Communication, Processing, and Exchange of Database Information for High Integrity Geo-fences

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Topics

1. Introduction
2. Database Standards
3. Preflight vs. In-Flight Communication
4. Recommendations

How Good is Good Enough?

Flying beyond authorized safe regions is an operational hazard for unmanned aircraft…

"Small Drone Crashes Near White House Despite Ban Against Flights in D.C." ~ USA Today, Oct. 9, 2015

Precision Agriculture Application

but what if we could create a highly-reliable and independent geo-fence? Would that be good enough?

There is currently no cost-effective means to produce a small UAS with high reliability e.g. one out-of-control event per 100,000 flights.

Current methods would likely cripple the industry
- Cost and SWAP of redundant systems
- Complex s/w development procedures & oversight
- Highly constrained operating rules
- Infrastructure for independent monitoring & control

What Could Possibly Go Wrong?

A system is only as good as its weakest link:

(credit: US Army)

$1.5 million, 450 lbs. Shadow UAS.

Traveled over 600 miles after it was lost!

Possible Causes of Geo-fence Failures:

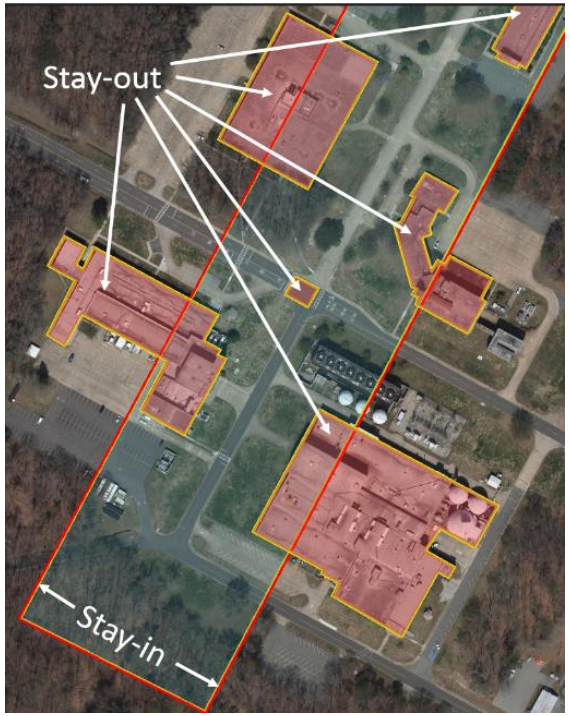
- Loss of Position Data
- Degradation of Position Data
- System Power Failure
- Hardware Failure
- Software Errors
- Failure to Command Contingency Maneuver
- Autopilot (Control Authority) Failure
- Invalid Constraint Data
- Corrupted Database Information
- Erroneous Data Transmission
- Etc.

Application of Existing Standards

Luckily, many applicable standards already exist!

All geofencing database information can be represented as points (with a radius), lines (with a width), and/or polygons (for irregular shapes).

Content, Processing, Exchange, and Quality Assurance can be done in accordance with proven standards for similar data types used in commercial manned aviation:



Example Geo-fences

- DO-200B: Standards for Processing Aeronautical Data
- DO-276C: User Requirements for Terrain and Obstacle Data
- DO-201A: Standards for Aeronautical Information
- DO-254: Design Assurance Guidance for Airborne Electronic Hardware
- DO-272D: User Requirements for Aerodrome Mapping Information
- DO-291C: Interchange Standards for Terrain, Obstacle and Aerodrome Mapping Data
- AC-20-1538: Acceptance of Aeronautical Data Processes and Associated Databases

**Many of these standards are also represented in ICAO SARPS (e.g. Annex 15)*

Preflight vs. In-Flight Communication

Preflight

Preload known geospatial limits from operator and/or UTM using physical connection.

Disadvantages:

- Cannot process changes to geo-fence mid-flight.

Advantages:

- Wireless link to vehicle is not required.
- Errors or conflicts can be determined and handled before operations.

In-Flight

Load/update geospatial limits from operator and/or UTM wirelessly.

Disadvantages:

- Highly reliable wireless link to vehicle is required.
- Errors or conflicts must be autonomously detected and managed.

Advantages:

Can dynamically change geospatial limits (e.g. “pop-up” geo-fence)

Recommendations

- **Move to develop and adopt standards for functions/systems that are safety-critical for certain UAS operations.**

- **Determine which existing standards can be applied to these functions, or where revisions are required.**

- **Conduct a hazard/risk analysis to determine required DPAL (Data Processing Assurance Level) for exchanging geo-fence data.**
  - **transmitted prior to flight**
  - **transmitted during flight**

Questions?

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