Full Utilization of Mobile LiDAR and AI on the City of Edmonton's Valley Line West LRT Expansion Project: Beyond an Alternative to Traditional Survey

Suliman Gargoum, PhD

suliman.gargoum@nektar3d.com

Contents

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Edmonton Valley Line West LRT Expansion

- The Edmonton Valley Line West LRT Expansion project is the second stage of building an urban-style 27 km rail line.
- The line extends between Downtown Edmonton and Lewis Farms (West Edmonton).
- In October 2020 , the City selected Marigold Infrastructure Partners as the preferred proponent for the **$2.61 billion project**.

Source: https://www.railwayage.com/passenger/edmonton-advances-c2-6b-valley-line-west-lrt-extension/

Motivation and Objectives

- This presentation demonstrates how *Mobile LiDAR*, *AI*, and *Cloud-Based Data Management* resources were used to support the following project activities:
  - **Design**
  - **Construction planning**
  - **Early works**

Efficient Data Collection using Mobile LiDAR Technology

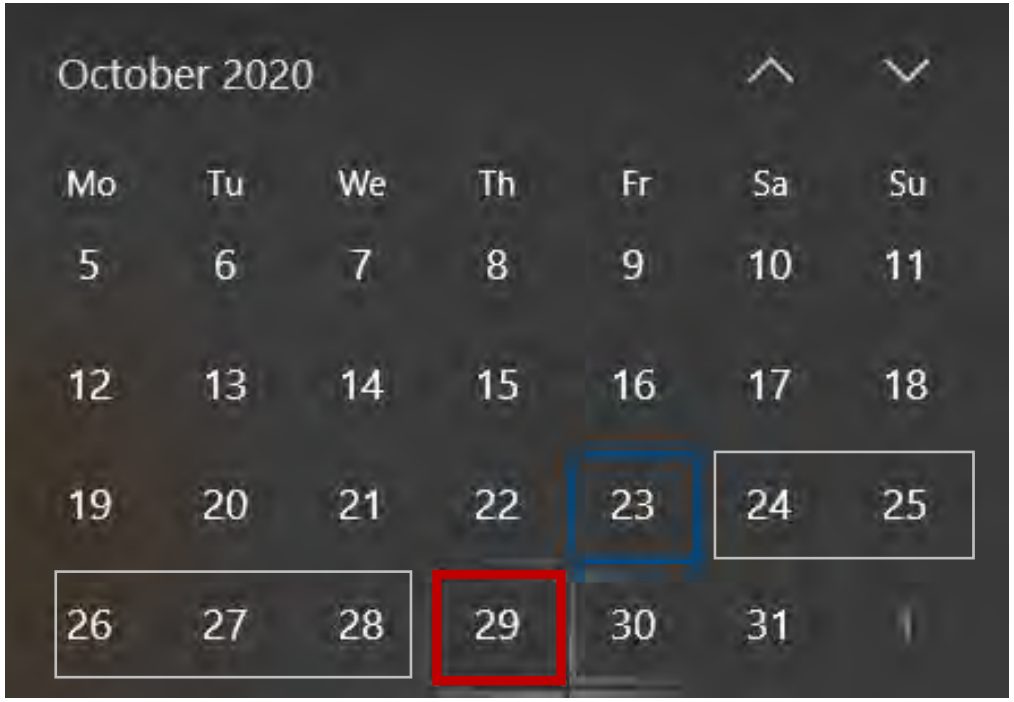
Mobile LiDAR Technology

- **LiDAR (Light Detection And Ranging)** is an optical remote sensing technology which uses near-infrared light rays to collect exact position and intensity information about objects.
- In Mobile Laser Scanning, a data collection truck is mounted with a laser scanning system.
    - The truck captures 360^0 representation of the road environment while travelling at the road's speed limit.

Mobile LiDAR Point Cloud

Efficient Data Collection

- The Project got awarded on the 23rd
- Heavy Snowfall took place on the 29th
- The Project team had 5 days (3 working days) to complete field work:
  - Obtain approval from the CoE
  - Carryout all safety checks
  - Layout 850 ground control points
  - Captured 3D data along the entire 28km corridor (multi-pass).



Project Award Date

Heavy Snowfall Forecasted

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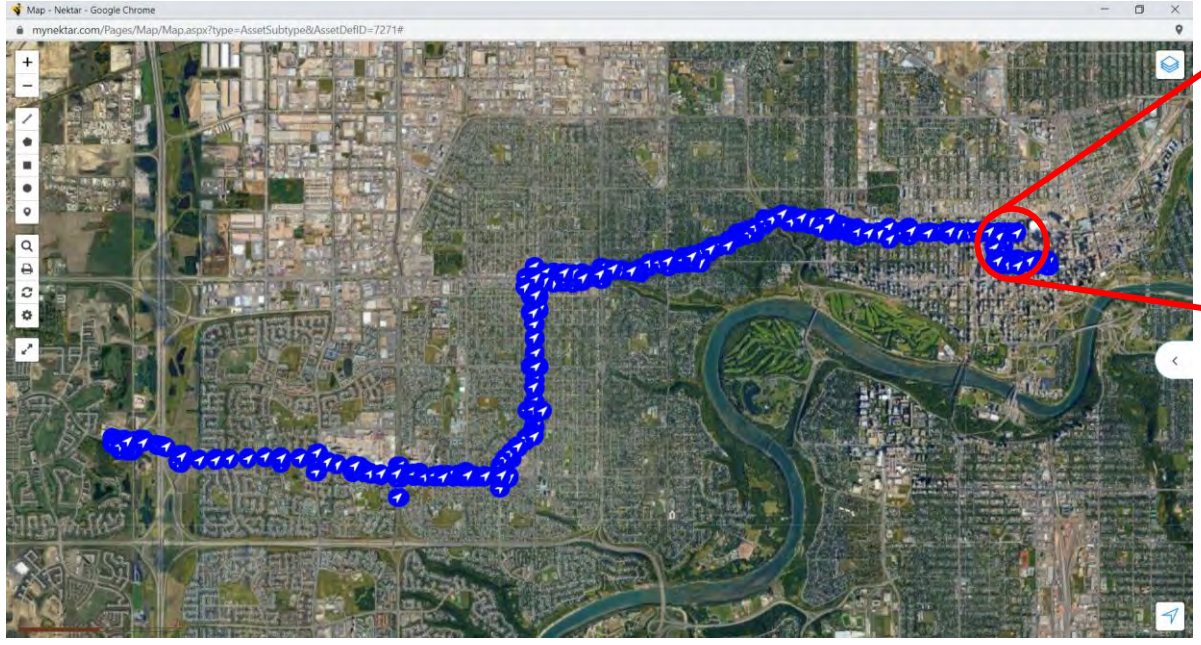
Efficient Data Collection

