



# SAFELY ENABLING LOW-ALTITUDE AIRSPACE OPERATIONS

## Unmanned Aerial System Traffic Management (UTM)

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University of Florida Seminar 2015

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*“...a million drones under people’s Christmas trees this year.”*

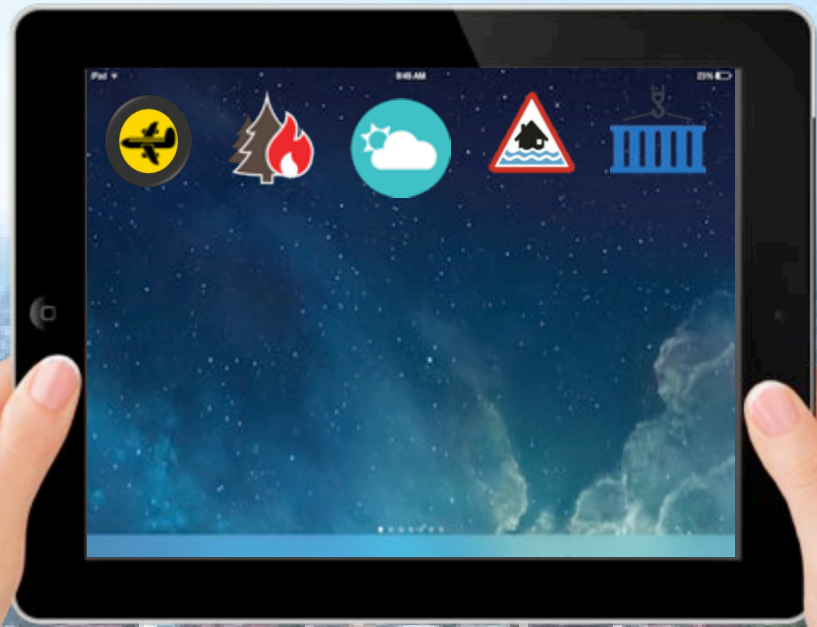
*- Rich Swayze, FAA*

*Consumer*



*Public Service*

*Commercial*



A woman and three children are sitting on a plaid picnic blanket in a grassy field. The woman is smiling and looking at the children. There is a wicker picnic basket in front of them. In the sky above, several drones are flying, some in a circular pattern. The background shows a line of trees under a blue sky with light clouds.

*Safety Security Privacy*

# Integration Challenges

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## Technology

Detect and Avoid  
Command and Control  
Human Factors / Autonomy  
Contingency Management  
Size, Weight, and Power  
GPS-Denied Environment  
Security

## Public

### Acceptance

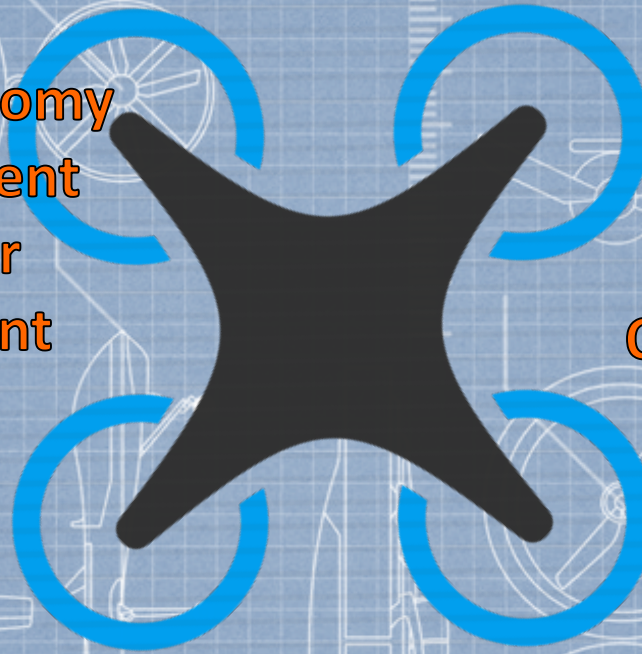
Perception of risk, benefit and capability  
Privacy, Liability, Admissible Evidence (Legal)  
Ethics  
Noise/Environment  
Politics and Media

