Coming to Rail Airspace Close to You - Drones:
* An update on the use of drones by the railroad industry

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Rockwell Collins ARINC

- Rockwell Collins is a $ 11 billion (Market Cap)
- 20,000 + employees
- Information Management Services (IMS) - ARINC
  - Industry Level Focus
  - Airline and business aviation communications
    - Air-to-ground voice and data network
    - Ground-to-ground network
  - Business aviation flight support services.
  - Airport operational efficiency systems
  - **Rail and security systems**
- Government and Commercial Systems
  - Integrated avionics
  - **Communications & Navigation**
  - Displays & surveillance systems
  - Integrated mission & training solutions
  - **Unmanned Aircraft Control and Non-Payload Communication**

"DRONES"

Common Terms

- UAS (unmanned aircraft system)
- UAV (unmanned aerial vehicle)
- RPV (remotely piloted vehicle)
- OPV (optionally piloted vehicle)

What do they do? They carry sensors (payload) to capture data.

- Pictures
- Video
- Point Clouds
- Measure airborne contamination
- "See" an oil slick

Use Cases

- ***Aerial survey***
  - ***PTC Asset V&V***
- Bridge inspection
- Track inspection
  - Rail Geometry
  - Ballast condition
- ***Incident response (derailment, hazmat, etc…)***
  - ***Demonstration project –Night Incident***
- Property Protection/Inspection
  - Trespasser detection
  - Abandoned property inspections
  - Encroachments
  - New construction inspection and monitoring
- Aerial photography and videography

Use Case – Aerial Survey

- PTC requires that CSX maintains location of PTC required assets to 7.2 feet accuracy
- Railroad is dynamic, we are estimating that there will be 160 changes per week requiring re-survey of assets
- CSX currently have staff of 17 augmented by contracts with two national survey firms

Use Case – Aerial Survey

- From test flights, there is a “sweet spot” where UAV survey will fit in
  - Not economical for small surveys, a few assets or compact area
  - Helicopter or vehicle based LIDAR more cost effective for larger surveys, 10 miles or more
- Further tests underway to pinpoint the cost trade offs

Agile Low-Cost Survey Demonstration

- Conducted by Near Earth Autonomy
- Goal:
  - Achieve full-size survey quality mapping on small agile platform
  - Show advantages of UAS sized LiDAR vs. Photogrammetry

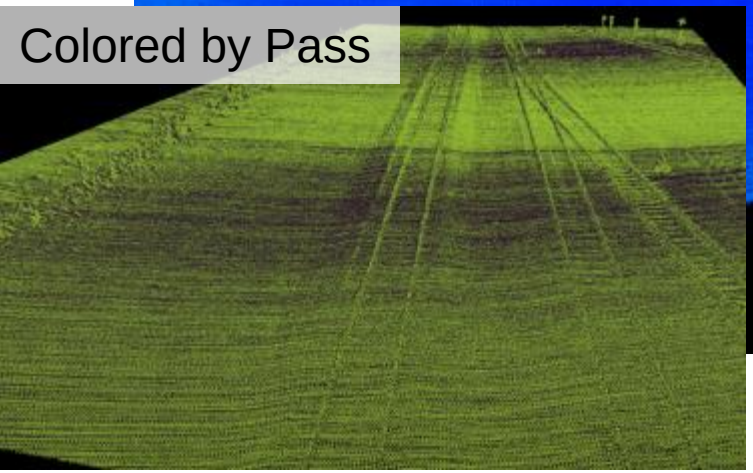
Advantages of LiDAR

- Detailed 3D data in real time
- Day and night operation
- Not dependent on visual texture
- Mitigates complex visual artifacts (shadows/reflections)
- Extra material properties from laser return signature
  - E.g. paint markings, mud vs. dry ground

Lidar Data Repeatability

Overlay of two passes (2nd and 8th, 15 minutes apart)

Colored by Height



Colored by Pass

Point Cloud Density:

- **Baseline ~65 points/m²**
- **S1 ~1100 points/m²**

➔ **Approx. 20x point density**

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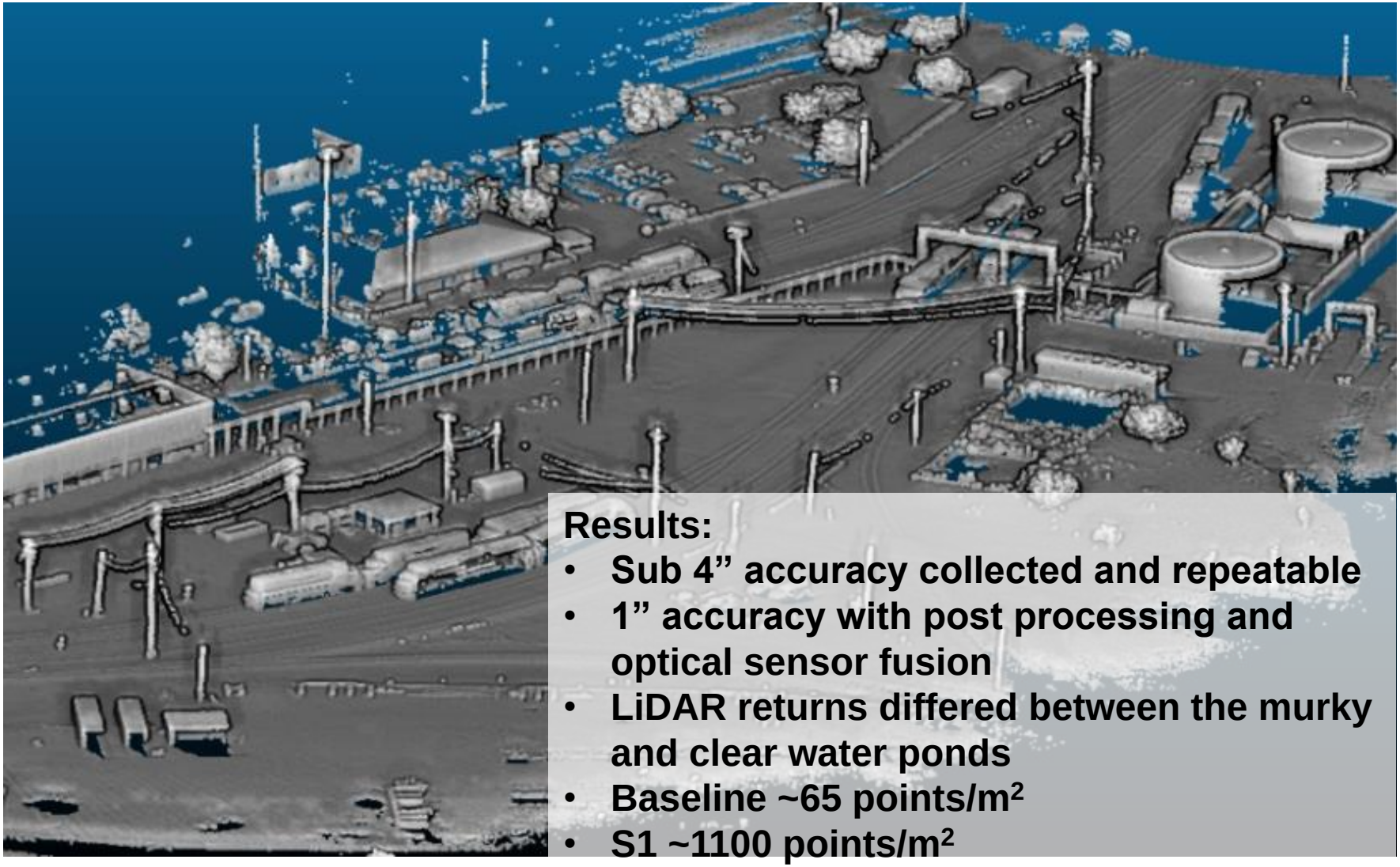
UAS Test Flight Results

