National Aeronautics and Space Administration

Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NASA

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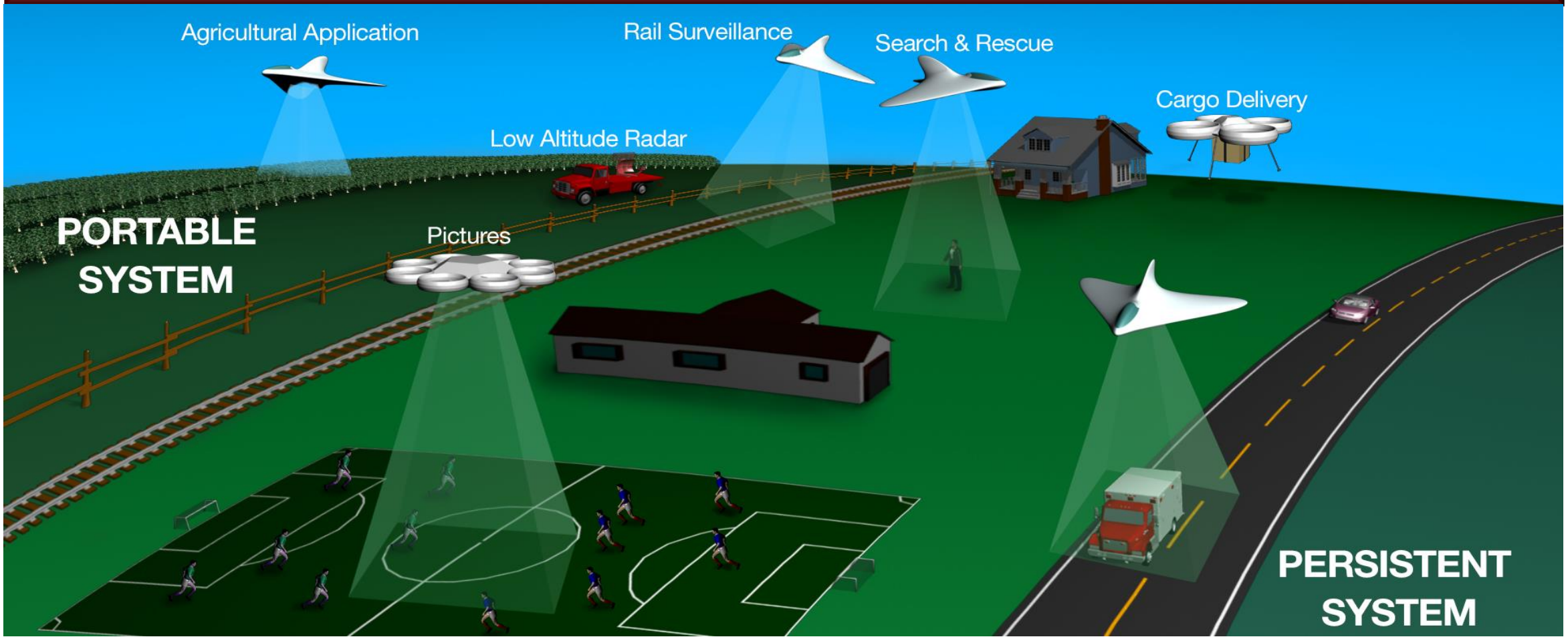
Unmanned Aerial System Traffic Management (UTM)

Near-term Goal: Safely enable initial low-altitude UAS as early as possible

Long-term Goal: Accommodate increased demand with highest safety, efficiency, and capacity



UTM: Balancing Multiple Needs

National and Regional Security

Protecting key assets

Safe Airspace Integration

Flexibility where possible and structure where needed

Geographical needs, application, and performance-based airspace operations

Scalable Operations for Economic Growth

Ever-increasing applications of UAS: Commercial, Agricultural, and Personal

Five Basic Principles

- Drones should not hit each other
- Drones should stay away from manned aviation
- Drone operator should have complete awareness of all constraints in the airspace
- Drones operating in airspace should have positive identification
- Drones should give preference to public safety drones and manned aircraft

