

# Unmanned Aerial Systems Traffic Management (UTM)

**SAFELY ENABLING UAS OPERATIONS  
IN LOW-ALTITUDE AIRSPACE**

NEXTGEN

NASA

<http://www.utm.arc.nasa.gov>

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# Requirements are Different



[http://www.kcet.org/updaily/socal\\_focus/history/la-as-subject/7th-and-broadway.html](http://www.kcet.org/updaily/socal_focus/history/la-as-subject/7th-and-broadway.html)

1920, Photo Collection, Los Angeles Public Library

# Low-Altitude Unmanned Aerial System Operations



Goal: Ensure safe and efficient operations



# NASA's UTM Research Goals and Characteristics



- Conduct research, development and testing to identify airspace operations requirements to enable large-scale visual and beyond visual line of sight UAS operations in the low-altitude airspace
  - Collaborate with FAA, DOD, DOI, and DHS through Research Transition Team
  - Collaborate and leverage industry capabilities and insights
  - Partner with FAA test sites for testing
  - Partner with FAA COE for key research needs
- Use build-a-little-test-a-little strategy – remote areas to urban areas
  - Low density: No traffic management required but understanding of airspace constraints
  - Cooperative traffic management – Understanding of airspace constraints and other operations
  - Manned and unmanned traffic management – Scalable and heterogeneous operations
- UTM construct consistent with FAA's risk-based strategy
- UTM research platform is used for simulations and tests
- UTM offers path towards scalability

# Balancing Multiple Needs



## NATIONAL AND REGIONAL SECURITY

Protecting key assets

## SAFE AIRSPACE INTEGRATION

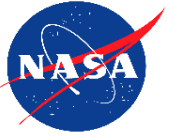
Mantra 1: Flexibility where possible and structure where needed

Mantra 2: Risk based- Geographical needs, application, and performance-based airspace operations

## SCALABLE OPERATIONS FOR ECONOMIC GROWTH

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

# Principles and Services for Safe Integration



- Principles
  - Authenticated users and UAS are allowed to operate in the airspace
  - UAS stay clear of each other
  - UAS and manned aircraft stay clear of each other
  - UAS operator has complete awareness of airspace and other constraints and stay clear of them
  - Public safety UAS have priority over other UAS
- Key UAS related services
  - Authentication
  - Airspace configuration and static and dynamic geo-fence definitions
  - Weather and wind prediction and sensing
  - Conflict avoidance (e.g., airspace notification, V2V)
  - Demand/capacity management
  - Large-scale contingency management – GPS outage, cell outage, etc.
- Research prototype is cloud-based
- UTM research identifies roles and responsibilities of operator, air navigation service provider, and UAS support service providers

# Defining UAS Operator and ANSP/UTM Roles



## UAS Operator

- Work with Original equipment manufacturer
- Communication, Navigation, and Surveillance (CNS)
- Register
- Train/qualify to operate
- Avoid other aircraft, terrain and obstacles
- Respect airspace constraints
- Avoid incompatible weather

Through

- Performance-based regulation where practical
- Limited categories of operator types, matched to regulations

**Third-party entities may provide support services but are not separately categorized or regulated.**

## Air Navigation Service Provider (ANSP)

### → *UAS Traffic Management (UTM)*

- Define airspace constraints
- Foster collaboration among UAS operators to deconflict their operations
- Where demand warrants, provide air traffic control

Through

- Near real-time airspace control
- Where it is needed, air traffic control integrated with manned aircraft traffic control

# UAS Operator/UTM Functions

## UTM: AIRSPACE MANAGEMENT

- Notifications accessible to UAS operators and public
- Static (like TFR) and dynamic (like security or public health scenario)

