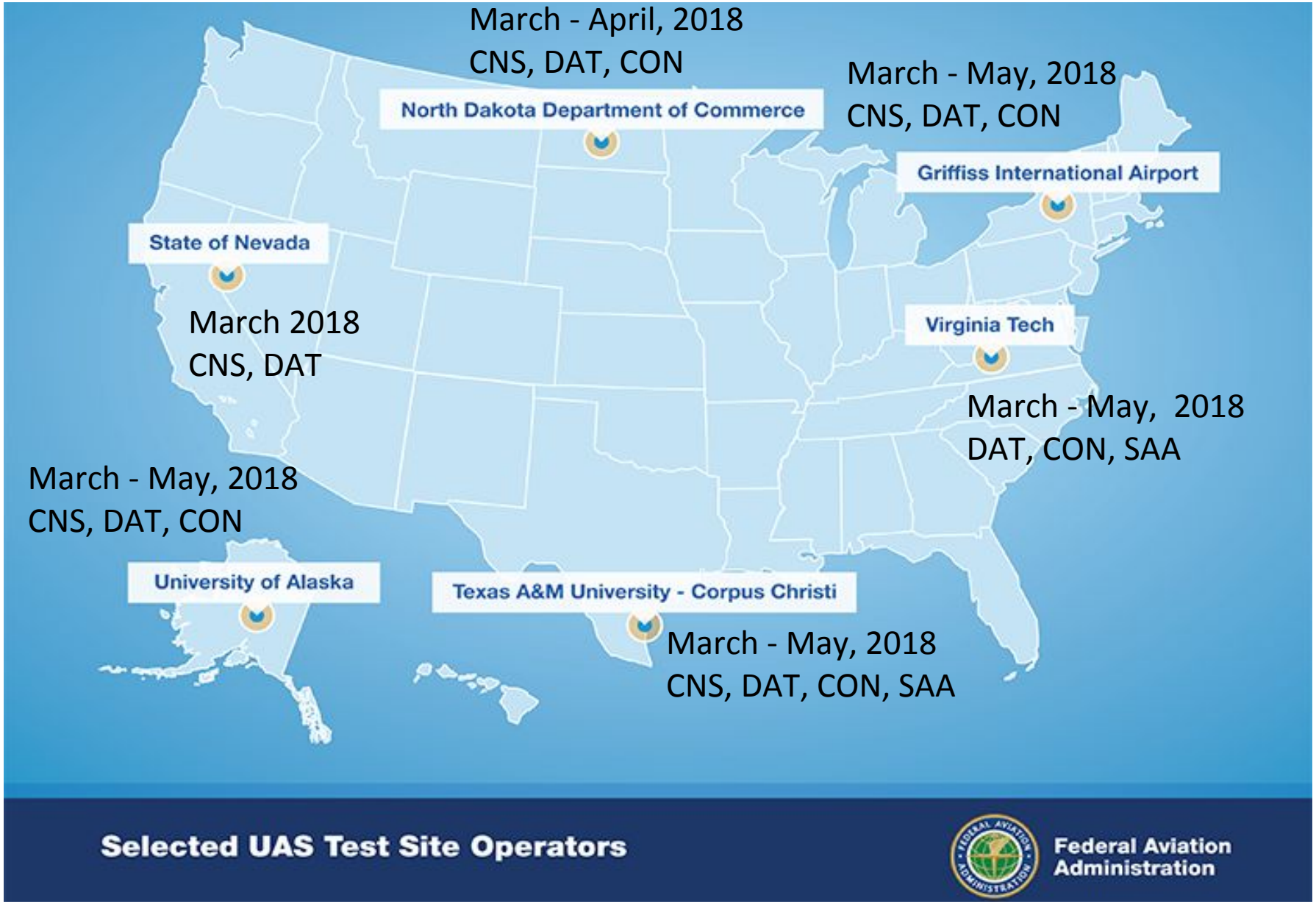
30

UAS Vehicles

31

10 Unique Use Cases

FAA Test Sites and Demonstration Schedule



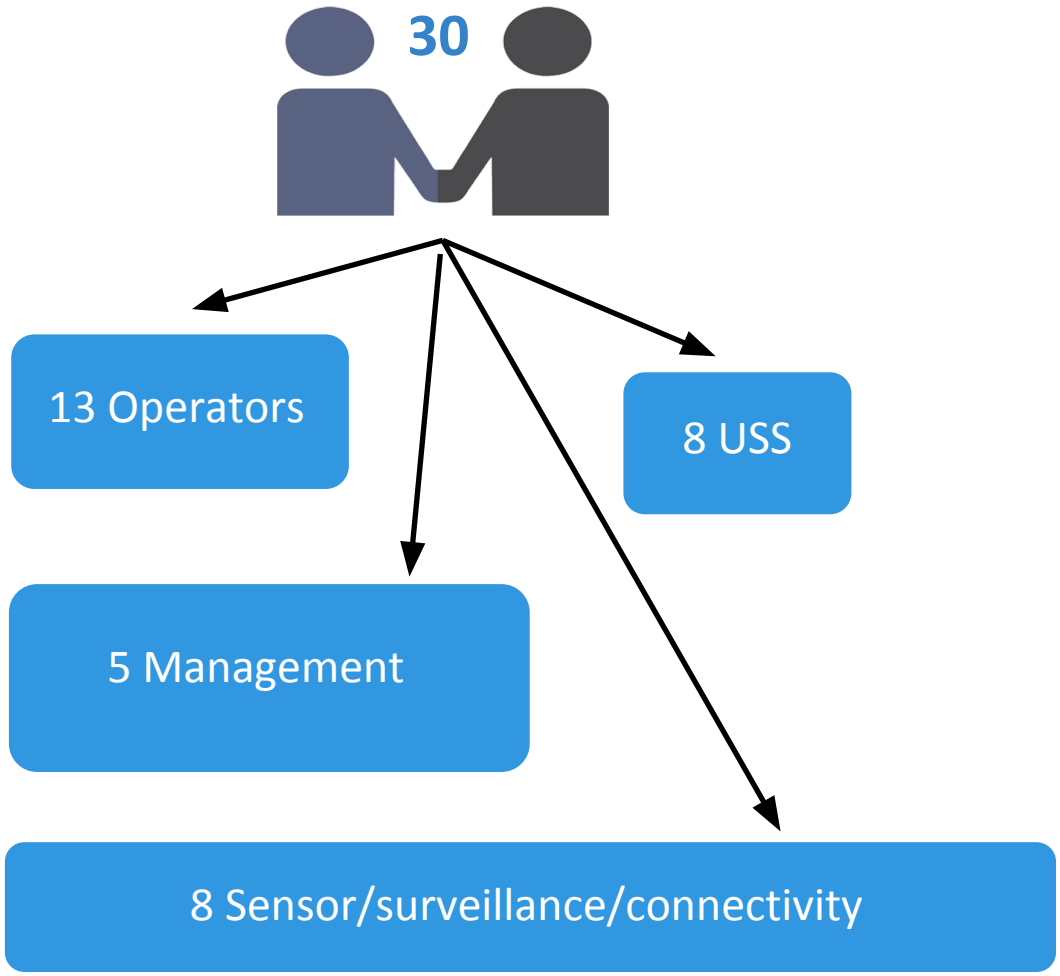
Unique Range Characteristics

Test Site	Capabilities
Alaska-University of Alaska, Fairbanks (UAF)	- Limited GPS performance due high latitude.
Nevada- Reno-Stead Airport	- Terrain includes obstacles to avoid in flight planning and that can enable BVLOS operations.
New York- Griffiss International Airport	- UAS controlled from an indoor operations center allowing BVLOS and can takeoff from and return to a hangar.
North Dakota- Camp Grafton North (CGN)	- Wide variety of environments to emulate suburban and rural environments and access to a lake for expanded operations.
Texas- Port Mansfield, TX	- Test range extends over the Gulf of Mexico and can be used to explore overwater UA operations.
Virginia- Kentland Farms and Virginia Smart Road	- Provides a full-scale, closed testbed research facility to explore integration of ground-based and airborne DSRC systems.

