National Aeronautics and Space Administration

Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NASA

utm.arc.nasa.gov

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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

What is UTM

Research software application prototype that

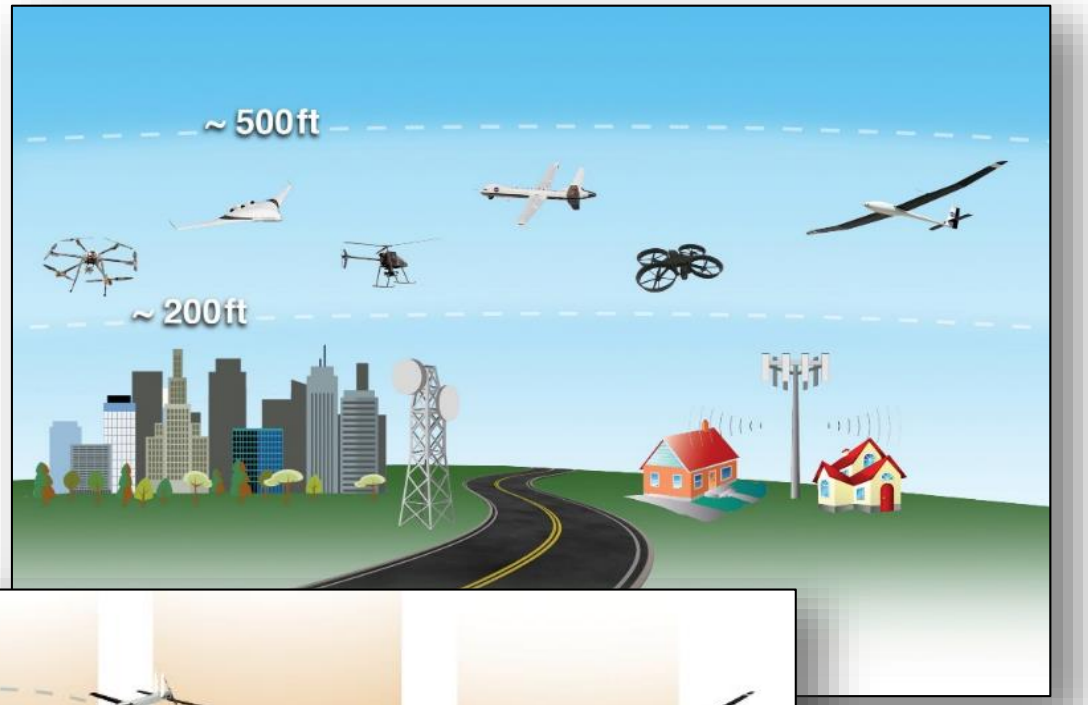
(1) Allows UAS operators to submit flight plans to execute a specific mission in low-altitude airspace, and

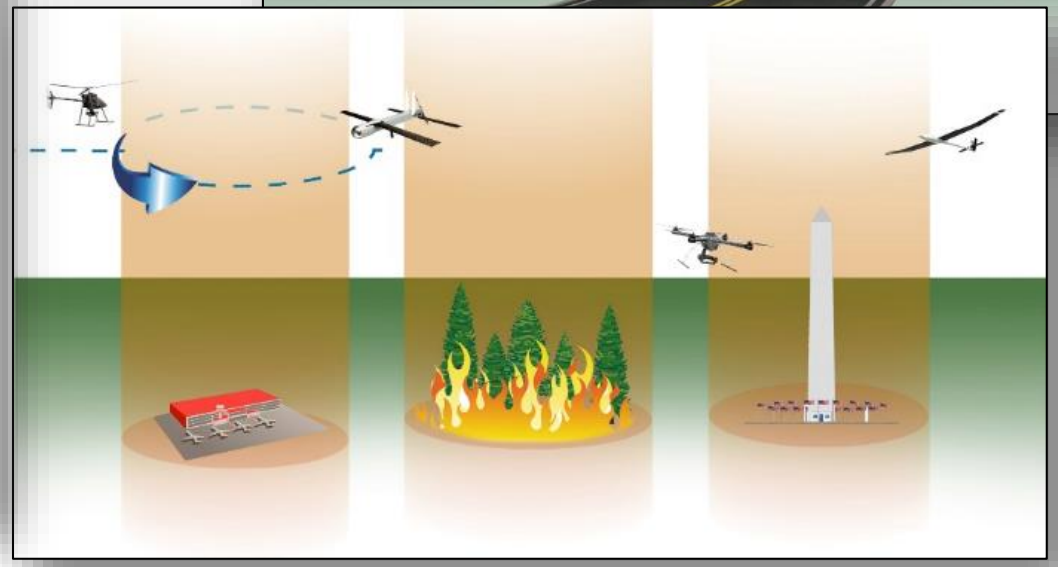
(2) Determines how to safely enable such single or multiple UAS operations either within visual line of sight or beyond visual line of sight