- The corridor was too busy to lay out Ground Control Points (GCP) during the day, thus **only 4 nights** were available to complete the work
- The 850 GCP were laid out at **intersections**, **tie-in locations,** and **midblock** every 100-200m
  - GCP were split into 25% validation, 75% registration



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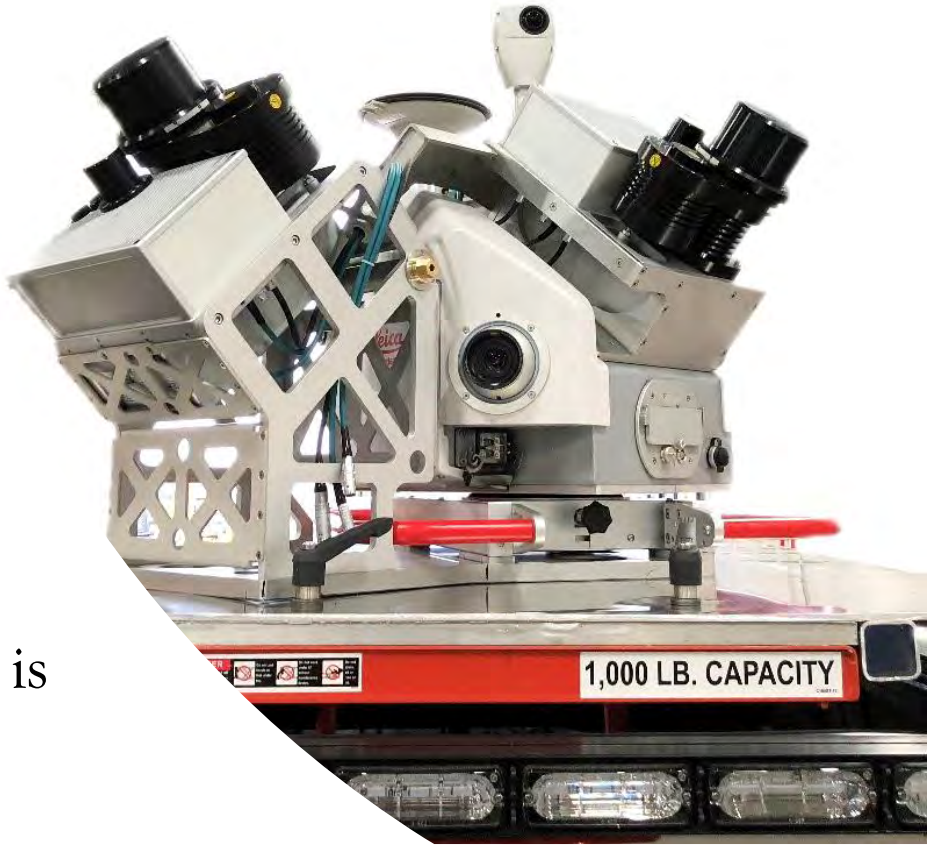
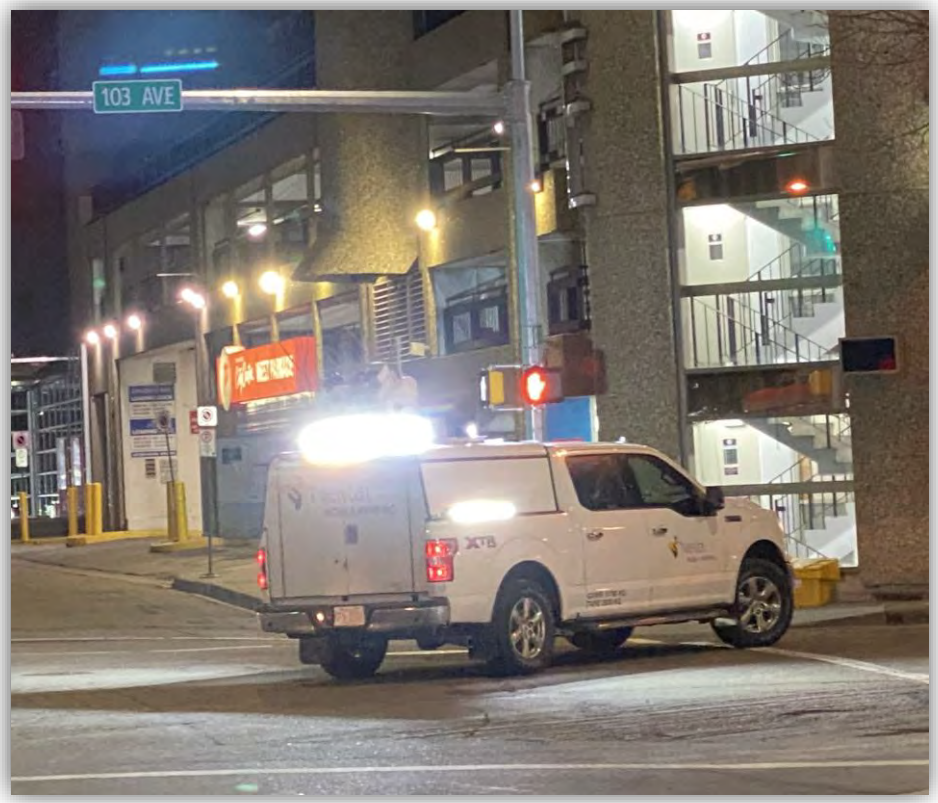
Efficient Data Collection

- After laying out the control data, the LiDAR scan was conducted.
- Data was collected using Nektar 3D's Dual-Sensor Leica Pegasus: Two Ultimate Laser Scanning System.
  - Unlike other sensors the unit provides extremely high-resolution data with a mm-level accuracy. This is critical when the data is to be used for design.
  - The dual sensor system minimizes shadowing and helps capture full site details.



