Drone Information Service Requirements for U-Space

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1910: Car introduction
1. Automobiles traveling on country roads at night must **send up a rocket every mile**, then **wait ten minutes** for the road to clear. The driver may then proceed, with caution, blowing his horn and **shooting off Roman candles**, as before.

2. If the driver of an automobile sees a team of horses approaching, he is to stop, pulling over to one side of the road, and **cover his machine with a blanket or dust cover which is painted or colored to blend into the scenery**, and thus render the machine less noticeable.

3. In case a horse is unwilling to pass an automobile on the road, the driver of the car must **take the machine apart as rapidly as possible** and conceal the parts in the bushes.
Contents

- Goal
- Method
- Gap identification
- Proposed solutions

Goal

To identify the gaps that have to be filled to provide drone operators/users with

comprehensive information services

to conduct

safe flights in VLL airspace.

(DREAMS, Grant Agreement 2017)
Method used

Recommendations

- U-Space
- High Level Services
- Survey
- Scenarios
- Drone Op/User Requirements
- Gap Analysis
- Proposed Solutions

Current UTM Service Providers

Manned Aviation SWIM Services

Existing manned/unmanned aviation information services
On-line Web Survey

Questions on:

1. Typical Drone Applications
2. Typical Operational Altitude
3. Urban Environment Flights
4. Flight Operations data
5. Flight Operational Risks
6. Time demanding pre-flight phase activities
7. Real-time info for BVLOS flights
8. Mandatory BVLOS flight planning data

Two cohorts:

1. Drone Operator & User (n=108)
2. Manned Aircraft pilots & authorities (n=45)
Scenarios identification

1. Electronic registration
2. Concurrent operations
3. Territory control
4. Cooperative geo-tagging
5. Controlled traffic zone crossing
6. Long-range operations (BVLOS)
7. De-confliction management
8. Emergency management
9. Capacity management
10. Reconnaissance and personal mobility
Existing manned/unmanned aviation services

Relevant manned aviation information services:

- **Airport information** services
- **Planning**, performance monitoring and analysis information
- **Flow and capacity management**
- **Flight data** services (real-time)
- **Flight planning** information
- **Communication/Surveillance** services

Unmanned aviation information services:

- **Flight planning** and validation
- **Local weather** information
- **Mission planning**
- **Geofencing**
- **NOTAM** advisory
- **Local rules and regulation** awareness
- **Remote identification**
- **Geospatial** data
- **Real-time tracking** and monitoring of unmanned traffic
Gap Identification & Analysis

Seven key information categories:

1. Flow management
2. Meteorological
3. Environment
4. Flight data
5. Communication
6. Surveillance
7. Drone
1. Flow management information

- De-confliction management
- Congestion management
- Hyperlocal airspace data
- Dynamic geofencing
- Urban airspace capacity management
- High-density traffic management
- Urban airspace conflict risk mitigation
- First/last 50ft of operations guidance
1. Flow management information

- De-confliction management
- Congestion management
- Hyperlocal airspace data
- Dynamic geofencing
- Urban airspace capacity management
- High-density traffic management
- Urban airspace conflict risk mitigation

Geofencing

*Limit 3D position*

Geocaging

*Limit 3D position*

Geovectoring

*Limit 3D speed vector*

Dynamic & static

**Geovectoring (ICRAT)**

Capacity management
Proposed solutions: *Bridging the gap*

1. Flow management

**Flow management gap:**
- De-confliction management
- Congestion management
- Urban airspace intrinsic and strategic conflict risk assessment
- Urban airspace capacity management
- High-density traffic management
- First/last 50ft of operations guidance
- Hyperlocal airspace data
- Dynamic geofencing

**Proposed solutions**
- Tactical *Conflict Detection & Resolution* (de-centralized)
- Introduce surge/*dynamic pricing*
- Use *geovectoring* to manage high-density traffic
- Use intrinsic *airspace constraints* for first/last 50ft of operations
- Use *dynamic geovectoring* for first/last 50ft of operations
- *Google street view concept to 500 ft & augment*
- Manage *hyperlocal airspace* data
- Geo-tagging and geo-marking *dynamic obstacles*
2. Meteorological information

- **Past, present and future** hyperlocal weather information;
- Sudden atmospheric warnings based on observations: e.g. hyperlocal **wind gusts** in urban environments.