TCL3 Test Site Photos

https://utm.arc.nasa.gov/index.shtml

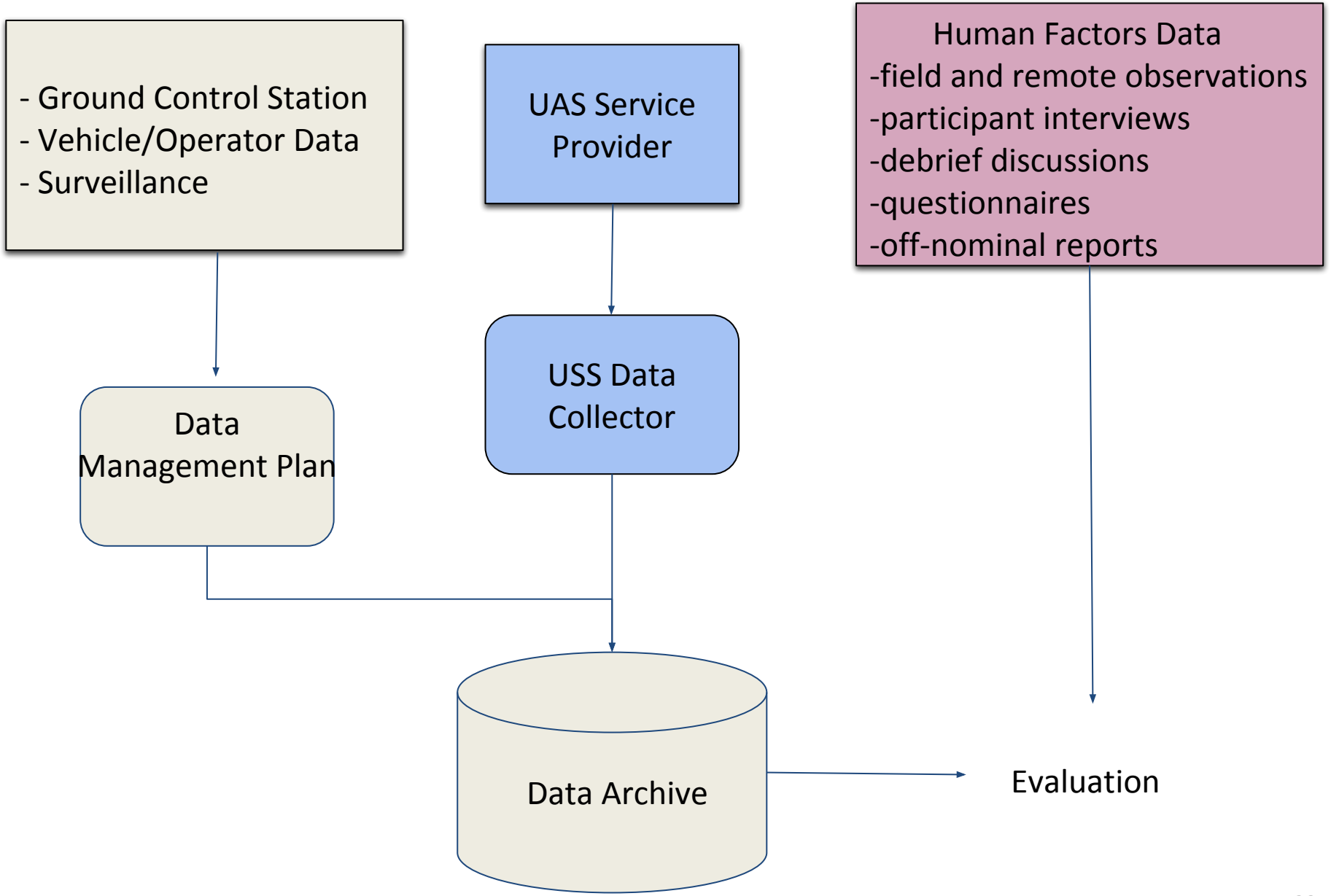
Participating Entities



Use Cases

- Package delivery
- Infrastructure inspection
- Disaster response
- Coastal video survey
- Aerial photography
- Hotel surveillance & security
- Critical medical supply delivery to disaster sites & victims
- Contingency management (loiter, return to bases, land now, etc.) due to intruder aircraft and/or aircraft failure
- Aircraft leaving authorized airspace and flying into controlled airspace
- UTM Public Key Infrastructure (PKI)broadcast information to properly identified authorities

Data Flow Design



Airspace Operations Lab Monitoring

Four Drones Flying Over Reno, NV, June 18, 2019

Summary

- Focused testing to address the joint FAA-NASA RTT's four target research areas
  - Development and testing of systems that enable improved navigation, long-range communications, and sense and avoid capabilities
  - Testing of existing technologies to determine potential improvements
  - Development and testing of tools that provide increased situational awareness of the flight environment and air traffic
- Accelerated partner development of their USSs (8 including NASA prototype) to NASA specifications
- TCL3 Demonstration
  - Assisted in identifying gaps in the data model and interface between components of the UTM System
  - Assisted in refining the UTM Concept for specific technical capability levels and envisioned operational environment
  - Will assist in development of performance requirements and guidelines for SAA and C&N technologies and procedures