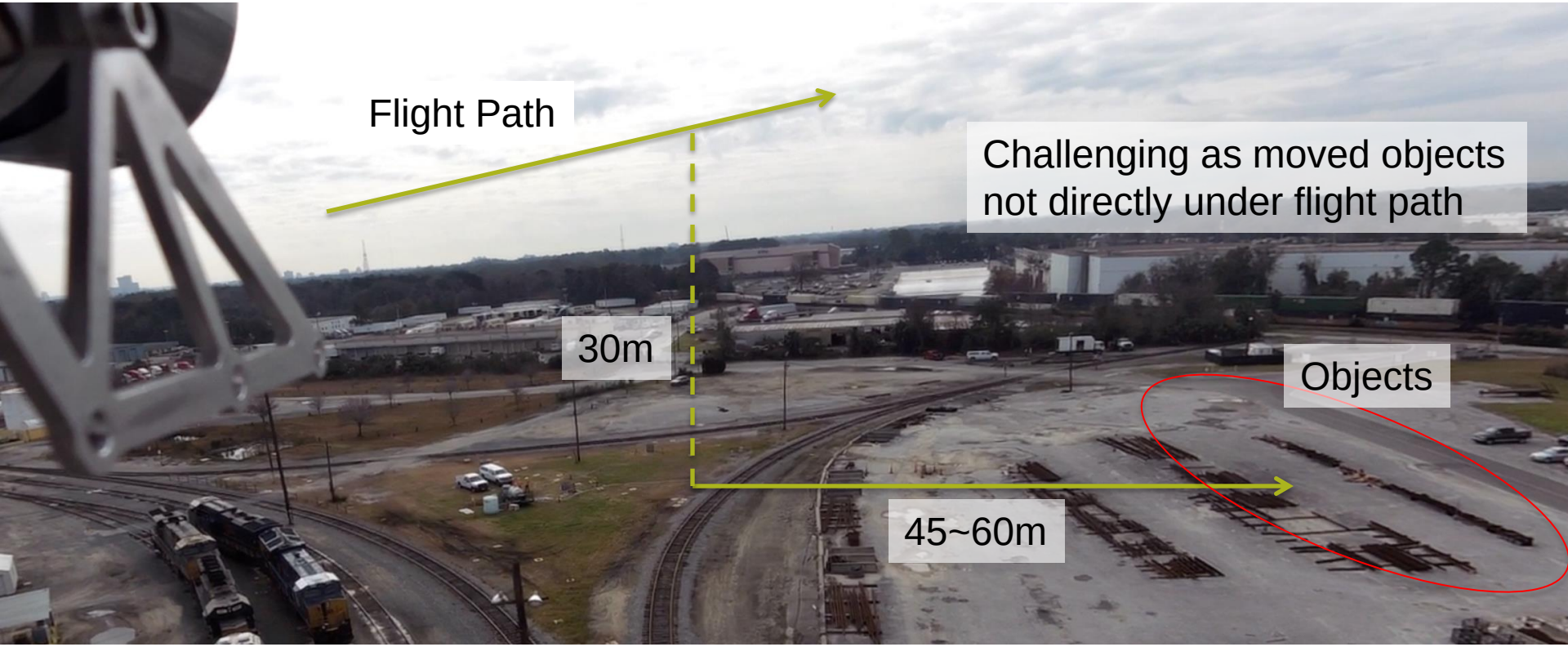


Results:

- **Sub 4” accuracy collected and repeatable**
- **1” accuracy with post processing and optical sensor fusion**
- **LiDAR returns differed between the murky and clear water ponds**
- **Baseline ~65 points/m^2**
- **S1 ~1100 points/m^2**

Change Detection

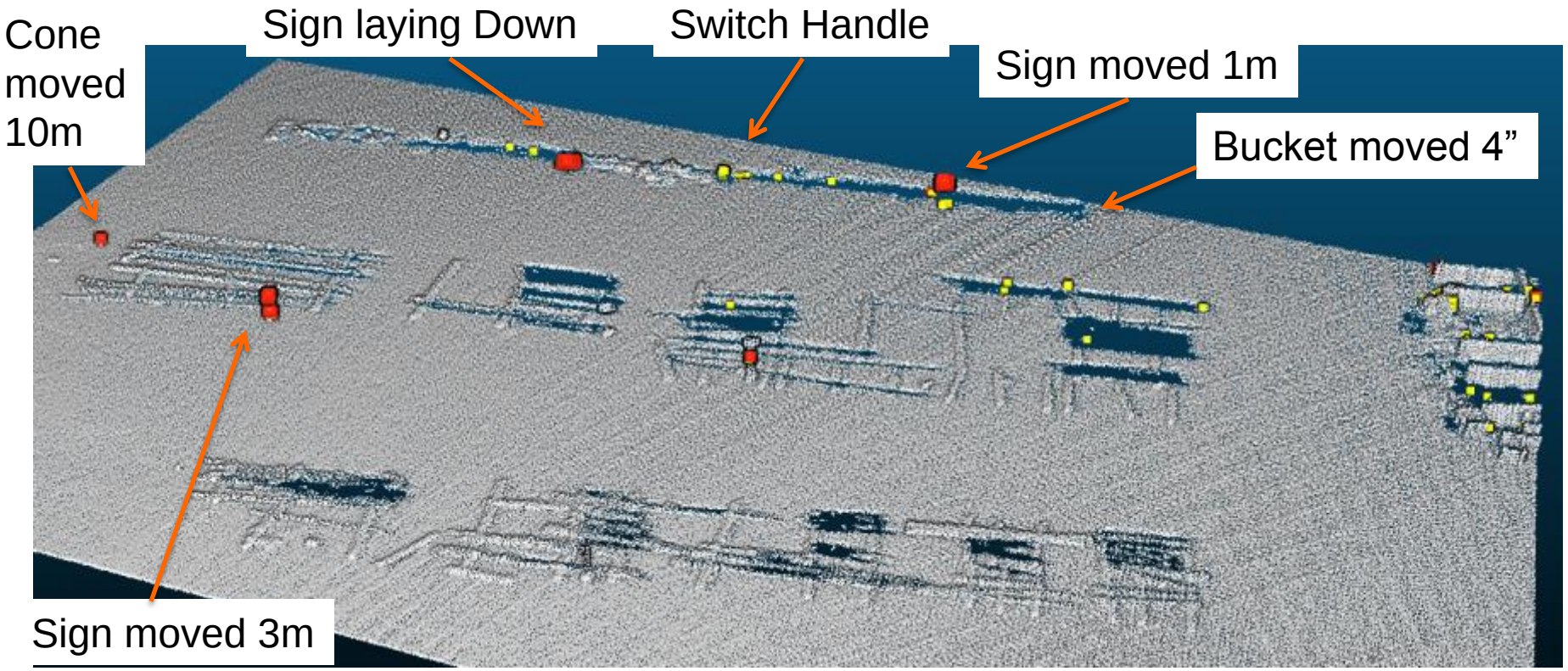
- Detect small changes:
  - 1.5’ Cone moved 10m
  - 4’ Sign moved 3m
  - 6’ Sign laying down flipped over
  - 4’ Sign moved 1m
  - Switch handle moved 0.5m
  - 1’ bucket moved 4”