Efficient Data Collection

- Multiple passes of the corridor were conducted to capture full right of way extents.
- The scan was also conducted at night to avoid high traffic during the day.
- To obtain a colourized scan, high power LED floodlight were mounted onto the truck.
  - Although useful in colourizing the scans, the intensity readings in the data were biased, which had some impacts on the AI classification.



Efficient Data Collection

Efficient Data Collection

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Georeferencing and Scan Registration

- After collecting the data, the scan files were processed and tied down using the ground control points.
  - The points were surveyed using the total station equipment.
- This resulted in an accurate scan of the entire project corridor.
- To assess accuracy, it is recommended that a subset of the GCP are NOT used in tie down and are kept for validation.


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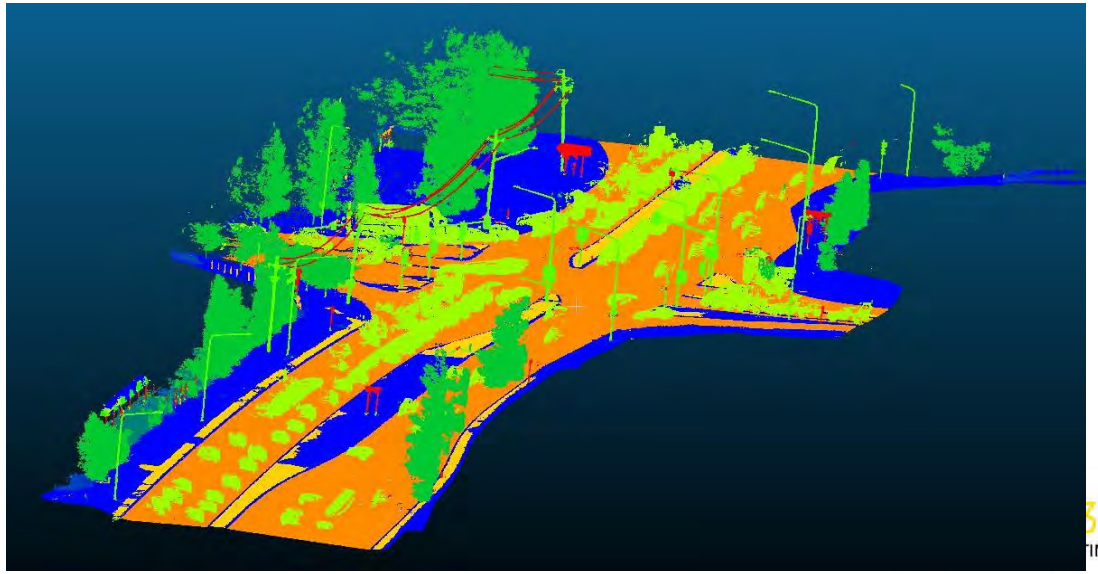
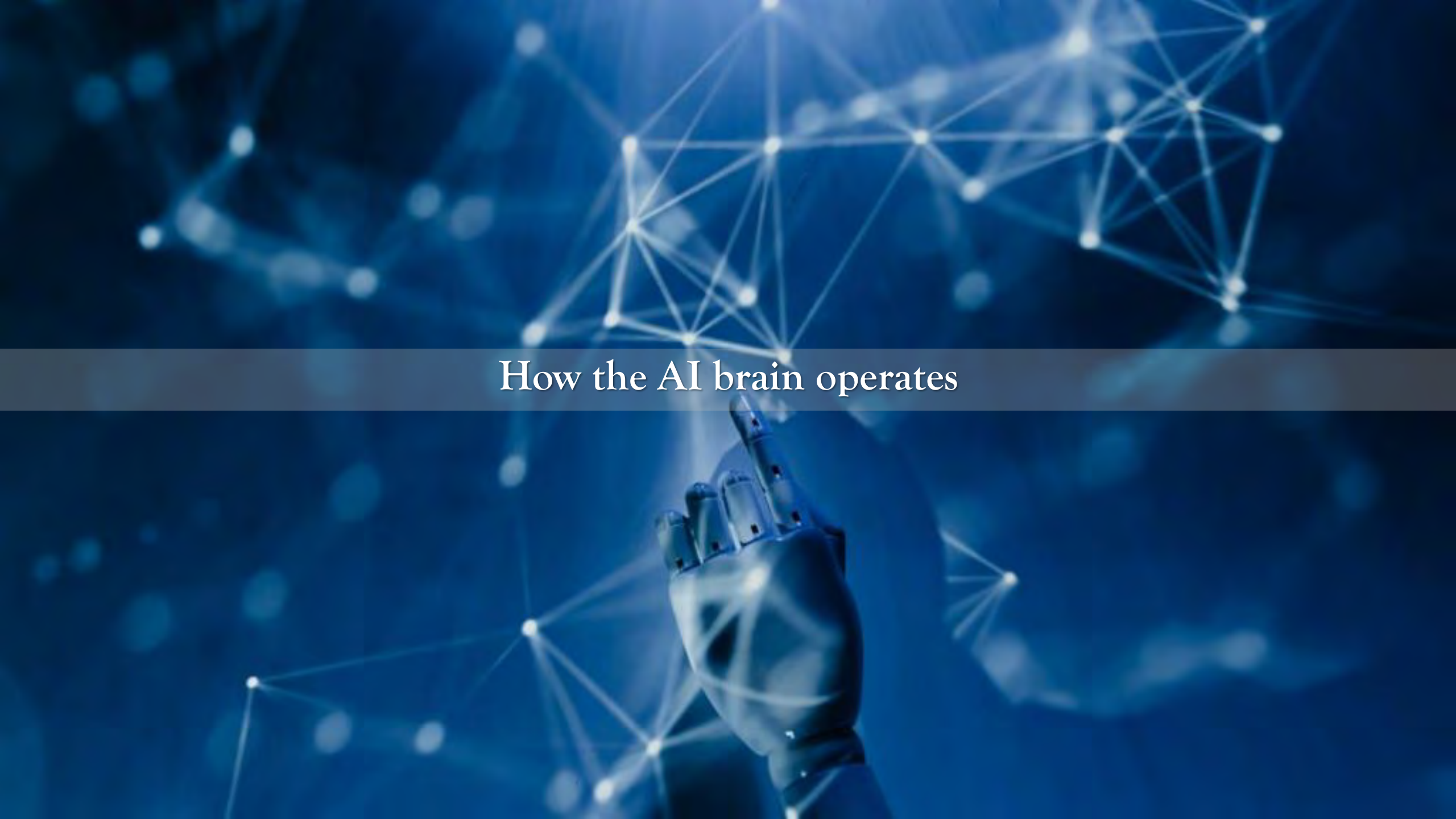
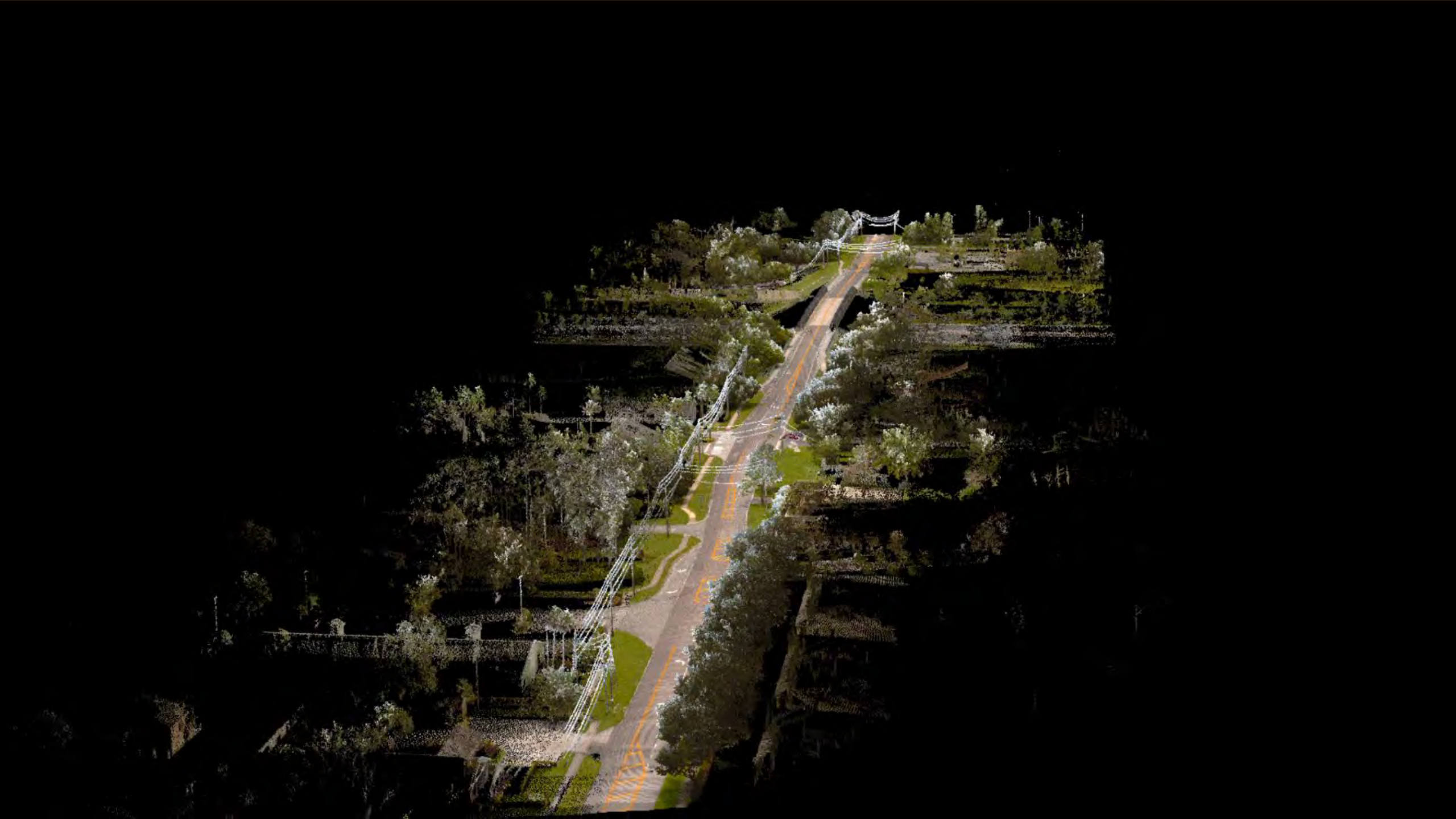
Automated Data Processing Using AI and ML

