UAV Management System based on IoT Platform & U2X Networks

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UAV Market is getting bigger and bigger!

Commercial drone market, 2012 - 2022
(USD Million)

Consumer drone market, 2012 - 2022
(USD Million)


Emerging New Business Using UAVs

UAV Use Cases

UAVs have received a lot of interest in the many service domains:

- **UAV-based delivery service**
  - Image of drones delivering packages.

- **UAV-assisted Agriculture Service**
  - Image of drones spraying crops.

- **UAV-based Security Service**
  - Image of drones monitoring a house.

- **UAV-based Multimedia Service**
  - Image of drones filming a fire.

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IEEE 5G-IoT Summit Helsinki
Numerous Drones

How can they communicate each other for safety?

How can they be managed and controlled?
A Project for U2X (UAV to Everything) networks

Continuous Technology Evolution Required for Safety

- Enhanced Range
- High Reliability
- Low Latency
- High Throughput

Direct Communication

Collision warning
Emergency alert
Cooperative adaptive control
Blind warning
Direct Communication

D2D (Device to Device) Communication

- Direct communication between devices that do not go through infrastructure of a base station or an AP.
- High data rate, Low end-to-end delay.
- More resource and energy efficient.
- Offloading cellular traffic, alleviating congestion, benefitting other non-D2D devices.
- Range extension via relaying.
## Communications for U2X

<table>
<thead>
<tr>
<th>Category</th>
<th>Technology</th>
<th>Data Rate</th>
<th>Range</th>
<th>Latency</th>
<th>Applicability</th>
<th>Note</th>
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</thead>
<tbody>
<tr>
<td>WPAN</td>
<td>Bluetooth 4.0</td>
<td>&lt;1Mbps</td>
<td>&lt;60m</td>
<td>M</td>
<td></td>
<td>ADS-B operation</td>
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<tr>
<td>WPAN</td>
<td>Zigbee</td>
<td>&lt;250kbps</td>
<td>&lt;100m</td>
<td>M</td>
<td></td>
<td>ADS-B operation</td>
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<tr>
<td>WLAN</td>
<td>802.11a/b/g/n</td>
<td>&lt;150Mbps</td>
<td>&lt;250m</td>
<td>L</td>
<td></td>
<td>5Ghz Unlicensed band</td>
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<tr>
<td>WLAN</td>
<td>WAVE 802.11p</td>
<td>&lt;27Mbps</td>
<td>&lt;1km</td>
<td>H</td>
<td></td>
<td>5.9Ghz Licensed band</td>
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<tr>
<td>LPWA</td>
<td>LoRA</td>
<td>&lt;50kbps</td>
<td>&lt;15km</td>
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<td></td>
<td>LoRa Alliance (completed) (Low data rate)</td>
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<tr>
<td>LPWA</td>
<td>SigFox</td>
<td>&lt;100bps</td>
<td>&lt;20km</td>
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<td>ETSI (completed) (Low data rate)</td>
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<tr>
<td>Cellular</td>
<td>NB-IoT (LTE Cat NB1)</td>
<td>&lt;250kbps</td>
<td>World wide</td>
<td>L</td>
<td></td>
<td>3GPP Rel. 13 (completed ‘16.3) (High delay)</td>
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<tr>
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<td>LTE-M</td>
<td>&lt;1Mbps</td>
<td>World wide</td>
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<td>3GPP Rel. 13 (completed ‘16.3) (High delay)</td>
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<tr>
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<td>M</td>
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<td>3GPP Rel. 10 (completed ‘11.3)</td>
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<tr>
<td>Cellular</td>
<td>LTE D2D</td>
<td>-</td>
<td>World wide</td>
<td>H</td>
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<td>3GPP Rel. 14 V2X (completed ‘17.6)</td>
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<tr>
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<td>&lt;10Gbps</td>
<td>World wide</td>
<td>H</td>
<td></td>
<td>3GPP Rel. 15 (‘18)</td>
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</tbody>
</table>
WAVE and LTE-D2D

**WAVE**
- Wireless Access in Vehicular Environments
- Support fast mobility: up to 200 km/h
- Range <1 km, Latency <100ms
- PHY, MAC layer: IEEE 802.11p
- Upper layer: IEEE 1609 series

**LTE-D2D**
- 3GPP: ProSe (Proximity Services)
- 3GPP Rel.12: LTE-D2D only in coverage
- 3GPP Rel.13: Relays and Priority handling
- 3GPP Rel.14: LTE V2X

- WSMP: WAVE Short Message Protocol
- LLC: Logical Link Control
- WME: WAVE Management Entity
- MLME: MAC Layer Management Entity
- PLME: PHY Layer Management Entity
- PDCP: Packet Data Convergence Protocol
- RLC: Radio Link Control
A Project for UAV Traffic Management and Control

How can we manage a lot of UAVs?

- UAV Management System
- Reliable Communication Protocol
- Scalable and Integrated Architecture
- oneM2M-based IoT platform
Overview of Architecture with UAV Management Systems

Enhance oneM2M-based IoT platform for the UAV Management Systems
**Demo Scenario**

**Flying Ad hoc Network**

- Ad Hoc Mode
- Infrastructure Mode (WiFi or Cellular)

**Detection**

- Pedestrian detection (Raspberry Pi 3)
- YOLO detection (NVIDIA Jetson TX2)

**Network Module**

- Wi-Fi/WAVE

**Property**

- ID, Altitude, Longitude, Latitude, Speed, and Direction

**Control Data**

- Command & Control

**Surveillance Data & Sensing Data**

- Surveillance

**Drone as a Service (DaaS)**

- Command & Control
- Surveillance

**Network Mode**

- Ad-hoc Mode
- Infrastructure

**Application**

- Pedestrian detection
- YOLO detection

**Internet**

developers.iotocean.org

GCS

**Flying Ad hoc Network**

1.1.1.1
1.1.1.2
192.168.1.1
192.168.1.2
192.168.1.3
192.168.1.4

**Detection**

- Pedestrian detection
- YOLO detection
UAV, IoT and Platform:
Exploring a Standard-based Approach to Multi-UAV Management System

Korea Electronics Technology Institute (KETI)
Thank You

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