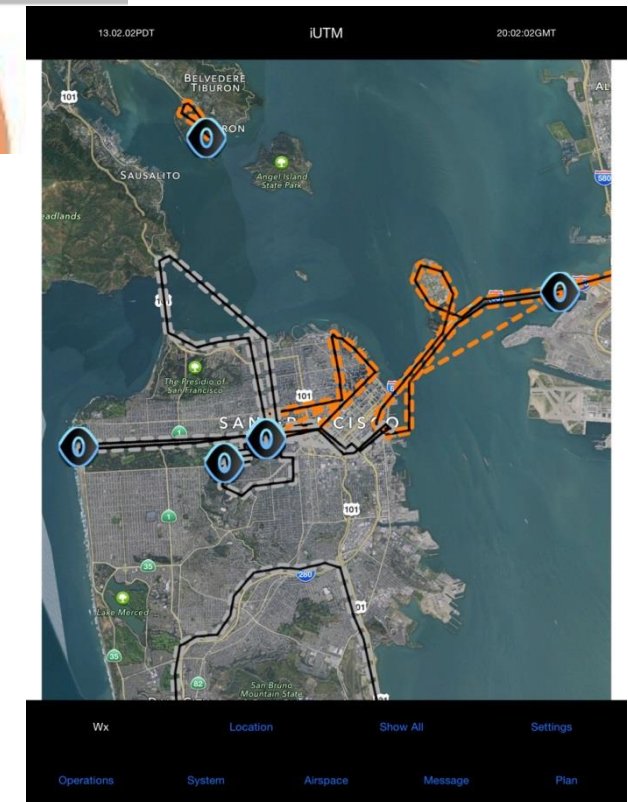


## UAS OPERATOR

- Broadcast identity (and possibly intent)
- Operations accessible by all
- No anonymous flying



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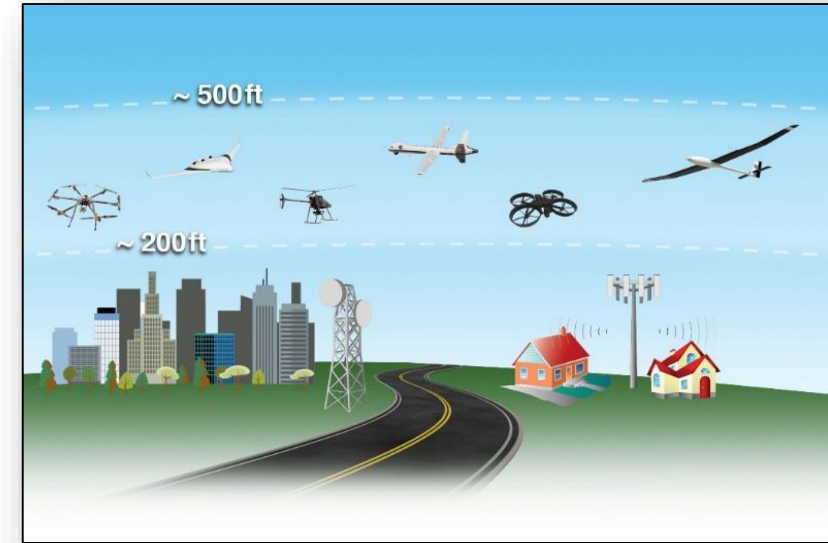




# UAS Operator/UTM Functions

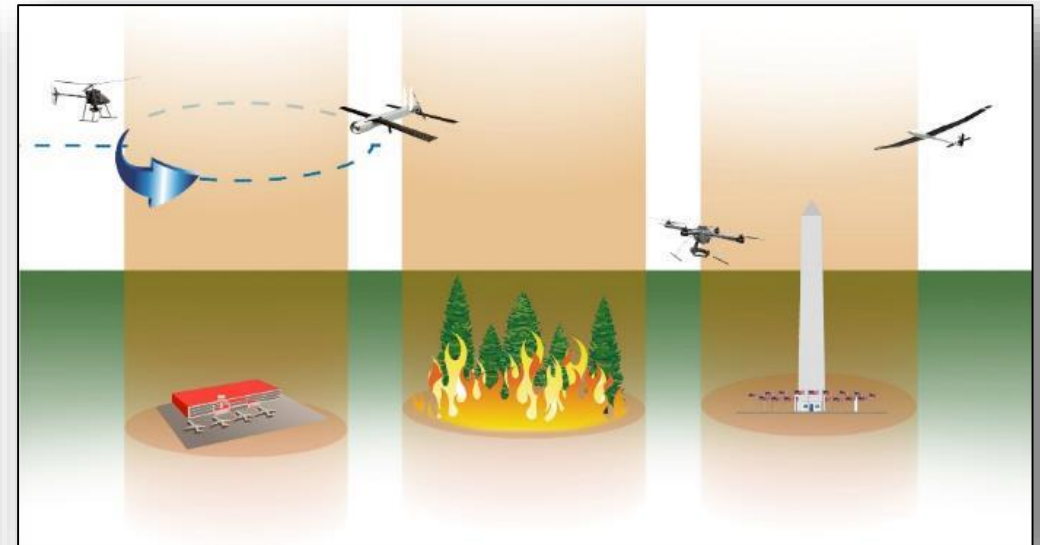
## UTM: EXAMPLE AIRSPACE MANAGEMENT

- Consider other traffic and underlying environment
- Can be keep-out or keep-in requirement
- May be static or dynamic (near-real time)



