Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NASA

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

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Applications of Unmanned Aerial Systems

- Public Safety
- Deliveries
- Surveillance
- Weather Monitoring
- Agriculture
- Mapping
- Disaster Relief
- Entertainment
http://www.kcet.org/updaily/socal_focus/history/la-as-subject/7th-and-broadway.html
1920, Photo Collection, Los Angeles Public Library
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
**Challenge and Opportunities**

- Challenge: Acceptance of large-scale UAS operations in low altitude airspace
  - Airspace operations requirements: technology and procedures
  - Safety
  - Privacy policy
  - Security
  - Noise
  - Public perception

- Economics: Safe, secure, and scalable “Beyond visual line of sight” operations

- Opportunities: Technology advancements and new business models
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 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

PRODUCT: Validated airspace operations requirements
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.
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
Information Flow

1. Operator submits operation (waypoints; vehicle info; operator data)
2. Check if UVIN is registered
3. Check static constraints
4. Check dynamic constraints
5. Contingency Management
   - Geo-fence breach
   - Loss of C2
   - Emergency responder
6. Operation completed

UTM Services

UTM Vehicles Registration

Vehicle Performance Database

Dynamic Constraints
- Weather
- Conflict Detection
- Feasibility

Model-Based Trajectory Constraint Check

Schedule delivery to ...

Check if UVIN is registered

Check static constraints

Check dynamic constraints

Operator submits operation (waypoints; vehicle info; operator data)

Contingency Management
- Geo-fence breach
- Loss of C2
- Emergency responder
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
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.

Single service provider: government entity
- Traditional ANSP, like the FAA
- Each state may implement or delegate to counties/cities

Single service provider: a non-government entity
- Web services - General Aviation flight service station model

Multiple service providers: state/local government entities

Multiple service providers: non-government entities
- Regional implementations by various companies - customized

UTM POTENTIAL BUSINESS MODELS

Web services - General Aviation flight service station model
- Each state may implement or delegate to counties/cities
- Regional implementations by various companies - customized

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

- **Air Traffic Controllers**
  - Makes strategic decisions to ensure safety, efficiency and equity of the UTM Airspace

- **Hobbyists**
  - Can use UTM information services for safety

- **Manned Aircraft Pilot**
  - Reviews UAS operations prior to take off, maintains situation awareness for safety

- **General Public**
  - Can use UTM information services for safety, privacy, and security concerns

- **UTM Manager**
  - Makes strategic decisions to ensure safety, efficiency and equity of the UTM Airspace

- **UAS Controllers**
  - Responsibly for the safe conduct of UAS vehicle(s)

- **UAS Operators**
  - Legal entity that requests access to UTM airspace and manages UAS operations
Progress

- Research Transition Team with FAA, DHS, and DoD
- 200+ industry and academia collaborators and increasing
- Initial UTM Concept of Operations: Industry, academia, and government
- Technical Capability Level 1 with 12 partners completed
- Technical Capability Level 2 in October 2016
- International interest
Opportunities: Research and Technology

- Beyond visual line of sight autonomous operations
- Tracking and locating every vehicle: Cooperative and non-cooperative
  - Cell/wireless, Automatic Dependent Surveillance, Satellite, localized beacon based systems
- Sense and avoid
  - Other vehicles (V2V) as well as objects such as wires
- Command, control, and communications without aviation certified systems: cell phone, etc.
- Last/first 50 feet: sensors, hardware, and software for autonomous operations
- Security
Policy and Public Acceptance

- Policy
  - Acceptable noise
  - Privacy considerations
  - Transportation safety

- Public Acceptance
  - Humanitarian applications: Disaster relief, medicine delivery, etc.
  - Public safety: Traffic, bridge inspections
  - Agricultural: Large remote areas
  - Commercial: Cargo and package delivery
  - Personal applications: roof top inspection

- Crawl-walk-run strategy – from remote areas to urban areas
Next Steps

- Development, simulations, and testing of UTM Builds 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
• 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, etc.

• Support UAS manufacturers, consumers, FAA, insurance companies, and public at large through objective assessments

• Forensics analysis: Re-creation of incidents and accidents
Questions

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