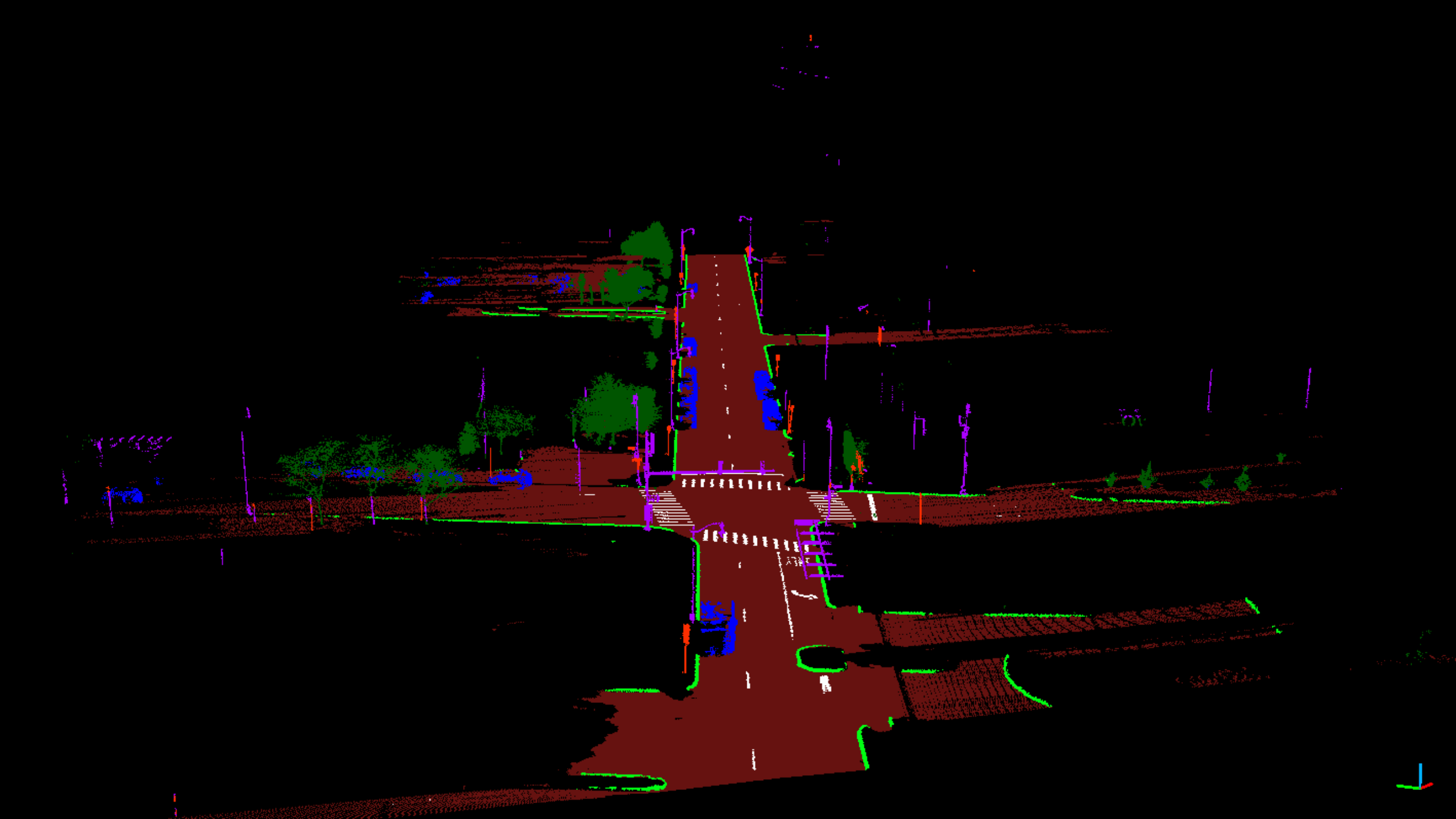
Data Cleaning and Classification

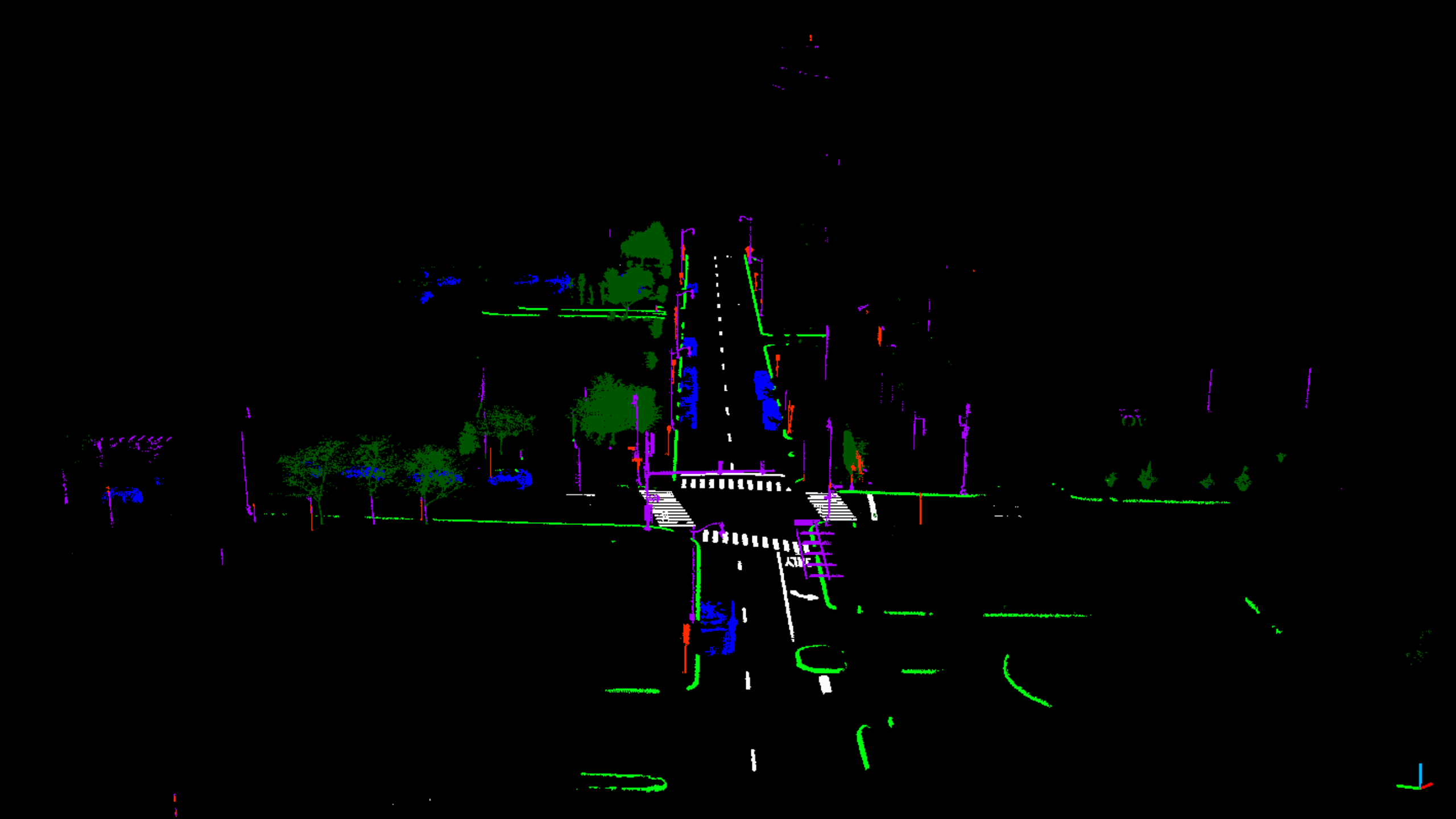
- After tying down the scans, the data was then segmented using AI algorithms.
  - The algorithms use a deep neural network to classify every point within the point cloud into a specific type of object.
  - This helps remove unwanted points (eg: cars, construction equipment, noise…etc) from the point cloud