UTM Functions

Airspace Operations & Management

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





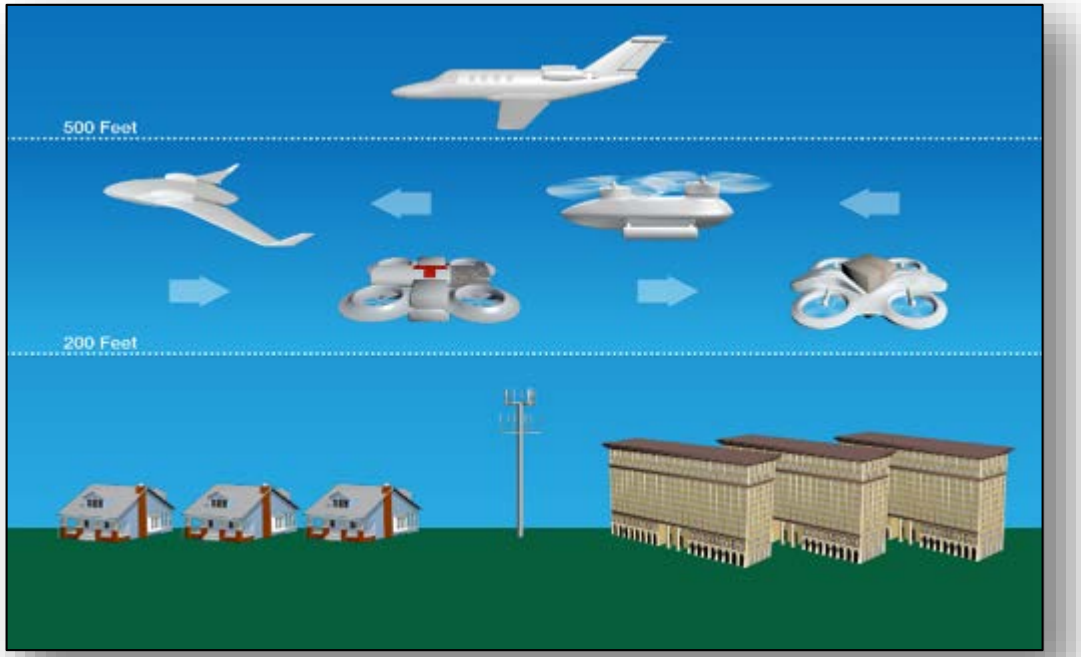
UTM Functions

Wind & Weather Integration

- Actual and predicted winds/weather

Congestion Management

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



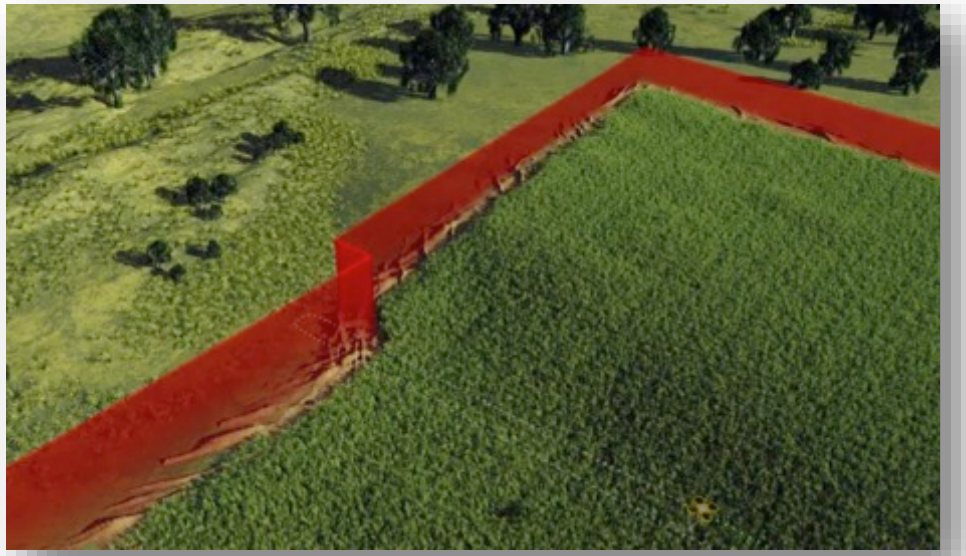
UTM Functions

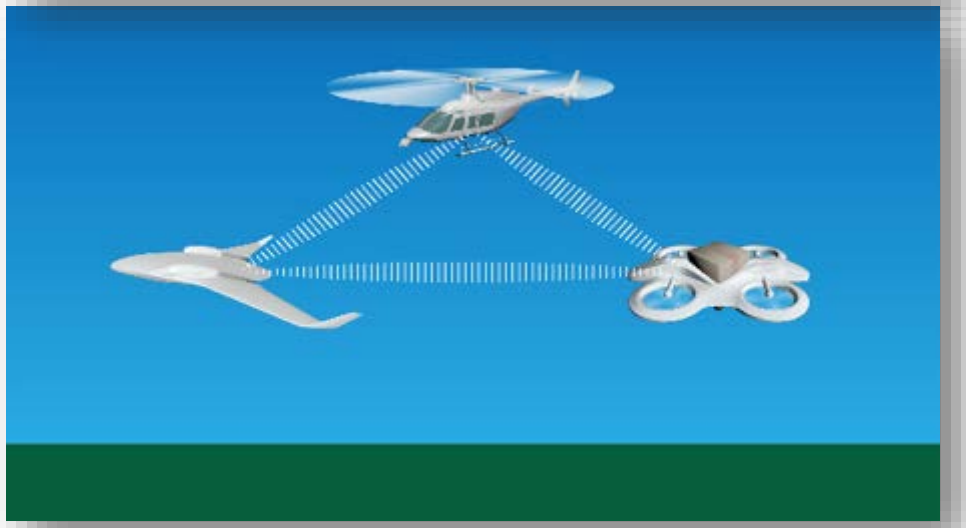
Separation Management

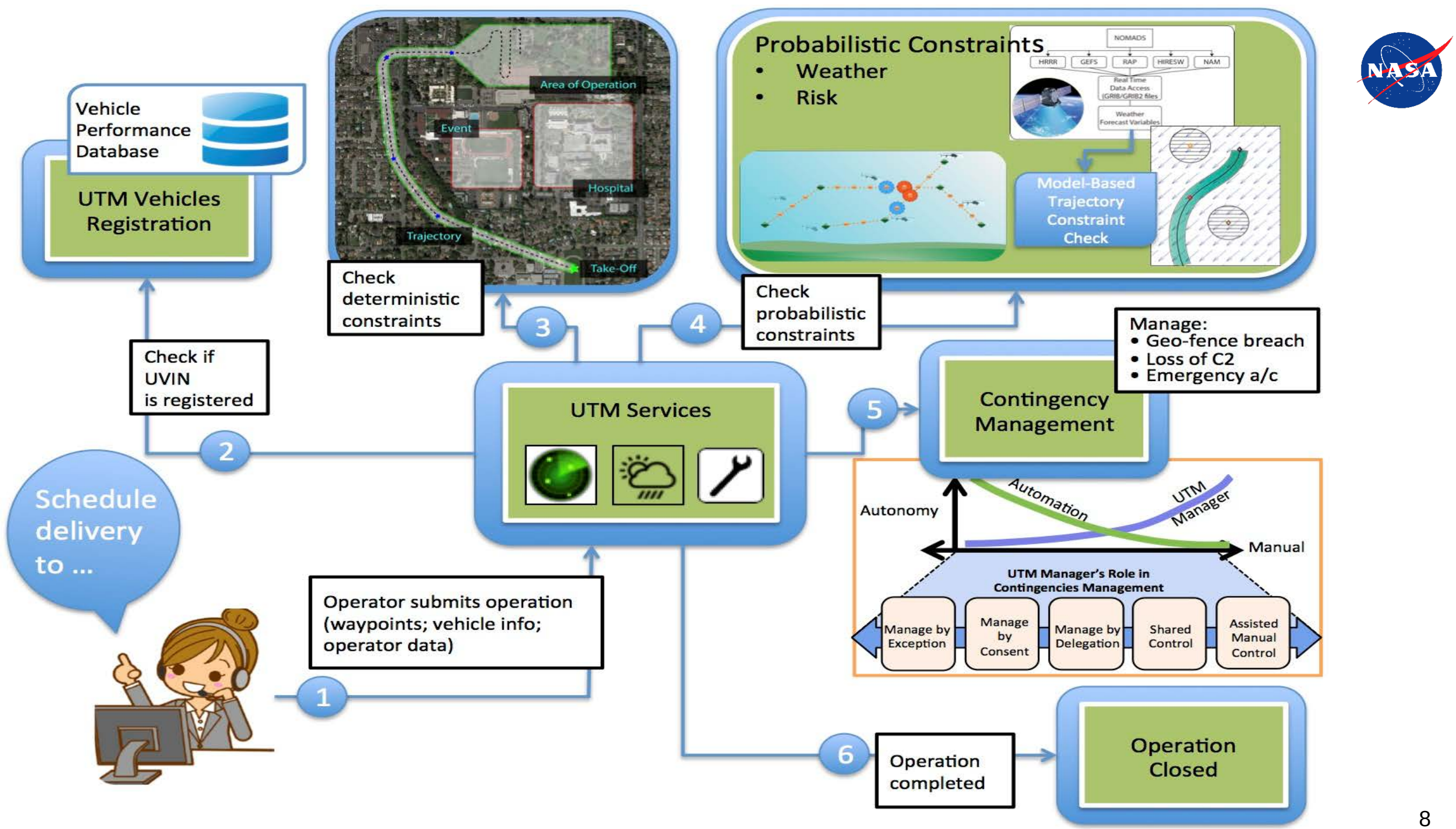
- Airspace reservation
- V2V and V2UTM
- Tracking: ADS-B, cellphone, & satellite based

Contingency Management

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






Vehicle Performance Database
UTM Vehicles Registration
Area of Operation
Event
Hospital
Trajectory
Take-Off
Check deterministic constraints
Probabilistic Constraints
• Weather
• Risk
NOMADS
HRRR
GEFS
RAP
HIRESW
NAM
Real Time Data Access (GRIB/GRIB2 files)
Weather Forecast Variables
Model-Based Trajectory Constraint Check
Check probabilistic constraints
Check if UVIN is registered
2
3
4
5
UTM Services
Contingency Management
Manage:
• Geo-fence breach
• Loss of C2
• Emergency a/c
Autonomy
Automation
UTM Manager
Manual
UTM Manager's Role in Contingencies Management
Manage by Exception
Manage by Consent
Manage by Delegation
Shared Control
Assisted Manual Control
Schedule delivery to ...
Operator submits operation (waypoints; vehicle info; operator data)
1
6
Operation completed
Operation Closed