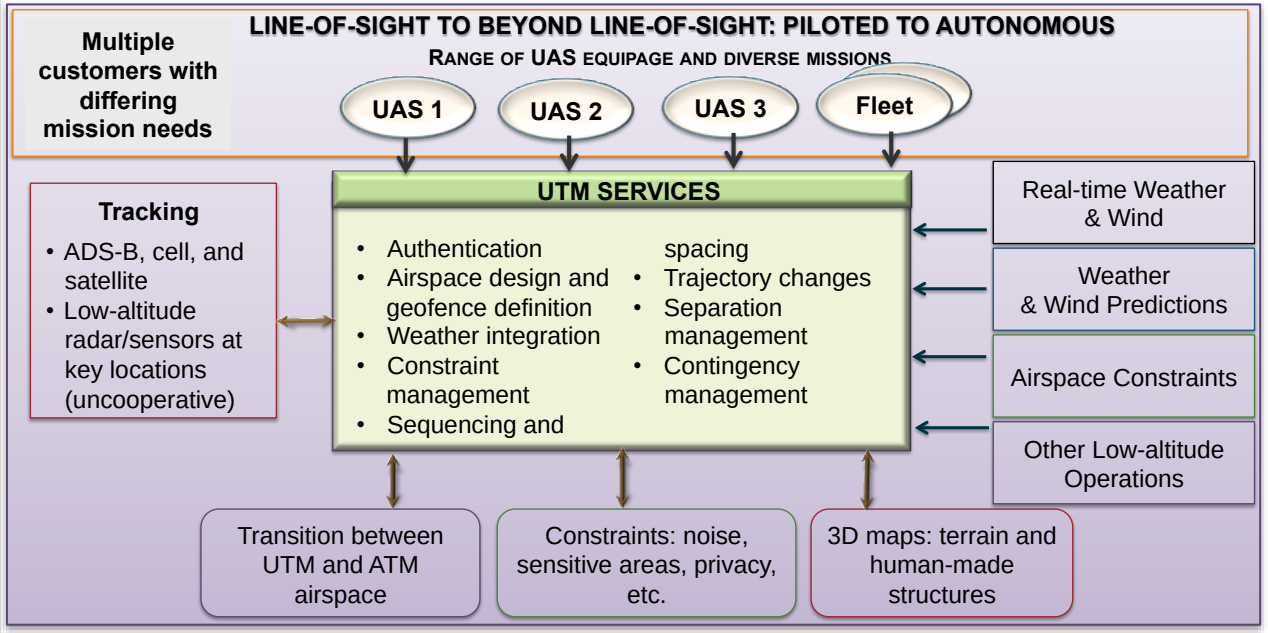
System should scale to accommodate future demand

UTM Design Functionality: Cloud-based

Self-driving car does not eliminate lanes and rules for efficient and safe operations

DIGITAL, VIRTUAL, & FLEXIBLE RISK-BASED APPROACH AND SERVICE INFRASTRUCTURE

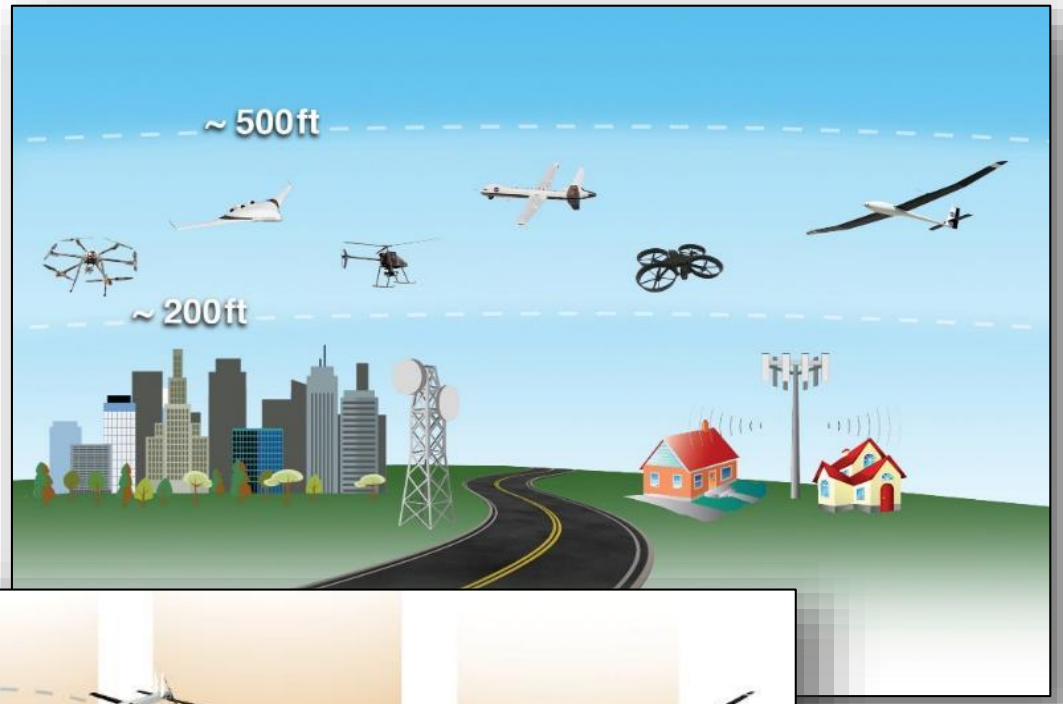
- Safe low-altitude UAS operations with
  - Airspace management and geofencing
  - Weather and severe wind integration
  - Predict and manage congestion
  - Terrain and man-made objects: database and avoidance
  - Maintain safe separation (Airspace reservation, V2V, & V2UTM)
  - Allow only authenticated operations