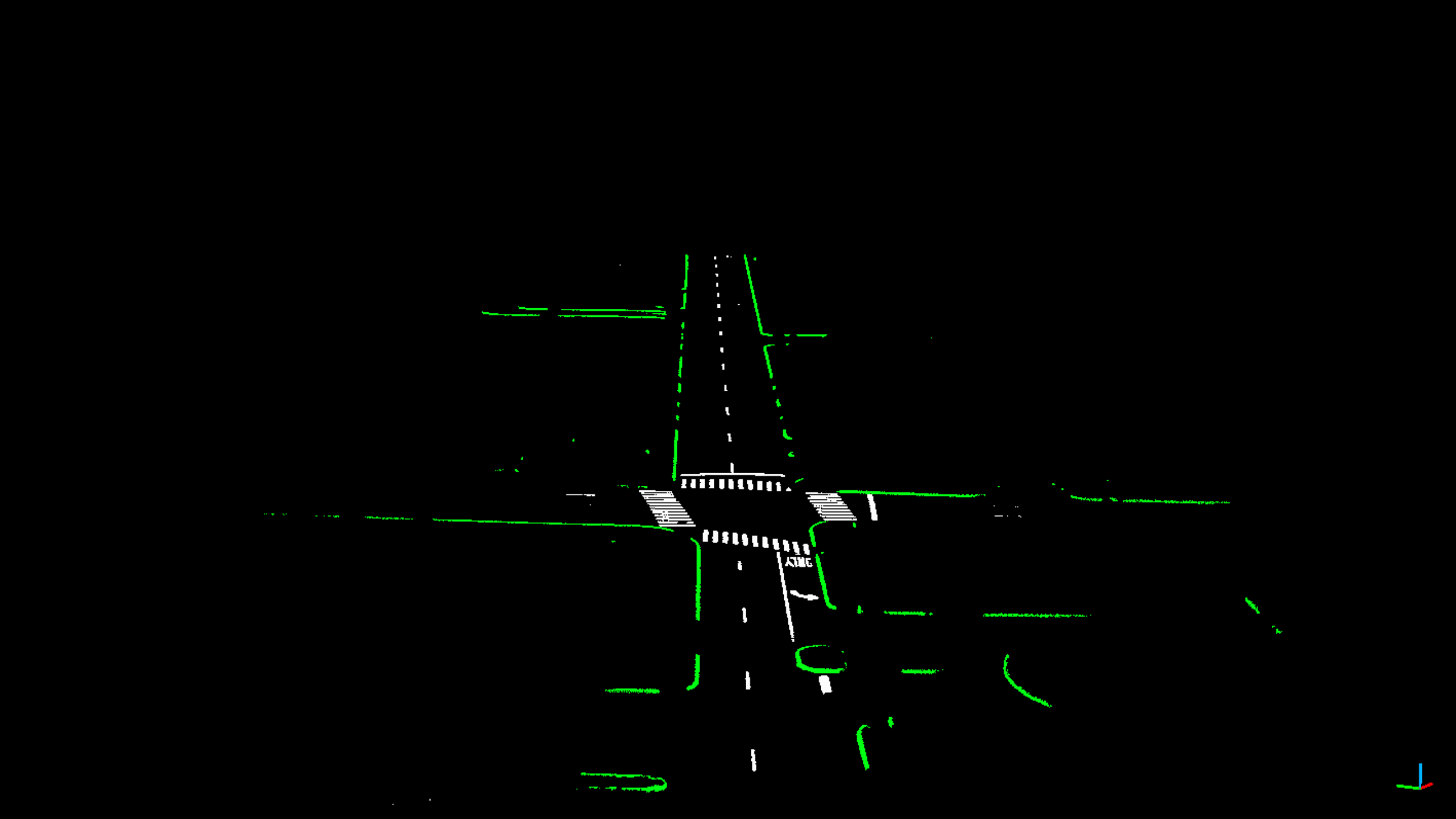



How the AI brain operates





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