Unmanned Aerial System Applications in International Railroads

Eric Sherrock
ENSCO, Inc.
Research and Development Program Manager
Springfield, VA

Cameron Stuart
Federal Railroad Administration
Office of Research, Development and Technology
Program Manager
Washington, DC
Key Take-Aways

• Based on FRA survey and interviews conducted in 2017:
  – International railroads generally focused on similar UAS use cases as North American operators although several unique UAS use cases identified;
  – Regulatory inconsistencies impacting UAS use in international settings with Beyond Visual Line of Sight (BVLOS) operations being most significant issue.

• In US:
  – BNSF continuing to expand BVLOS applications;
  – FAA and NASA working to support BVLOS operations;
  – FRA actively researching UAS use cases;
  – UAS test support available at Transportation Technology Center (TTC).
Agenda

• Introduction
• Global UAS Forecasts
• UAS Platforms and Sensors
• UAS Uses in International Railroads
• BVLOS Operations
• Domestic UAS Activities
• Conclusions
Introduction

- In February 2018, FRA published a report on UAS applications in international railroads.
- Objective was to provide overview of applications, issues and lessons learned on UAS operations outside North America.
- Report DOT/FRA/ORD-18/04 available at:
  https://www.fra.dot.gov/eLib/Details/L19380
Global UAS Forecasts
Projected Global UAS Market Size by Application

<table>
<thead>
<tr>
<th>Year</th>
<th>Law Enforcement Public Safety</th>
<th>Precision Agriculture</th>
<th>Media/Entertainment</th>
<th>Retail</th>
<th>Inspection/Monitoring</th>
<th>Surveying/Mapping</th>
<th>Hobbyist and DIY</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>49.3</td>
<td>204.9</td>
<td>416.8</td>
<td>24.0</td>
<td>262.6</td>
<td>149.9</td>
<td>221.9</td>
<td>55.0</td>
</tr>
<tr>
<td>2020</td>
<td>212.9</td>
<td>1,193.5</td>
<td>1,323.8</td>
<td>119.7</td>
<td>1,228.9</td>
<td>430.8</td>
<td>831.3</td>
<td>254.2</td>
</tr>
<tr>
<td>Growth (2015-2020)</td>
<td>33.99%</td>
<td>42.25%</td>
<td>26.00%</td>
<td>37.89%</td>
<td>36.16%</td>
<td>23.50%</td>
<td>30.23%</td>
<td>35.81%</td>
</tr>
</tbody>
</table>

UAS Platforms

- Rotary-wing UAS can be deployed virtually anywhere but generally low payloads.
- Fixed-wing UAS generally carry larger payloads for longer distances.

- Railroad starting to use rotary-fixed wing hybrids.
- Nano-type UAV with takeoff mass less than 30 g (1 oz) becoming more available in the market space.
• Choices in UAV payloads beyond navigation systems and basic cameras are continuously expanding.
• Challenges now move to automation and data management.
UAS Uses in International Railroads
FRA 2017 Survey

• Literature review conducted to identify international UAS practices, plans and lessons learned.
• Many applications similar to those in North America.
• Interviews conducted with:
  – Network Rail (United Kingdom);
  – Deutsche Bahn (Germany).
• Unique cases highlighted from:
  – Netherlands;
  – Israel;
  – France.
Network Rail

• Network Rail (United Kingdom) targeting or using UAS for:
  – Identifying and monitoring trespassing and suicide “hotspots”;
  – Monitoring status and maintenance of sea walls;
  – Surveillance of water risks such as water ponding and saturation near rivers;
  – Vegetation management and animal infestation monitoring.

• Employing optical cameras, infrared sensors, 4K cameras and LiDAR
Network Rail

• Lessons learned:
  – Management of expectations is key to early success of various programs/operations;
  – Limited number of qualified operators resulted in very high travel costs associated with the UAS program;
Deutsche Bahn

• Deutsche Bahn (DB) began using UAS in Germany to combat graffiti in known areas with vandalism in 2013.

• DB uses for UAS include:
  – Environmental monitoring;
  – Monitoring areas at risk for landslides;
  – Supervision of construction projects to monitor work progress;
Deutsche Bahn

• Lessons learned:
  – DB found a need to focus on a few pilots as operators rather than a large group of operators;
  – DB had to address concerns from labor unions that the technology would be used for performance monitoring;
  – Spending time selecting proper hardware and software for the given application was the strongest recommendation.
Netherlands

- Operators in the Netherlands have been using UAS equipped with infrared cameras to monitor the performance of switch heaters.

Photo Courtesy of Photonics (www.photonics.com)
Israel

- Israel has been using UAS since 2014 to monitor lines for riots.
- Video imagery used to identify those damaging infrastructure.

Photo Courtesy of SmartRail World (www.smartrailworld.com)
France

- SNCF has been using UAS since early 2013.
- In addition to infrastructure inspection, SNCF uses UAS for:
  - Vegetation maintenance plans;
  - Inspection of station roofing and other structures.
- In March 2017, SNCF created ALTAMETRIS, a subsidiary to deliver UAS-based solutions for applications outside of the railroad.
• In 2016, Italian researchers proposed the concept of a network of sensors including fixed UAV stations for monitoring infrastructure.

Railroads interviewed for survey cited BVLOS issues as most significant issue affecting long-term UAS use in railroad applications:
  – DOT/FRA/ORD-18/04 summarizes BVLOS regulations from around the world.

Federal Aviation Administration (FAA) actively working on BVLOS issues.

NASA currently working with industry to develop technologies to support an Unmanned Traffic Management System for low-altitude airspace to facilitate BVLOS.

BNSF only non-military organization with BVLOS UAS operations.
BNSF BVLOS Operations

• Employing hybrid vehicle with vertical takeoff and landing capabilities of a quadrotor and efficiency, speed, and range of fixed-wing aircraft.

• BVLOS use cases include:
  – Crosstie assessments including condition, skew, spacing;
  – Identification of track obstructions and broken rail;
  – Fouled ballast detection;
  – Thermal misalignments (summer 2018).
Additional Notes

• FAA has streamlined the process for obtaining Part 107 waivers for controlled airspace operations through its DroneZone Portal
  
  https://www.faa.gov/uas/request_waiver/

• In May 2018 DOT/FAA announced ten awardees for the Unmanned Aircraft Systems Integration Pilot Program.
  – Two and one-half year program seeks to collect data for night operations, flights over people, BVLOS, package delivery, detect-and-avoid technologies as well as security and reliability of communications.
  
  https://www.transportation.gov/briefing-room/dot3419
FRA Research and Support

• FRA actively researching UAS applications including:
  – Track Evaluation Approaches Including Change Detection
  – Trespasser Detection

• FRA has helped establish test beds, safety protocols and operational support at TTC for testing use cases for infrastructure and rolling stock evaluations.

• UAS also used by TTC Security and Emergency Response Training Center.

https://www.youtube.com/user/usdotfra
Conclusions

• International railroads generally focused on similar UAS use cases as North American operators.

• Unique UAS use cases from international railroads included:
  – Vandalism and trespasser monitoring;
  – Construction monitoring;
  – Switch heater monitoring.

• BVLOS regulations impact operations around the world. Solutions such as traffic management systems will assist but further development is required.