## UAS OPERATOR:

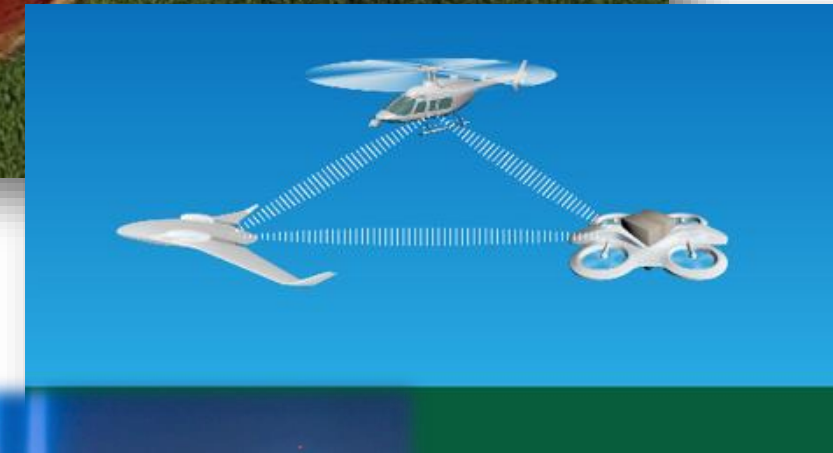
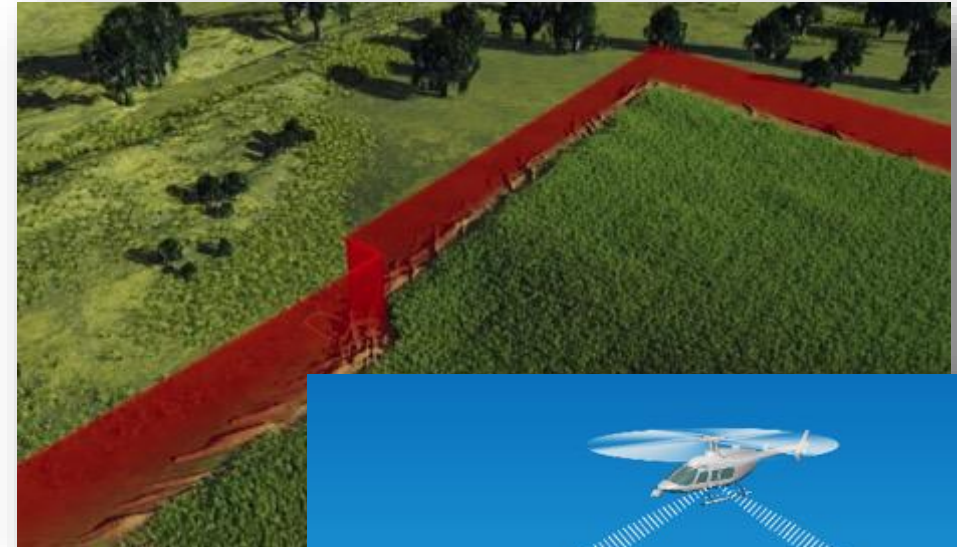
- Operator can comply through geofences or operational control



# UAS Operator/UTM Functions

## UAS OPERATOR: TRAFFIC AVOIDANCE

- Detect Sense And Avoid (DSAA) to manned aircraft predicated on right of way
- Status and intent exchange in accordance with standards
- Collaborative decision making
- Contingency planning and response (system outages, unreported weather, etc.)



## UTM: ENABLE COLLABORATIVE EXCHANGE

- Standards for publish and access
- If needed, provision of data repository



## ROUTE STRUCTURE

- Only where needed for safety or efficiency of flight
- Procedural rules-of-road (corridors, altitudes, etc).

## AIR TRAFFIC CONTROL

- Integrated with manned air traffic control, where positive UAS control is required for safety or efficiency of flight
- Static or dynamic application (e.g., ability to respond in crisis situation where sustained mixed operations are required)

## FLOW CONTROL

- Only where needed for safety or efficiency of flight
- Manage access into areas of operation, not particular operation