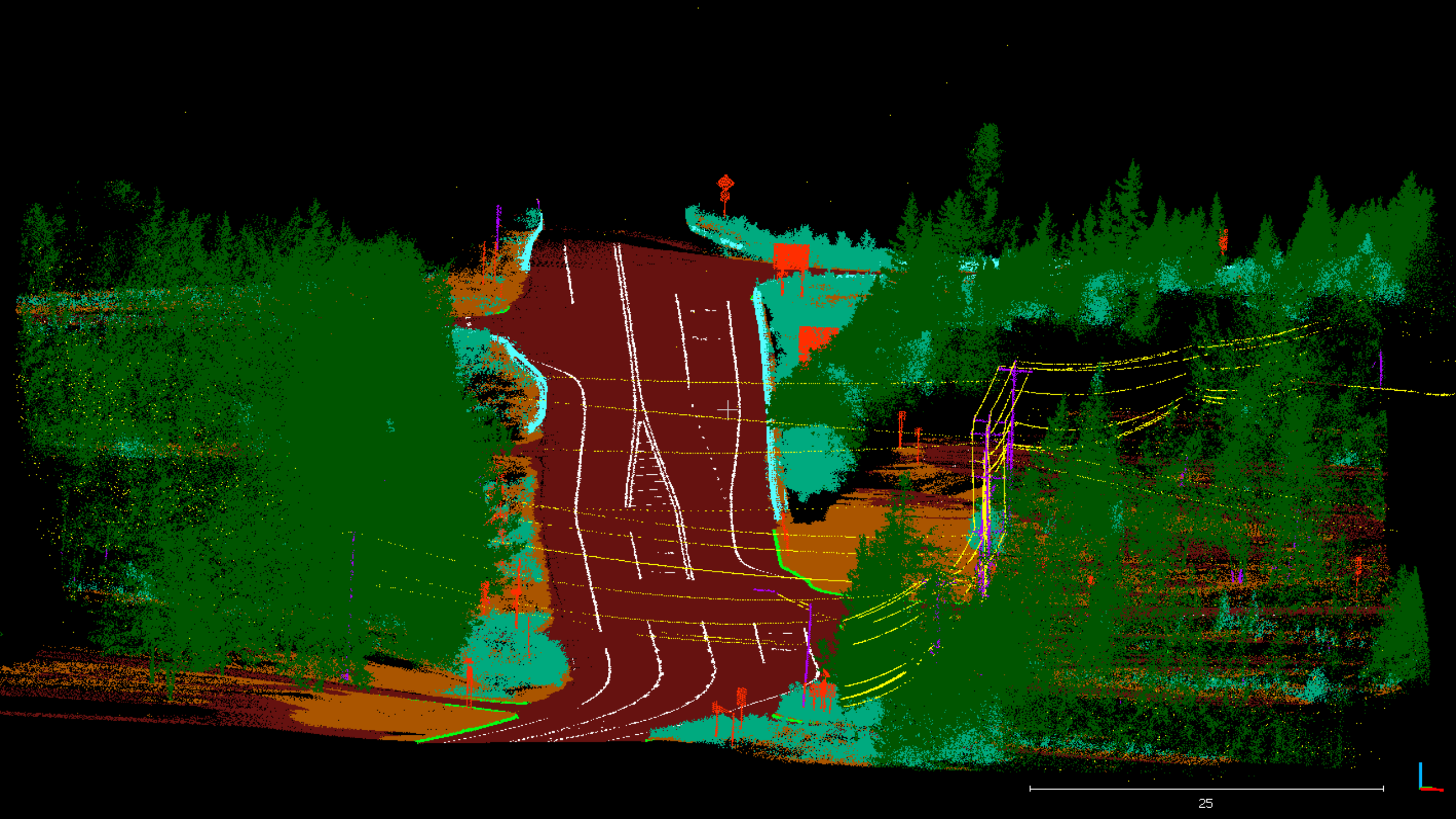
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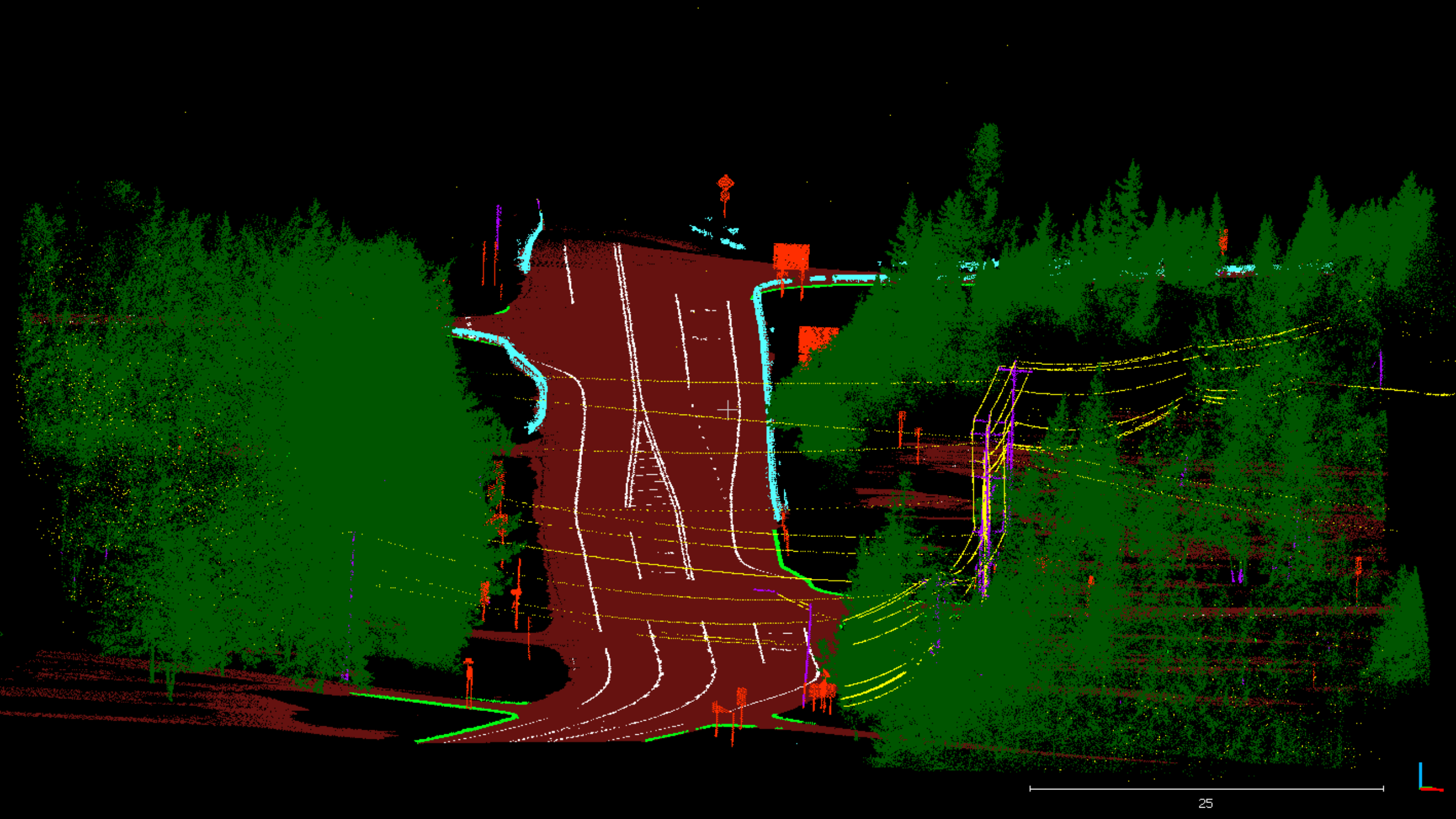