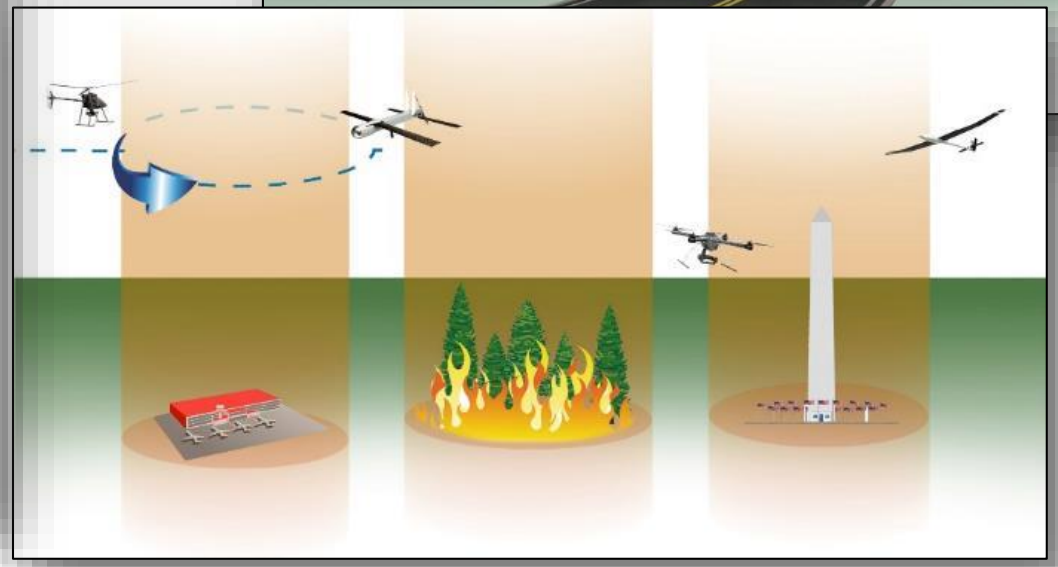


UTM Functions

Airspace Operations & Management

- ~500 ft. and below
- Geographical needs and applications
- Rules of the airspace: performance-based
- Geofences: dynamic and static