*Mantra 1:*

*Flexibility where possible and structure where needed*

*Mantra 2:*

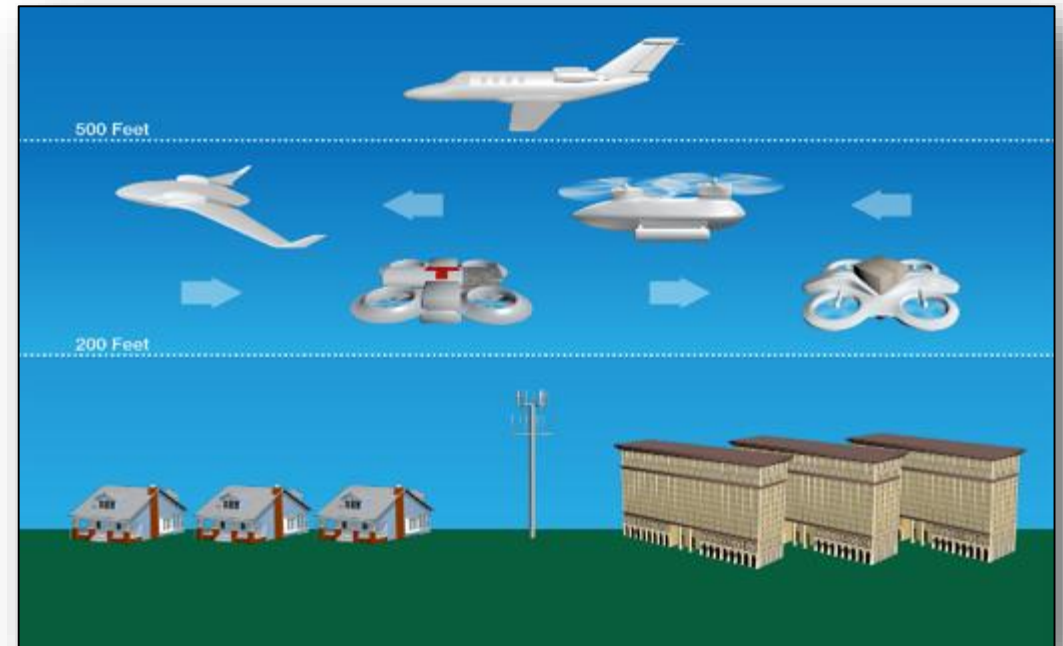
*Risk based- Geographical needs, application, and performance-based airspace operations*

# Supporting Functions



## WIND & WEATHER INTEGRATION

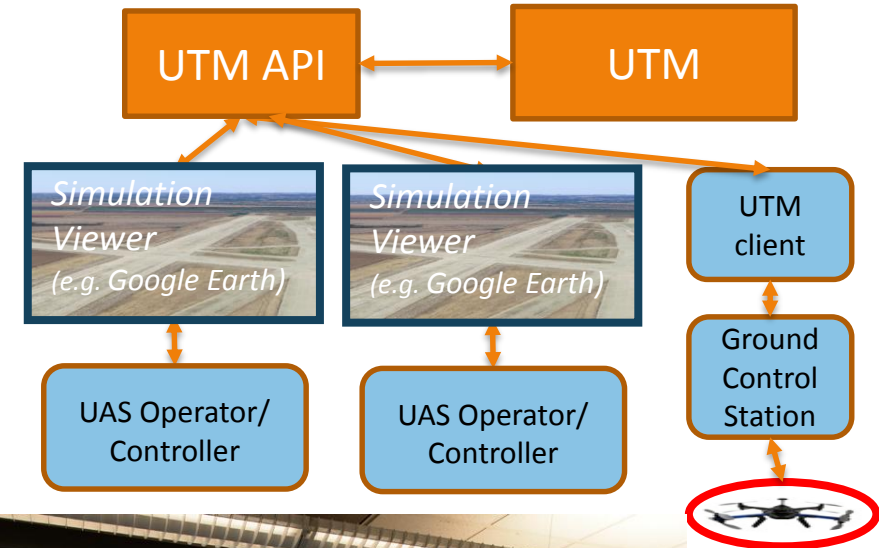
- Operator responsibility, may be provided by third party
- Actual and predicted winds/weather
- No unique approval required



# NASA UTM Simulation Capabilities



- Validation and Verification of UTM research prototype functions
- Develop, demonstrate, and evaluate advanced UTM services and operations
- Develop tools and procedures to manage UTM ops
- Accelerate and increase value of field tests and provide live virtual constructive (LVC) environments
- Simulate complex operations that cannot be done in the field (e.g. urban ops, 911 type scenarios)



# UTM Research Technical 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 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

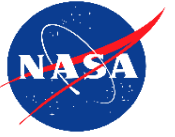
## CAPABILITY 2 (OCTOBER 2016)

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

## CAPABILITY 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

# Working Groups



- Collaborations in place with over 200 partners: industry, academia, and government are all represented
- Leveraging this by frequently meeting, obtaining solid stakeholder buy-in early and often on concepts
- Establishing semi-formal working groups to tackle specific issues, open to all of our collaborators to participate

## Current Working Groups

### Flight Planning

Ease use of the UTM System by developing services to bridge operators to UTM during flight planning. Additional services such as terrain checking, fleet optimization are possibilities

### Conformance Monitoring

Ensure operations are staying where they said they would stay. Potential predictive capabilities to catch non-conformance as soon as possible.