UTM Target Capability Level

Each capability is targeted to type of application, geographical area and uses risk-based approach

Capability 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

Capability 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

Capability 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

Capability 4 (March 2019)

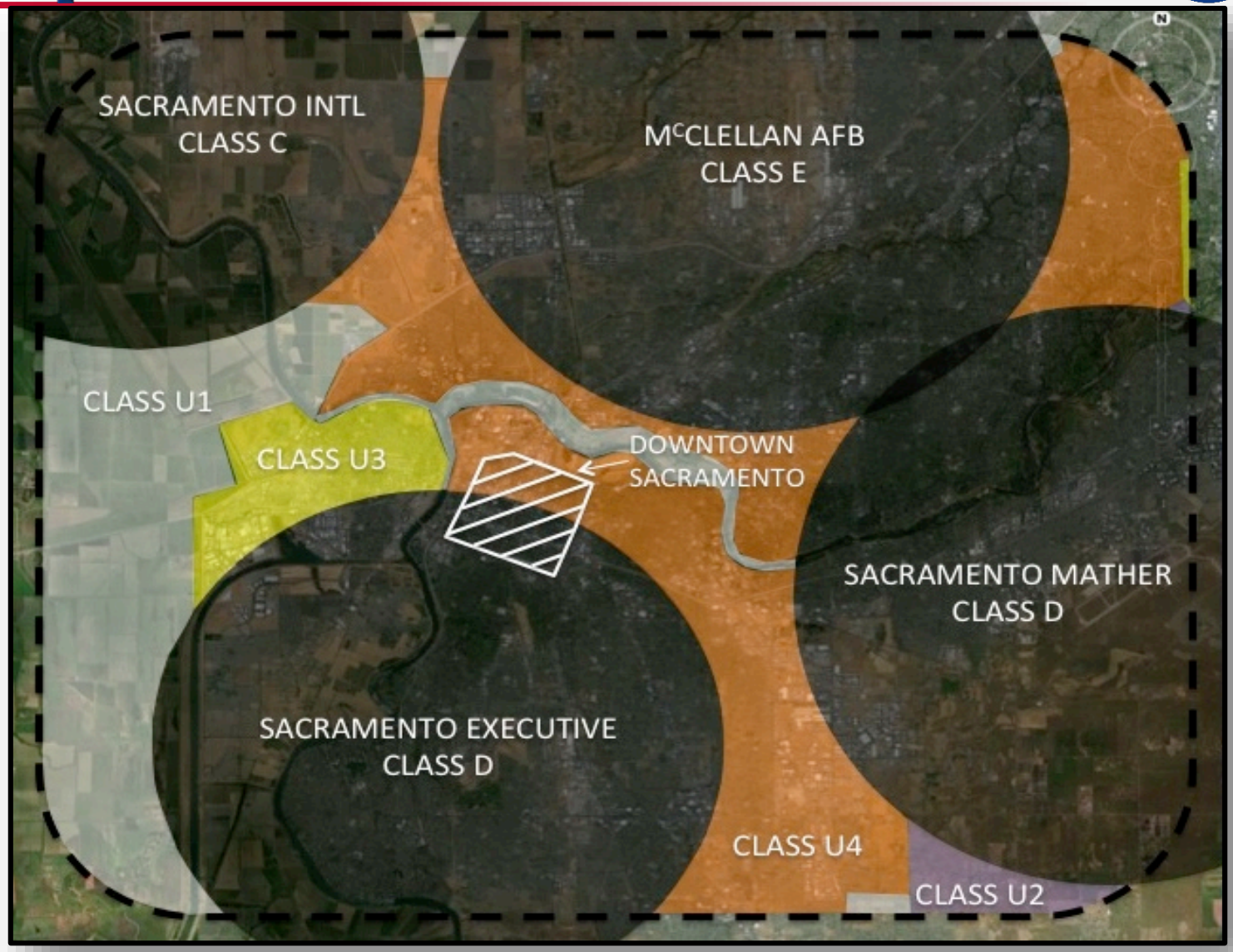
- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use