## Regulation

Airworthiness  
Certification  
Registration  
Safety Case  
Separation Standards  
Operational Flight Rules

## Economics

Business Model  
Size of Market  
Volume and Demand  
Market Inertia  
Market Entry Strategies  
Return on Investment



**Allowed Operations:**  
**Model Aircraft**  
**Public Operations**  
**Civil Operations**



**Rules:**

**Section 333 Exemption and (COA)**

**Special Airworthiness Certificate (COA)**

**Visual Line of Sight or Chase Plane**

**Sparsely Populated Areas**

**Don't Fly within 5 mile of Airports**

**No Reckless Operations**

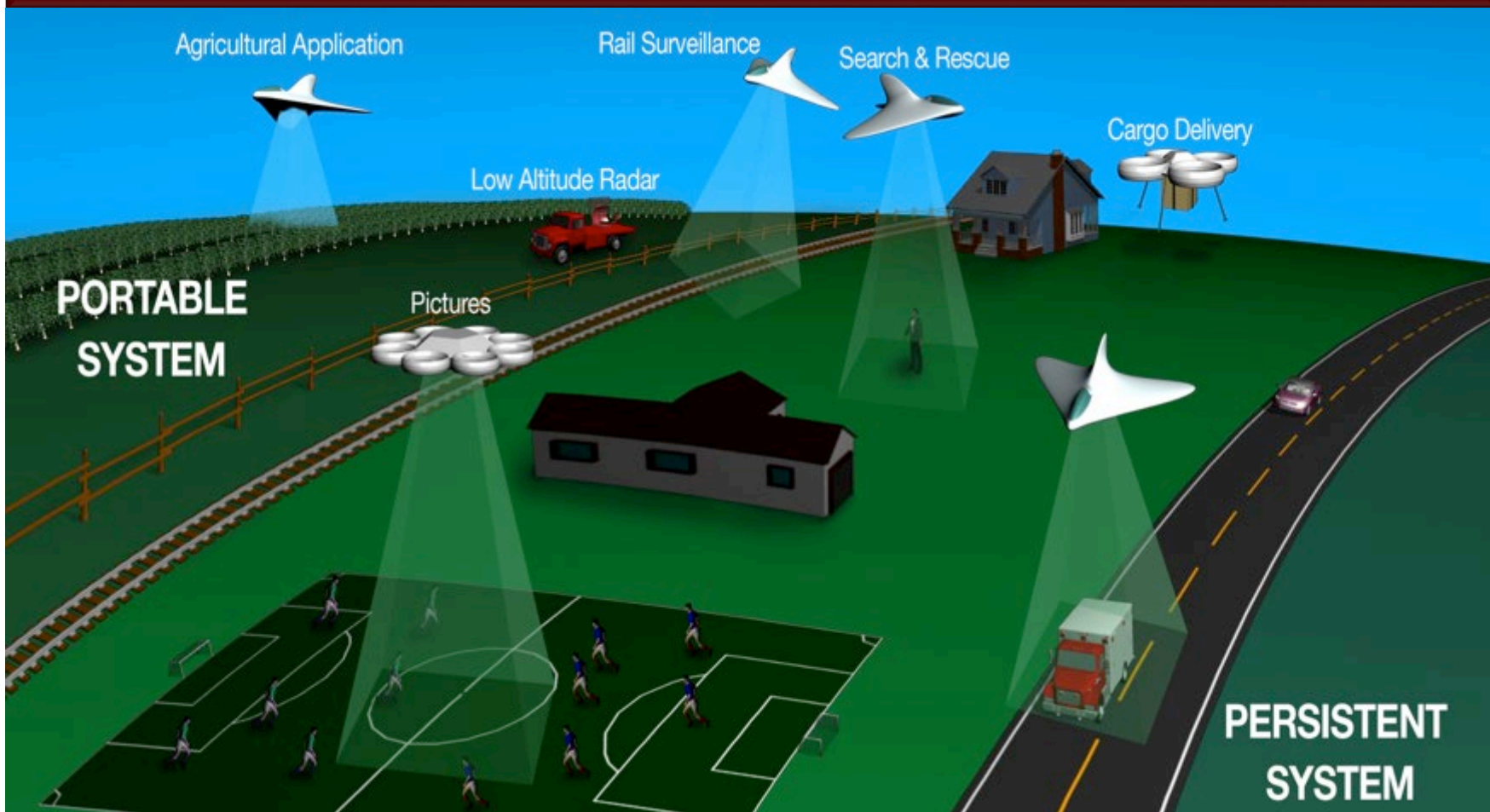


# Grand Canyon June 1956

# 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





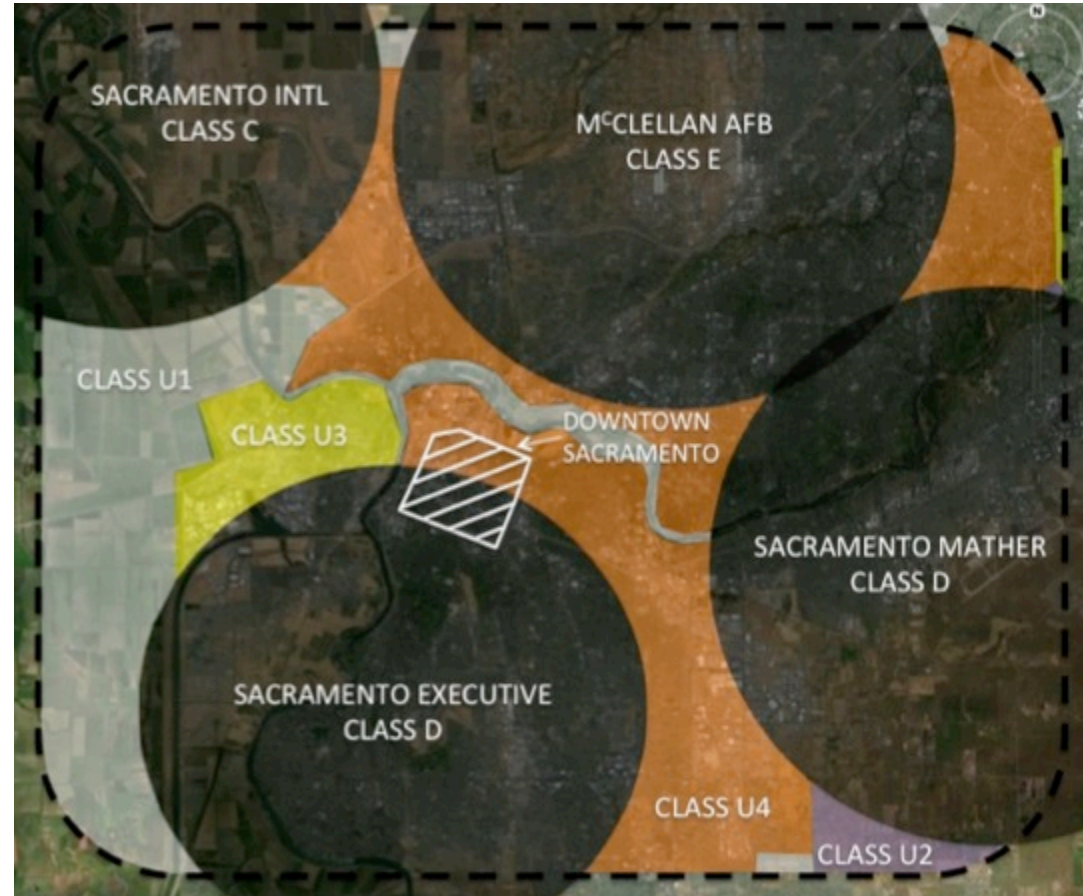
# Airspace Managed by UTM

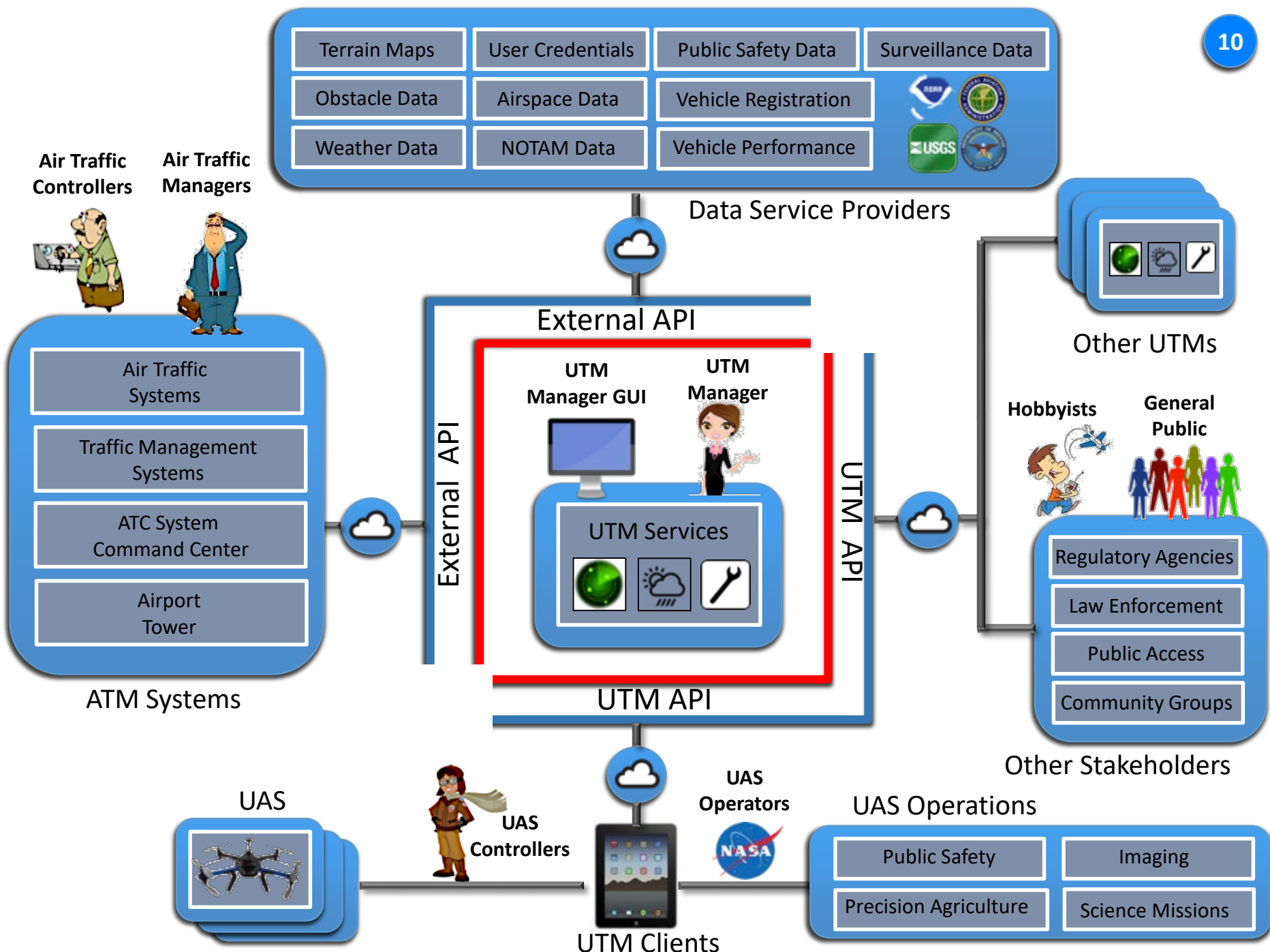
## Based upon four risk-based criteria:

- Population Density
- Density of Man-made Structures
- Likelihood of Manned Operations
- Number of UTM operations

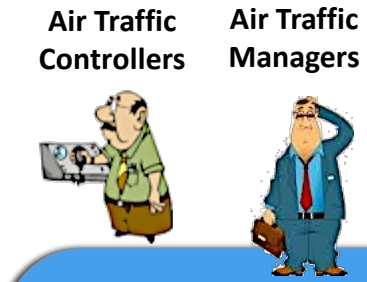
## Bounded by

- Jurisdiction and Airspace Management Authority
- UTM Connectivity





Terrain Maps	User Credentials	Public Safety Data	Surveillance Data
Obstacle Data	Airspace Data	Vehicle Registration	
Weather Data	NOTAM Data	Vehicle Performance	



**ATM Systems**

- Air Traffic Systems
- Traffic Management Systems
- ATC System Command Center
- Airport Tower

**External API**

**UTM Manager GUI**   **UTM Manager**

**UTM Services**

- 
- 
- 

**UTM API**

**Other UTMs**

**Hobbyists**   **General Public**

**Other Stakeholders**

- Regulatory Agencies
- Law Enforcement
- Public Access
- Community Groups

**UAS**

**UAS Controllers**   **UAS Operators**

**UTM Clients**

**UAS Operations**

- Public Safety
- Imaging
- Precision Agriculture
- Science Missions

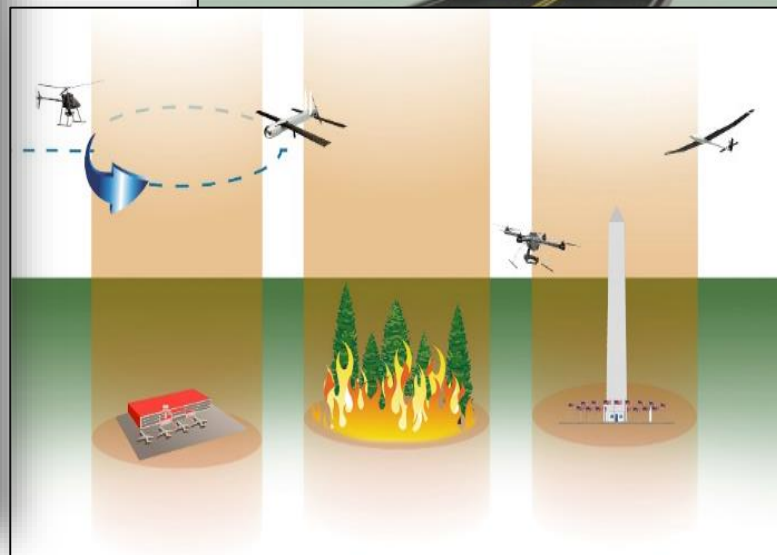
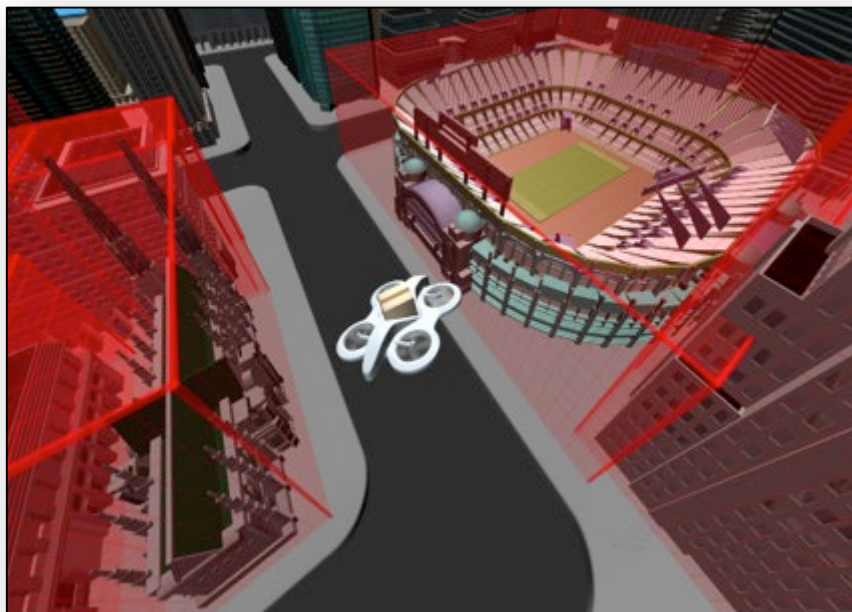
# UTM Services