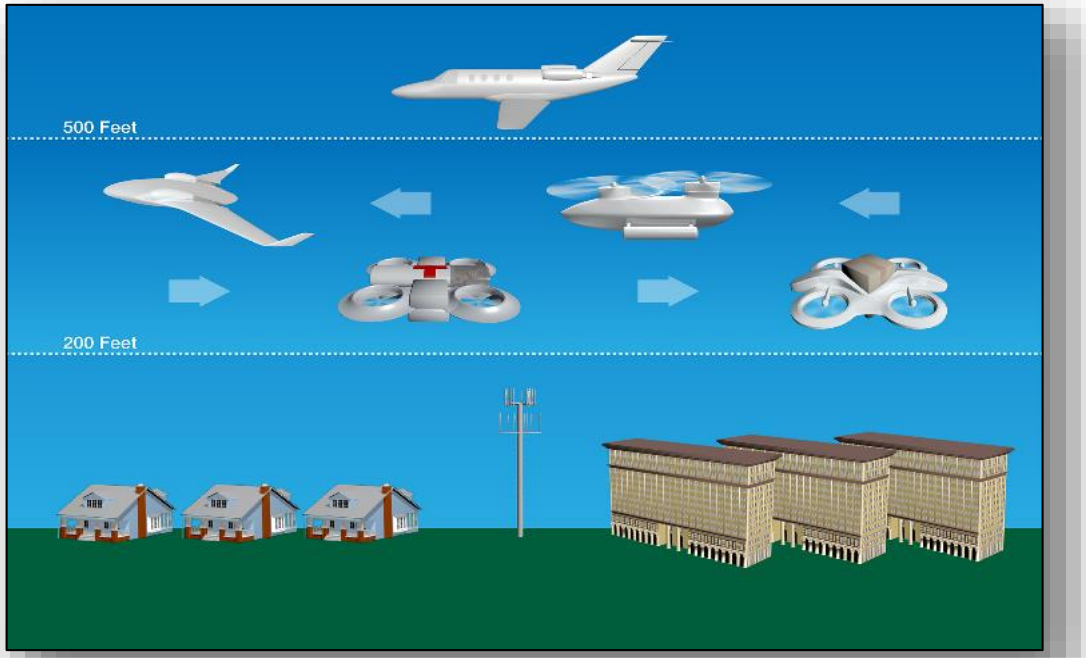
UTM Functions

Wind & Weather Integration

- Actual and predicted winds/weather

Congestion Management

- Demand/capacity imbalance
- Only if needed – corridors, altitude for direction, etc.



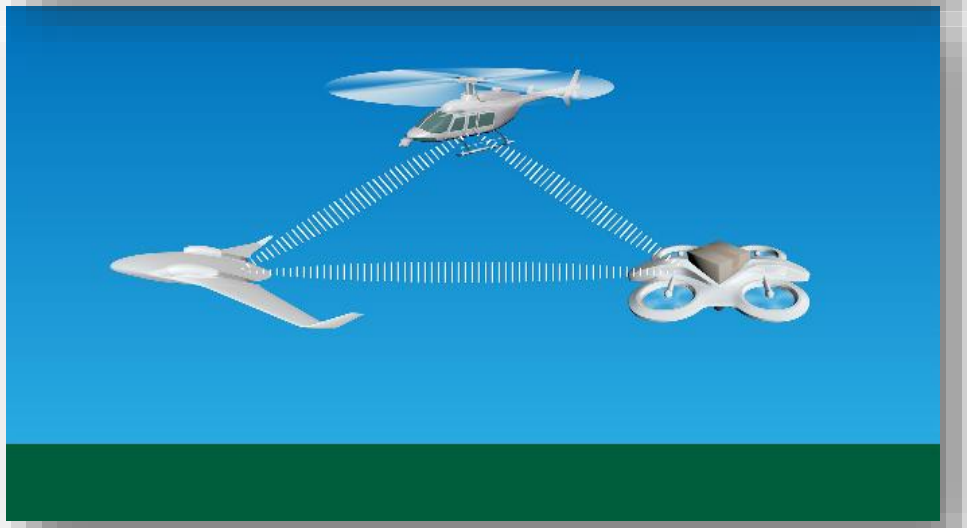
UTM Functions

Separation Management

- Airspace reservation
- V2V and V2UTM
- Tracking: ADS-B, cellphone, & satellite based

Contingency Management

- Large-scale GPS or cell outage
- 9-11 like situations



UTM Builds:

Each build is independent and deployable

Build 1 (August 2015)

- **Reservation of airspace volume**
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot
- Enable agriculture, firefighting, infrastructure monitoring

Build 2 (October 2016)

- **Beyond visual line-of-sight**
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

Build 3 (January 2018)

- Beyond visual line-of-sight
- Over moderately populated land
- Some interaction with manned aircraft
- **Tracking, V2V, V2UTM and internet connected**
- Public safety, limited package delivery

Build 4 (March 2019)