Notional UTM Airspace

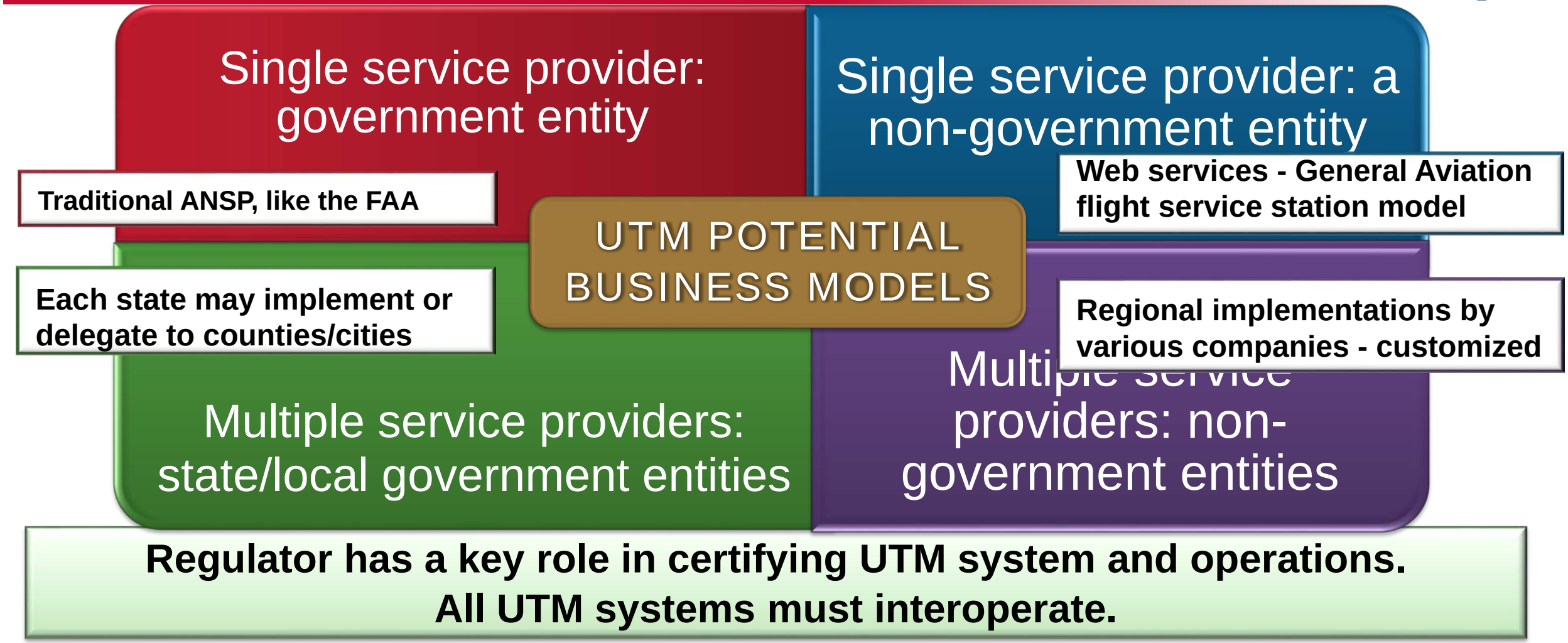
Multiple providers could offer some UTM services

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.

Progress

- Research Transition Team with FAA, DHS, and DoD
- **125+** industry and academia collaborators and increasing
- Working groups on UTM services
- Initial UTM Concept of Operations: Industry, academia, and government
- UTM Client interface is ready – **You can connect with UTM**
- **TCL1 tests** with 12 partners completed
- **International interest**

Next Steps

- Development, simulations, and testing of UTM TCL 2-4
- Safety analysis

- 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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