# 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

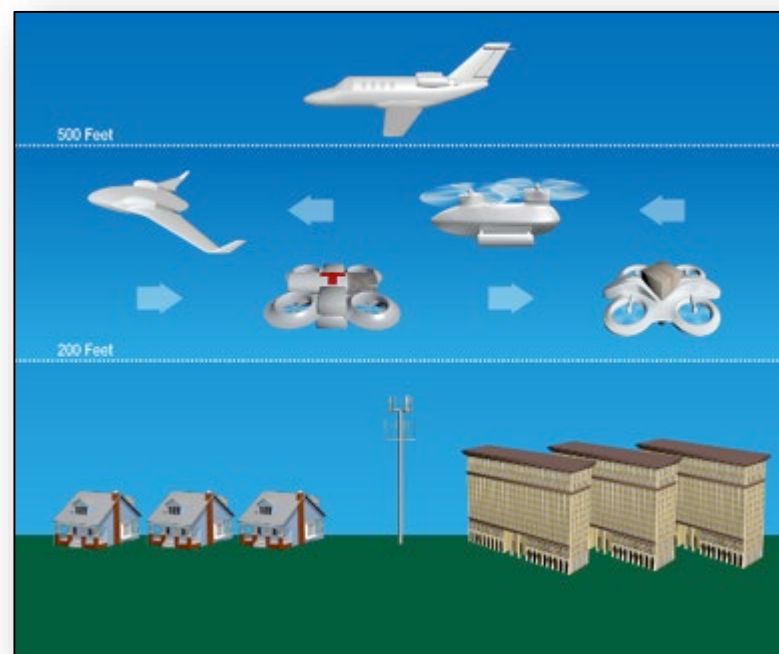
## WIND & WEATHER INTEGRATION

- Actual and predicted winds/weather



## CONGESTION MANAGEMENT

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



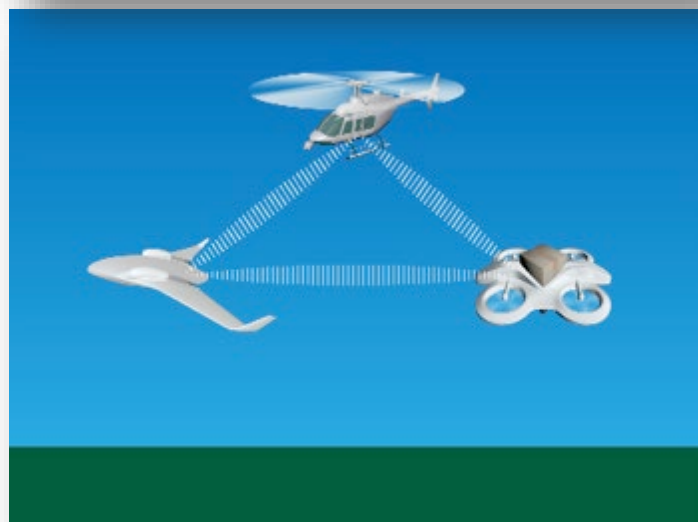
# UTM Functions

## SEPARATION MANAGEMENT

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

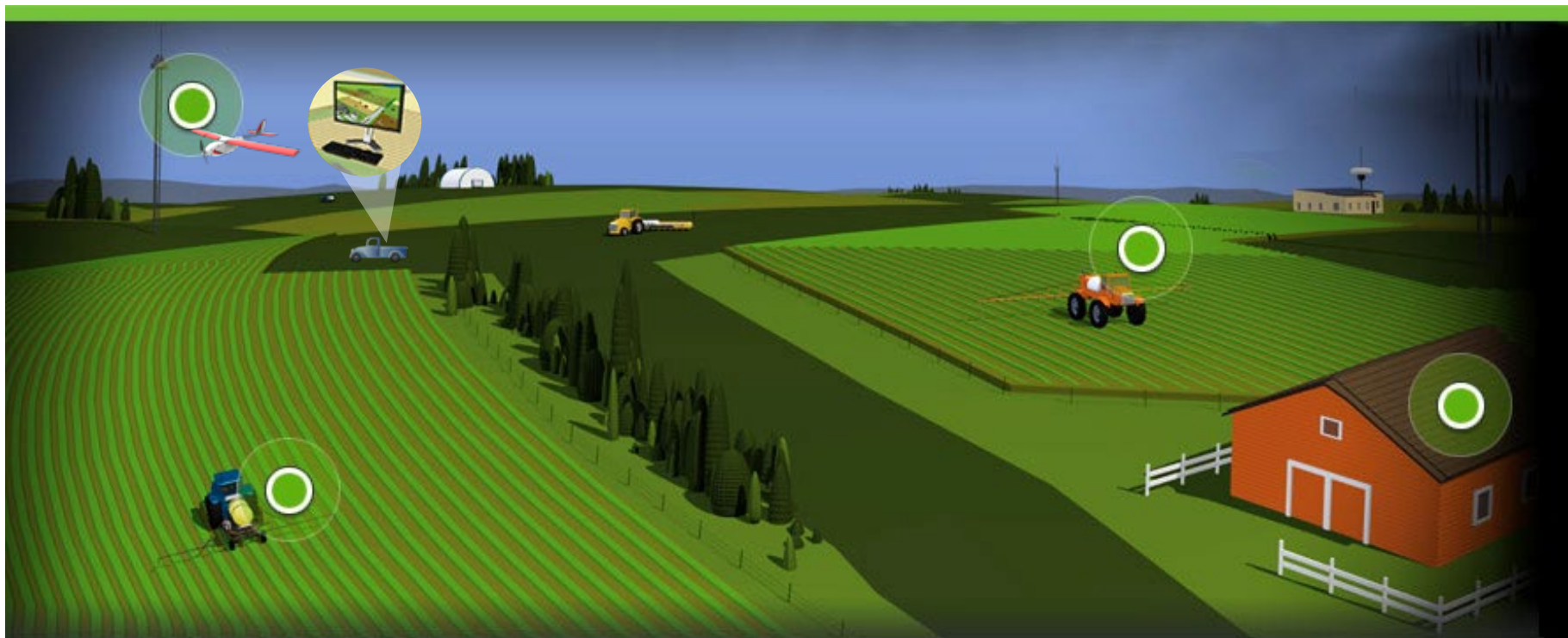
## CONTINGENCY MANAGEMENT

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



# Example Use Case: Precision Agriculture

- 1 Operation Plan Submitted (4am) – LOS, 200 ft AGL, 6-7:30am, Circular Pattern (0.25 NM radius)
- 2 Operation Plan Rejected- Building Over-flight
- 3 Operation Plan Resubmit- Accepted



- 4 UAS Controller Observes Clear Skies and sends “ALL CLEAR” message to UTM (5:55am)
- 5 Aircraft Takes Off (6:00 am)
- 6 UTM Reports Adverse Weather- UAS Controller continues (6:30 am)
- 7 Mission Complete- UAS Lands (7:15 am)
- 8 UAS Controller Terminates Operation Plan (7:20 am)

## Build 1: August 2015

Line of Sight Operations

Low Risk Environment

Airspace Reservation

Geo-fencing for Separation

No Fly Zones

User Authentication

## Build 2: October 2016

Beyond Line of Sight Operations

Low Risk Environment

Segmented Flight Plans

Weather and Traffic Advisories

Altitude Stratification

Contingency Management (Alerting)