Source: KIT, Germany
Proposed solutions: *Bridging the gap*

2. Meteorological information

**Met information needs**

- Past, present, future hyperlocal Wx forecast
- Sudden warnings

**Proposed solutions**

- Install **hyperlocal** Met sensors for data capture
- **Drone to Everything** (D2X)
- **Crowd source** data
- Scale and extrapolate hyperlocal Wx services
3. Environment information

- Geometrical data (height, dimension, coordinates):
  - **Permanent obstacle** data
  - **Non-permanent obstacle** data
- **Population** density of overflown areas
- Advisory of uncontrolled traffic e.g. *birds*
Proposed solutions: *Bridging the gap*

3. Environmental information

**Environmental data needs**

- (Non)Permanent obstacles
- Geometrical data
- Population density of overflown areas
- Advisory of uncontrolled traffic

**Proposed solutions**

- Collaborate and coordinate w/ CityGML, 3D model and BIM communities (A. Petrovsky et al., 2018)
- Provide a tool to compute population density of overflown areas e.g. World Bank data
- **D2X concept** for bird movement
- On-board **drone imagery** devices to provide situational awareness on **non-permanent obstacles such as cranes**

* See also TU Delft MAVLab publications: [http://mavlab.tudelft.nl/publications/](http://mavlab.tudelft.nl/publications/)
4. Flight information

- Flight planning assistance
- Optimal altitude allocation data
- Flight risk analysis
- Vert/horiz. separation guidance
- Real-time telemetry
- Contingency management
- Emergency management

Proposed solutions: *Bridging the gap*

4. Flight information (1/2)

**Flight** data needs:
- Flight planning assistance
- Optimal altitude allocation data
- Flight risk analysis
- Vert/horiz. separation guidance
- Real-time telemetry
- Contingency management
- Emergency management

**Proposed solutions:**
- Optimal *flight route planning* assistance
- An *optimal altitude* decision engine
- *Flight risk data*
- Dynamic Vert/Horizontal separation minima (function of airspace capacity, physical constraints & drone specs)
Proposed solutions: *Bridging the gap*  
4. Flight information (2/2)

**Flight data needs:**
- Real-time telemetry
- Contingency management
- Emergency management

**Proposed solutions:**
- OEM’s, mandated to provide real-time **telemetry**: battery status, estimated endurance, min/max velocity, min/max vert speed, altitude ceiling
- Telemetry data w.r.t. potential conflicts with other traffic etc.
- **Text-based instructions** for emergency landing events
- European Drone Crisis Coordination Cell
5. Communication information

- Hyperlocal GNSS and 4G/5G coverage map
- ATC-Drone operator/user datalink
- U-Space instant message service
- High-quality video datalink
- Authorities datalink


Source: Doole, M. 2018, TU Delft
5. Communication information

**Coms. Data needs**
- Hyperlocal GNSS and 4G/5G coverage map
- ATC-Drone operator/user datalink
- U-Space instant message service
- High-quality video datalink
- Authorities datalink

**Proposed solutions**
- **GNSS availability tool** e.g. AUGUR (but for hyperlocal level)
- **Cellular network**, mandated to provide **real-time** hyperlocal coverage maps
- **Instant message** services
- Uninterrupted communication bandwidth for **video transfer**
6. Surveillance information

- Real-time unmanned traffic data
- Digital NOTAM management
- Drone incident support
- Traffic monitoring service


Source: WeTalkUAV.com
Proposed solutions: *Bridging the gap*

6. Surveillance information

Info needs:
- Real-time unmanned traffic data
- Digital NOTAM management
- Drone incident support
- Traffic monitoring service

Proposed solutions:
- Invest and install ADS-B receivers
- Mandate all aircraft (esp. at VLL) to be equipped with ADS-B transponders or similar technology*
- Govern and manage open-source surveillance data
- Investigate the use of GPS and GSM tech. for drone tracking
- Investigate the use of SASS-C tool by Eurocontrol
- Govern and manage NOTAM info

*See also poster on CLASS, Surveillance of UAS Traffic ENAC, Airbus, Unifly et al*
7. Drone information

- Vehicle
- Performance characteristics
- Specification data
- Serial number data
7. Vehicle information

Vehicle info needs:
- Drone performance
- Specifications
- Serial numbers

Proposed solutions:
- Mandate OEM to provide all drone performance and specification information directly to U-Space.
- Ensure integrity of data
Results & Conclusions

- Seven key information gap areas were identified
- Majority of existing information services cannot be applied for future unmanned flight
- Current U-Space services only support low densities of traffic
- Urban airspace capacity management, high-density traffic management and separation guidance are critical information services for drone operation in VLL urban airspace
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