Unmanned Aerial System Applications in International Railroads

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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

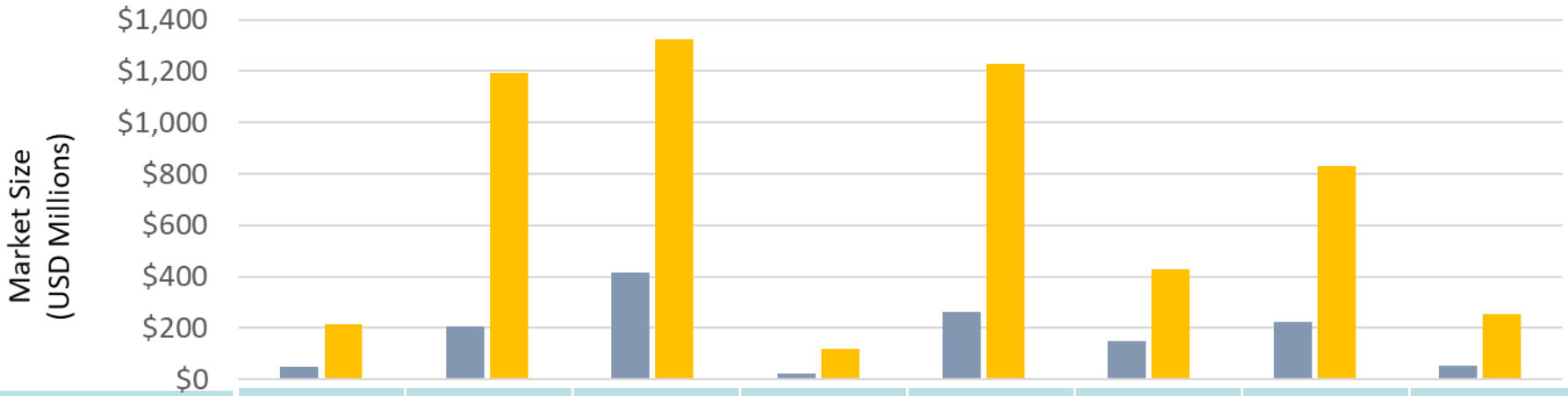
- Introduction
- Global UAS Forecasts
- UAS Platforms and Sensors
- UAS Uses in International Railroads
- BVLOS Operations
- Domestic UAS Activities
- Conclusions

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



Year	Law Enforcement Public Safety	Precision Agriculture	Media/ Entertainment	Retail	Inspection/ Monitoring	Surveying/ Mapping	Hobbyist and DIY	Education
2015	49.3	204.9	416.8	24.0	262.6	149.9	221.9	55.0
2020	212.9	1,193.5	1323.8	119.7	1,228.9	430.8	831.3	254.2
Growth (2015-2020)	33.99%	42.25%	26.00%	37.89%	36.16%	23.50%	30.23%	35.81%

Courtesy of European Aviation Safety Agency. (2015). *Notice of Proposed Amendment 2017-05 (B)*

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.

UAS Sensors

- Choices in UAV payloads beyond navigation systems and basic cameras are continuously expanding.
- Challenges now move to automation and data management.

Thermographic Cameras

Gas Detectors

LiDAR Scanners

Multispectral Cameras

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;

Photo Courtesy of Network Rail (www.networkrail.co.uk)

Deutsche Bahn

- Deutshce 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.

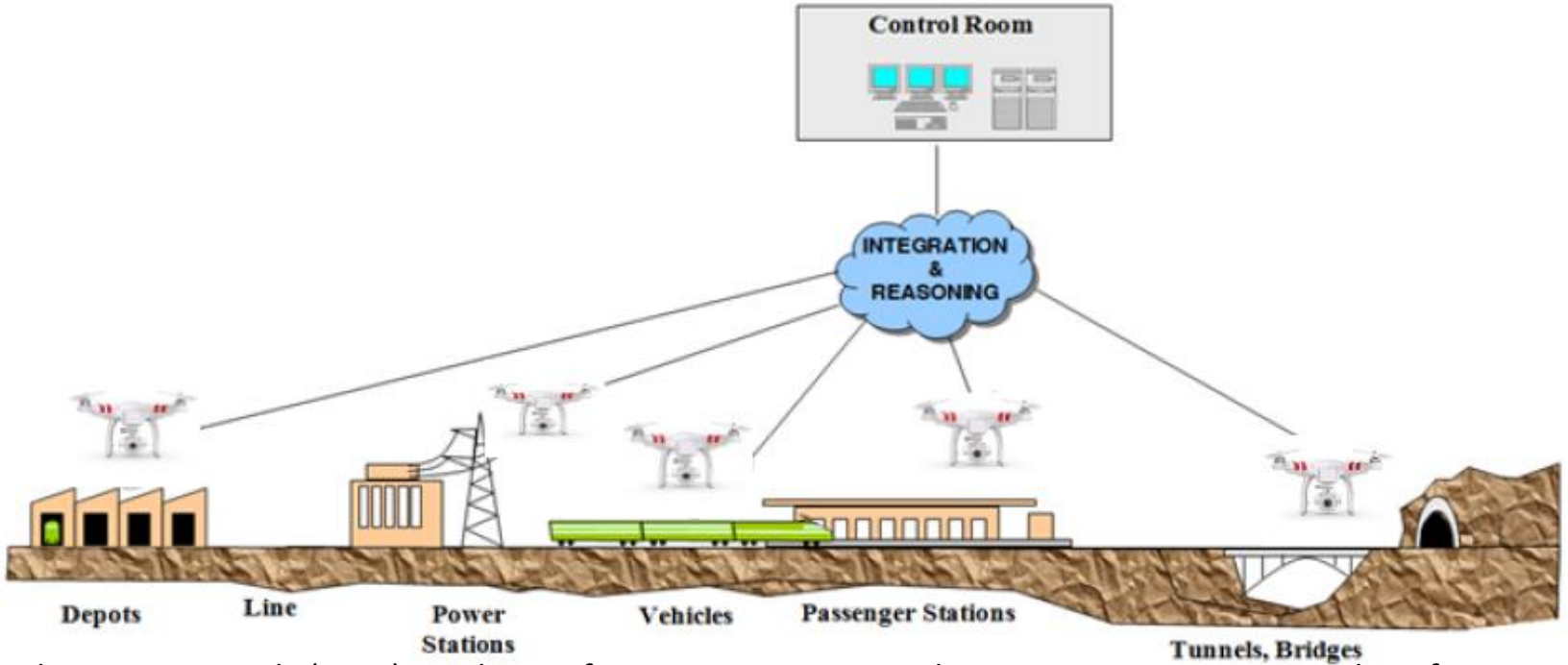
Photo Courtesy of SmartRail World (www.smartrailworld.com

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.

Surveillance Network

- In 2016, Italian researchers proposed the concept of a network of sensors including fixed UAV stations for monitoring infrasturcture.



Flammini, F., et. al. (2016). *Railway Infrastructure Monitoring by Drones*. 2016 International Conference on Electrical Systems for Aircraft, Railway, Ship Propulsion and Road Vehicles & International Transportation Electrification Conference (ESARS-ITEC).

BVLOS Operations

- 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.

Photo Courtesy of BNSF

- 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.

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

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

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.