System Health Monitoring





## Build 3: January 2018

Beyond Line of Sight Operations  
Suburban Environment  
In-Flight Separation Provisions  
Contingency Management (Resolutions)  
On-demand Public Service Operations  
Spectrum Management  
Interacting UTM's  
Limited Connections to ATM  
Weather and Traffic Avoidance

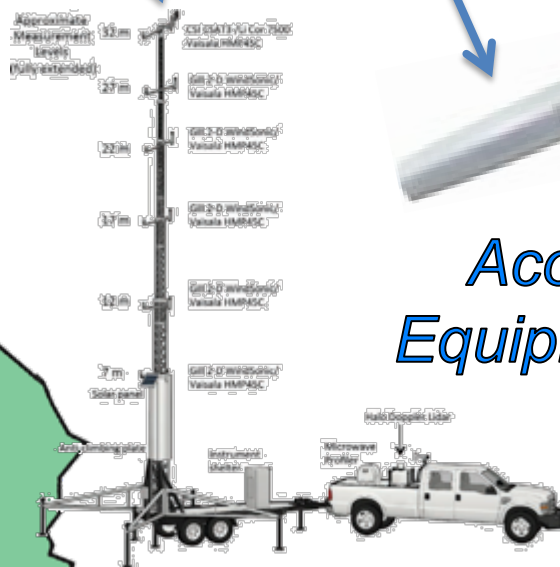
## Build 4: March 2019

Beyond Line of Sight Operations  
Urban Environment  
Detect and Avoid  
GPS-Denied Environments  
Large Scale Contingency Management  
Dynamic Airspace Reconfiguration  
High Density Operations



# UTM Build 1 Flight Test

## Crows Landing, CA



*Acoustic Equipment*



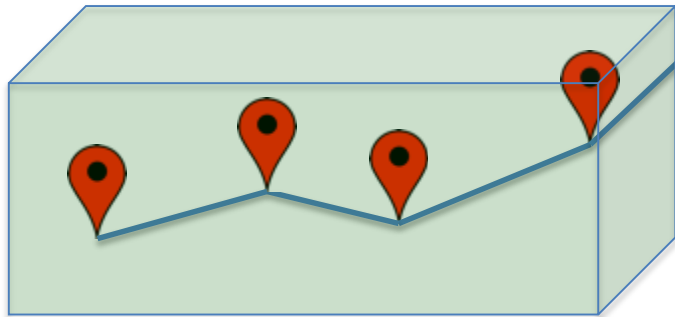
*Surveillance Equipment*

*Weather Equipment*

# Demonstration Objectives



**Objective 5:** Collect Data on Noise Signature of UAS Vehicles

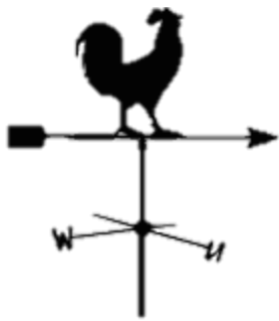


**Objective 2:** Collect Data on UAS Navigation Performance Error



**Objective 1:** Demonstrate UTM Capabilities

**Objective 3:** Collect Data on Aircraft Tracking Performance



**Objective 4:** Collect Weather Observations for Forecasting Models

# Partnerships



# UTM Build 1 Demonstration Highlights

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- **8 Different types of UAS (2 fixed wing, 6 multi-rotors)**
- **Variety of surveillance, weather, and acoustic equipment**
- **Flight included 2 aircraft conducting missions simultaneously**
- **General Statistics:**
  - **108 flights over 8 days**
  - **~18 hours of flight time**
  - **Flights averaged about 11 minutes (ranging from 2- 38 minutes)**
- **Data analysis is being conducted and a draft report is expected by the end of Nov. 2015**

# Concluding Remarks

- **UAS is a divisive, multi-faceted topic**
- **A variety of integration challenges need to be overcome**
- **UTM is a solution to safely manage airspace for UAS operations**
- **Near-term goal is to safely enable initial low-altitude operations within 1-5 years**