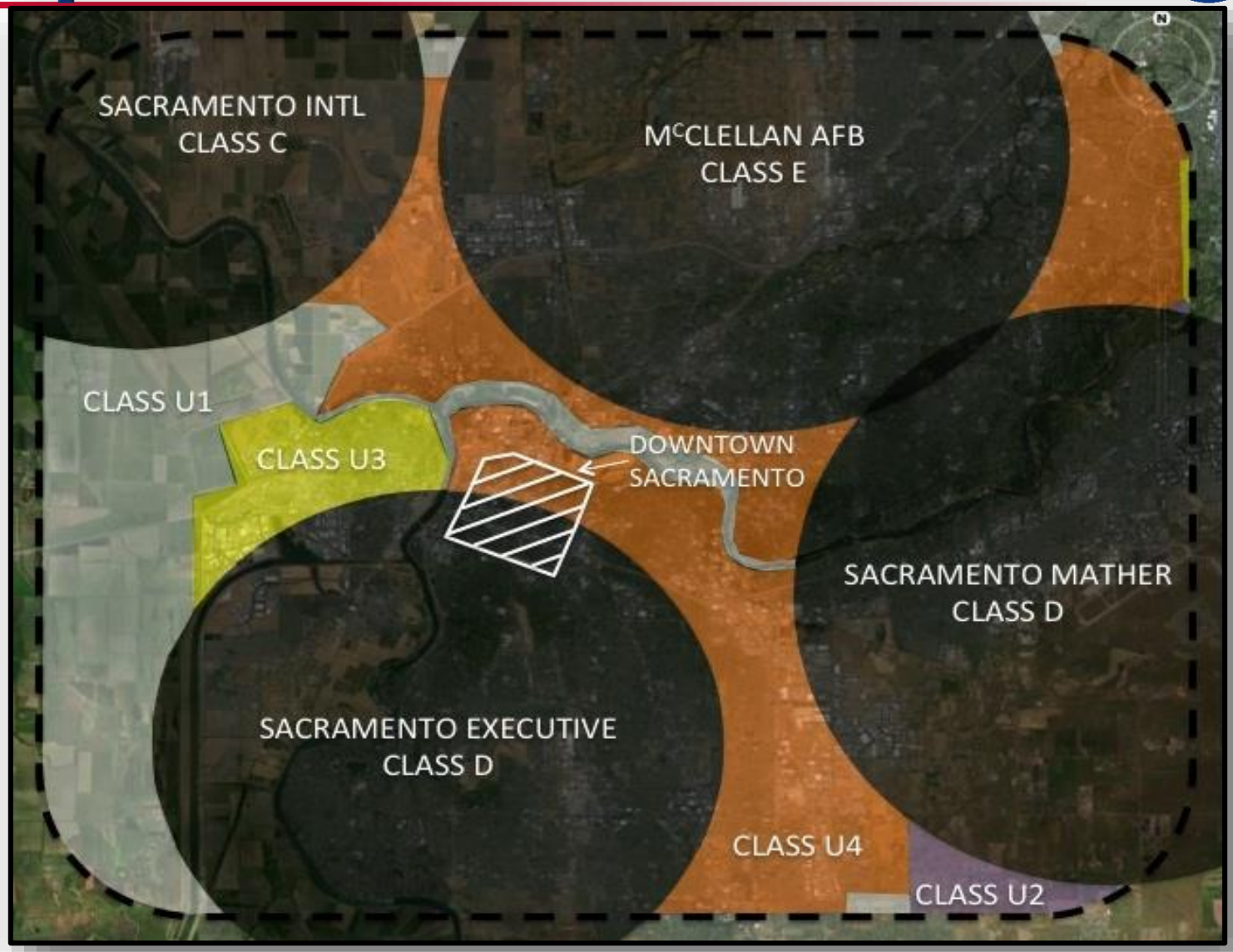
- Beyond visual line-of-sight
- **Urban environments, higher density**
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use