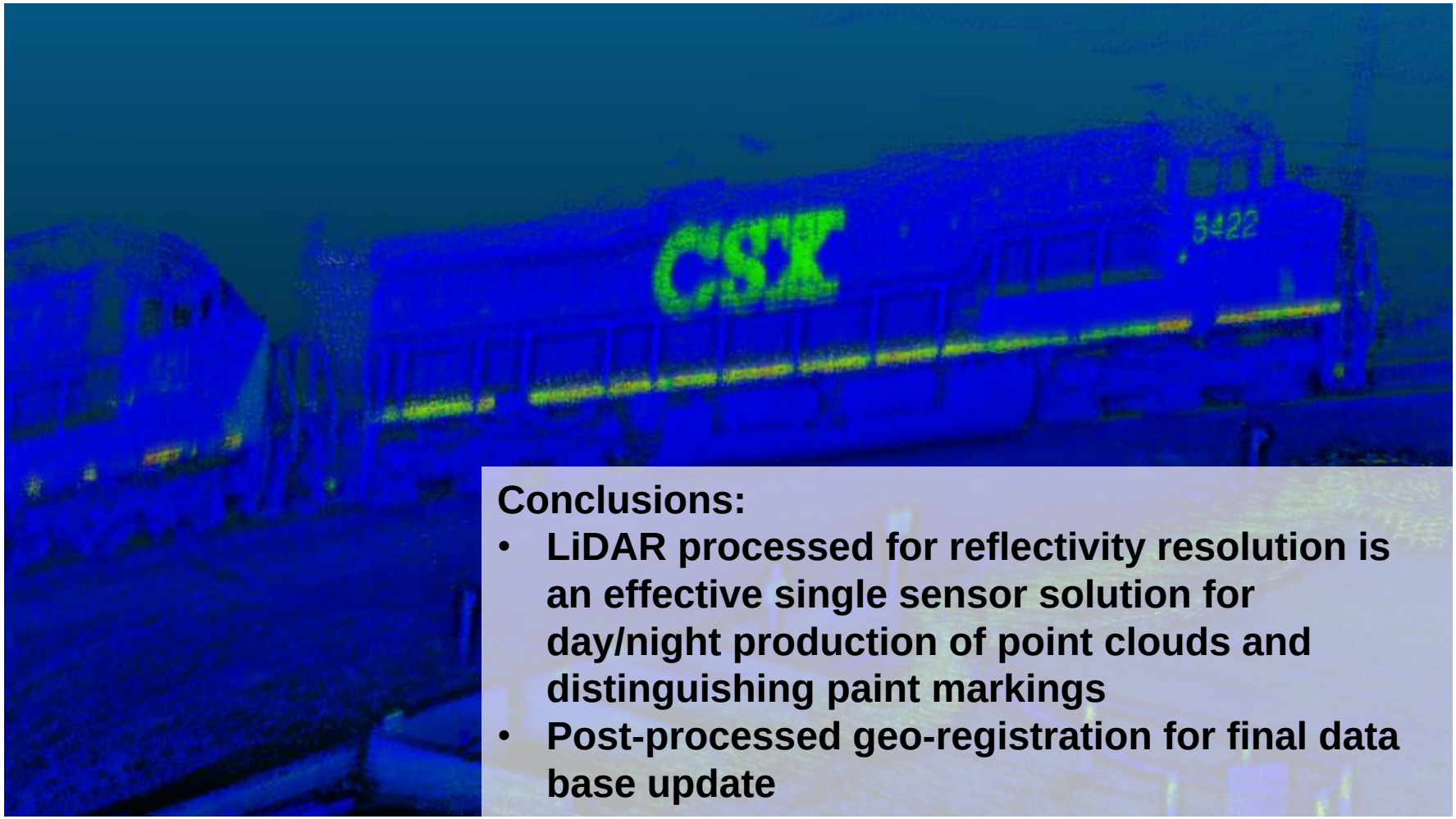
Post-Processed Auto Change Detection

- Example Algorithm:
  - Identification of changes within the radius of previous data

Key:
Radius = 0.1m
Radius = 0.05m



GPS Free Survey (Colored by Reflectivity)

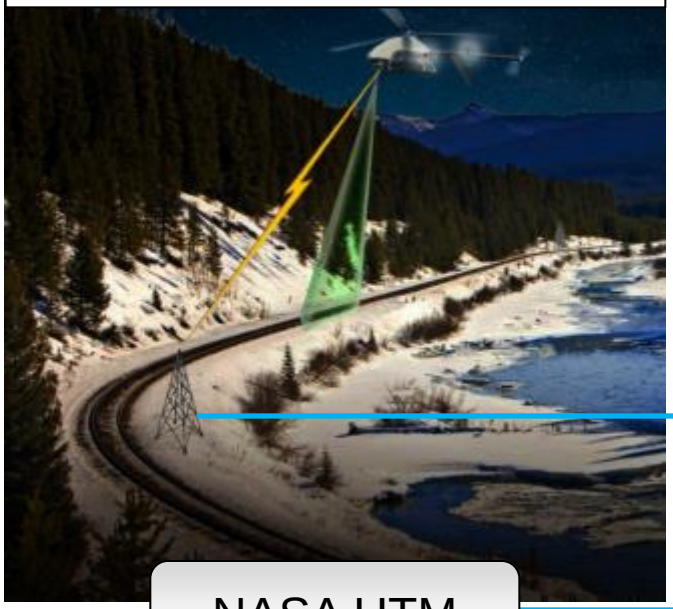


Conclusions:

- **LiDAR processed for reflectivity resolution is an effective single sensor solution for day/night production of point clouds and distinguishing paint markings**
- **Post-processed geo-registration for final data base update**