### Separation Assurance

Help monitor and alert for potential conflicts. Offer potential solutions to conflicts before vehicle to vehicle solutions are required.

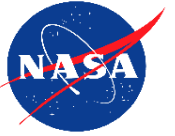
### Public Safety

Allow access to the airspace for public safety functions: police, fire, medical, national security, etc. Develop standards for prioritization of access.

### MultiUTM

Develop concepts for enabling multiple UTM instances to communicate. Potentially allow for several different UTM Service Suppliers.

# National Safe UAS Integration Campaign



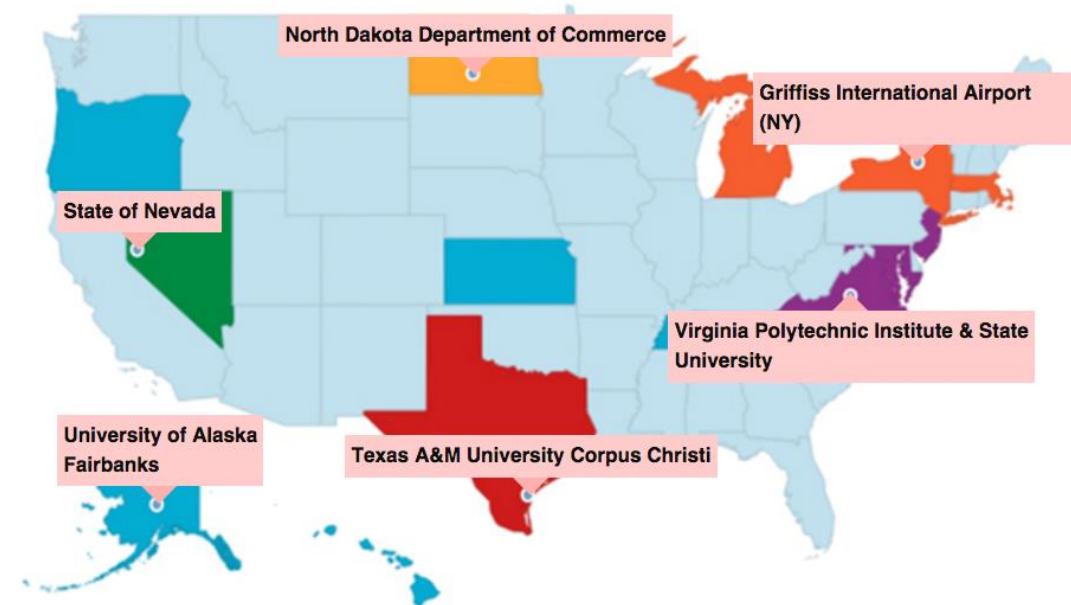
**What:** Demonstrated management of geographically diverse operations, 4 vehicles from each site flown simultaneously under UTM

**Where:** All 6 FAA UAS Test Sites

**Who:** NASA, Test Sites, support contractors

**When:** 19 April 2015

**24 live vehicles, over 100 live plus simulated flights under UTM in one hour**



Obtain detailed feedback from the FAA Test Sites on the UTM concepts, technologies and operations

Learn what requirements might be needed for management of geographically diverse operations



# NuSTAR: Performance Benchmarking for sUAS



- Performance benchmarking: responsible, credible, collaborative
- National UAS Standardized Testing and Rating (NuSTAR)
- Parallel: Underwriter's Laboratory, Consumer Reports, JD Powers, Which?
- Credible test bed and scenarios
  - Drop tests
  - 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, etc.
- Support UAS manufacturers, consumers, insurance companies, and public at large through objective assessments for self-certification to meet FAA requirements
- Forensics analysis: Re-creation of incidents and accidents

# Summary and Next Steps



- NASA works closely with many industry, academia, and government partners
- NASA and FAA have established Research Transition Team (RTT) to collaborate on UTM research – includes DOD, DHS, DOI
- NASA has over 200 collaborators and various work groups
- Test four technical capability levels
- Initial technical capability level 1 was initially tested in August 2015
- Capability 1 was further successfully tested simultaneously with all six FAA test sites
- Capability level 2 will be tested in October (target: Beyond Visual Line of Sight)
- Continue collaboration with all