Notional UTM Airspace

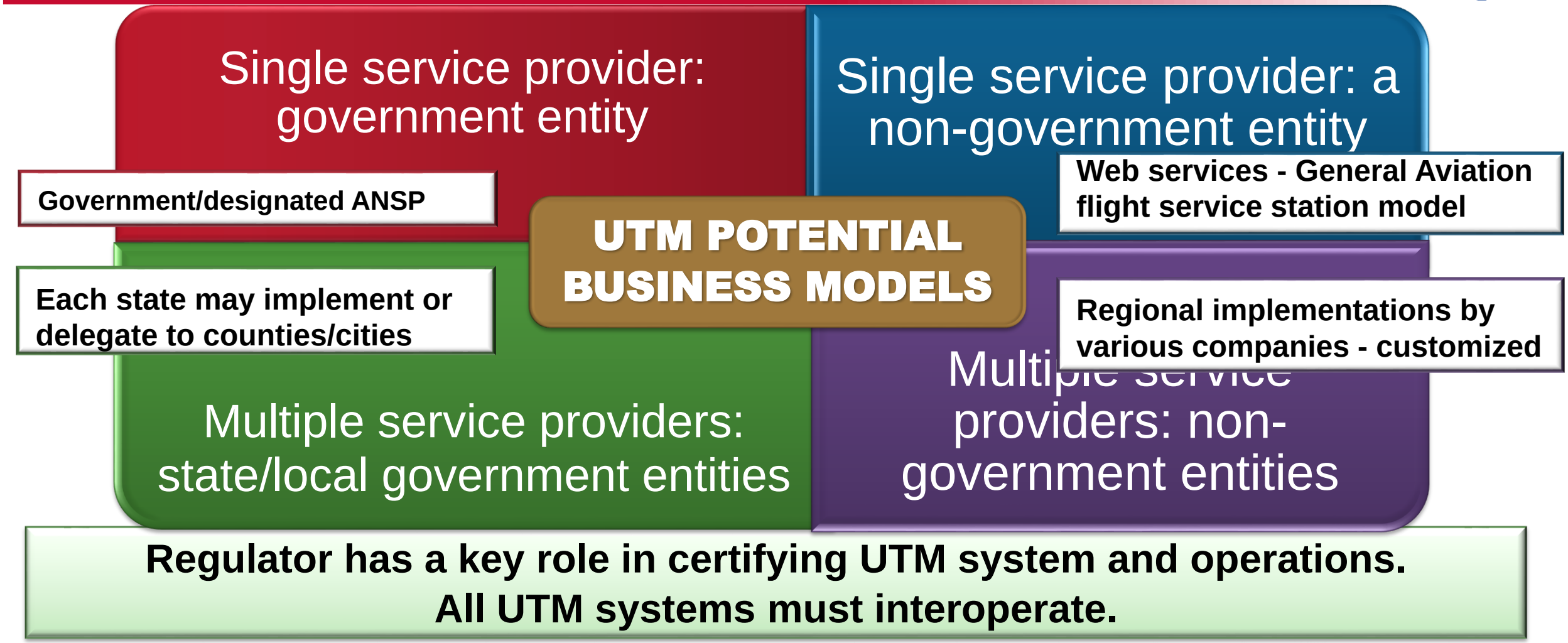
Multiple providers could offer some UTM services

Tailoring operational services based on geographical area needs

Vehicle performance could be different



Consideration of Business Models



Regulator has a key role in certifying UTM system and operations.
All UTM systems must interoperate.

NuSTAR: Towards Self-Regulation

Idea under consideration

- Self-regulation: responsible, credible, collaborative
- National UAS Standardized Testing and Rating (NuSTAR)
- Parallel: Underwriter's Laboratory, Consumer Reports, JD Powers, Which?
- Credible test bed and scenarios
  - Urban, rural, atmospheric conditions (e.g., fog, smog, rain)
  - Simulated pets
  - Failure modes
  - Sub-system level performance: engine/propulsion, networking, battery, sensor systems, software systems
  - Cyber-security
  - GPS denied conditions
- Support UAS manufacturers, consumers, FAA, insurance companies, and public at large through objective assessments
- Forensics analysis: Recreation of incidences and accidents

Progress

- Research Transition Team with FAA, DHS, and DoD
- **125+** industry and academia collaborators and increasing
- Initial UTM Concept of Operations: Industry, academia, and government
- Client interface is ready – **Partners can connect with UTM**
- **Build 1 tests** with 12 partners completed in August, next step is to roll out to FAA test sites for further validation
- **International interest**

Next Steps

- Roll out UTM Build 1 to FAA test sites for further validation
- Development, simulations, and testing of UTM Builds 2-4
- Safety analysis of BVLOS

- NASA will continue to work with industry, academia, and government groups
  - Refine operational requirements, system architecture(s), prototype, and conduct tests – Continue until safe airspace integration is proven!

- National initial safe UAS integration campaign: coordinated effort for data collection and demonstrations
  - Through FAA test sites and other approved locations

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