Demonstration Project: Night Incident

Night Rail Incident Assessment



UAV Ground Control Station

Command and Control, Sensor Video

NASA UTM

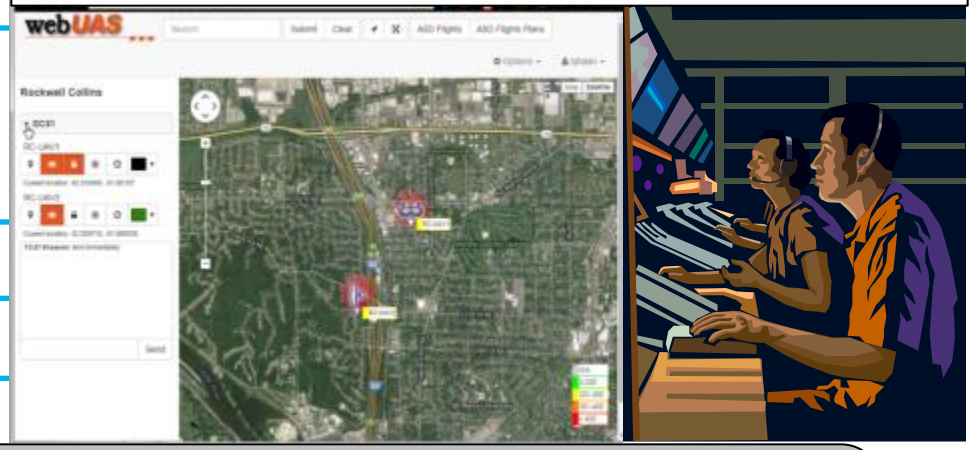
FAA ATC

Weather

Grand Forks Co. Sheriff OPS

webUAS Portal: UAV SA, UAV Video

CSX OPS



CSX Night Operations Trial

- *Night UAS Operations – Leverage Northern Plains Test Site Expertise*
- *RCI webUAS - Enables Real Time Video and SA and First Responder Connectivity*
- *ERAU – ATC Airspace Information Expertise*