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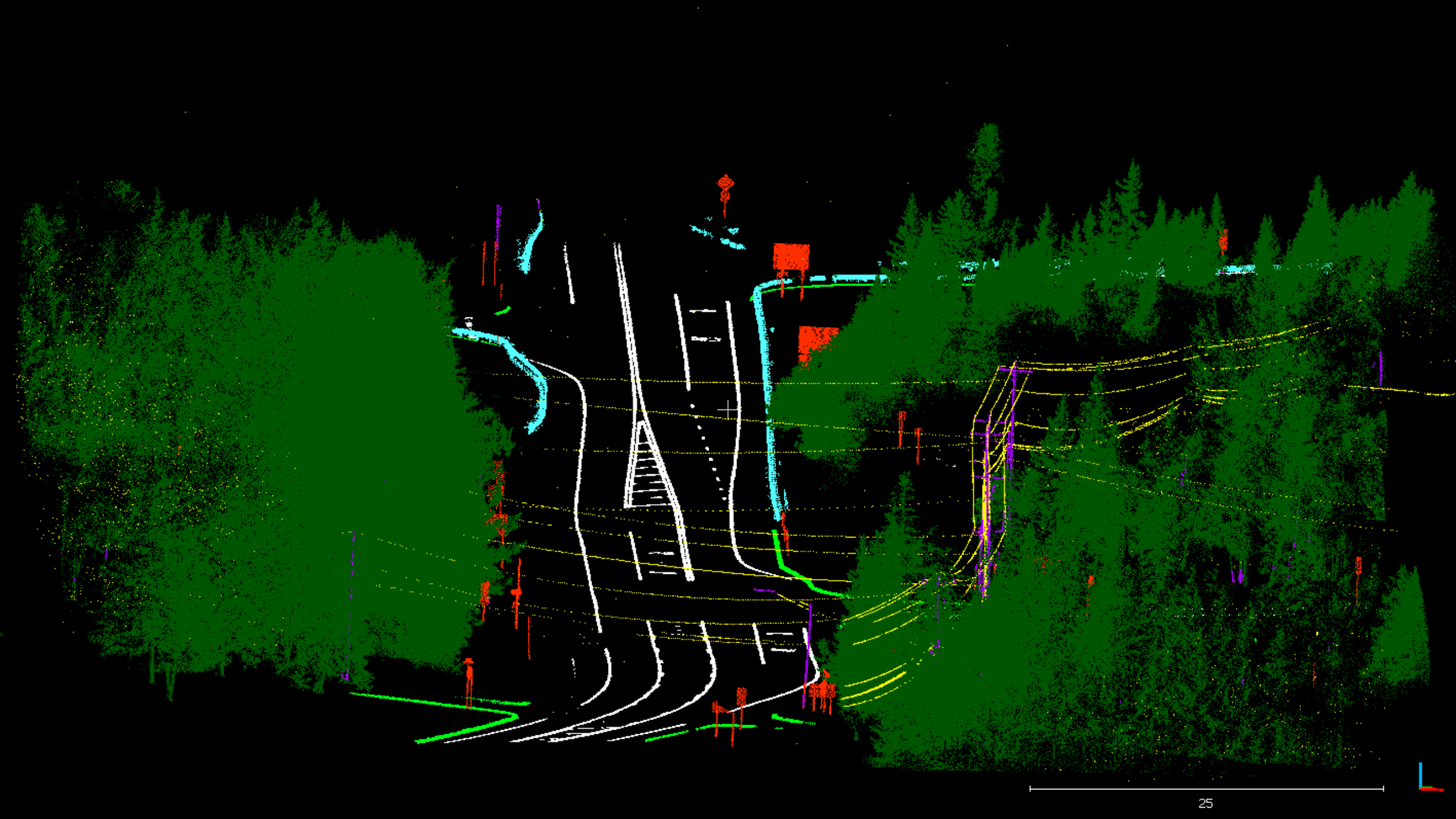
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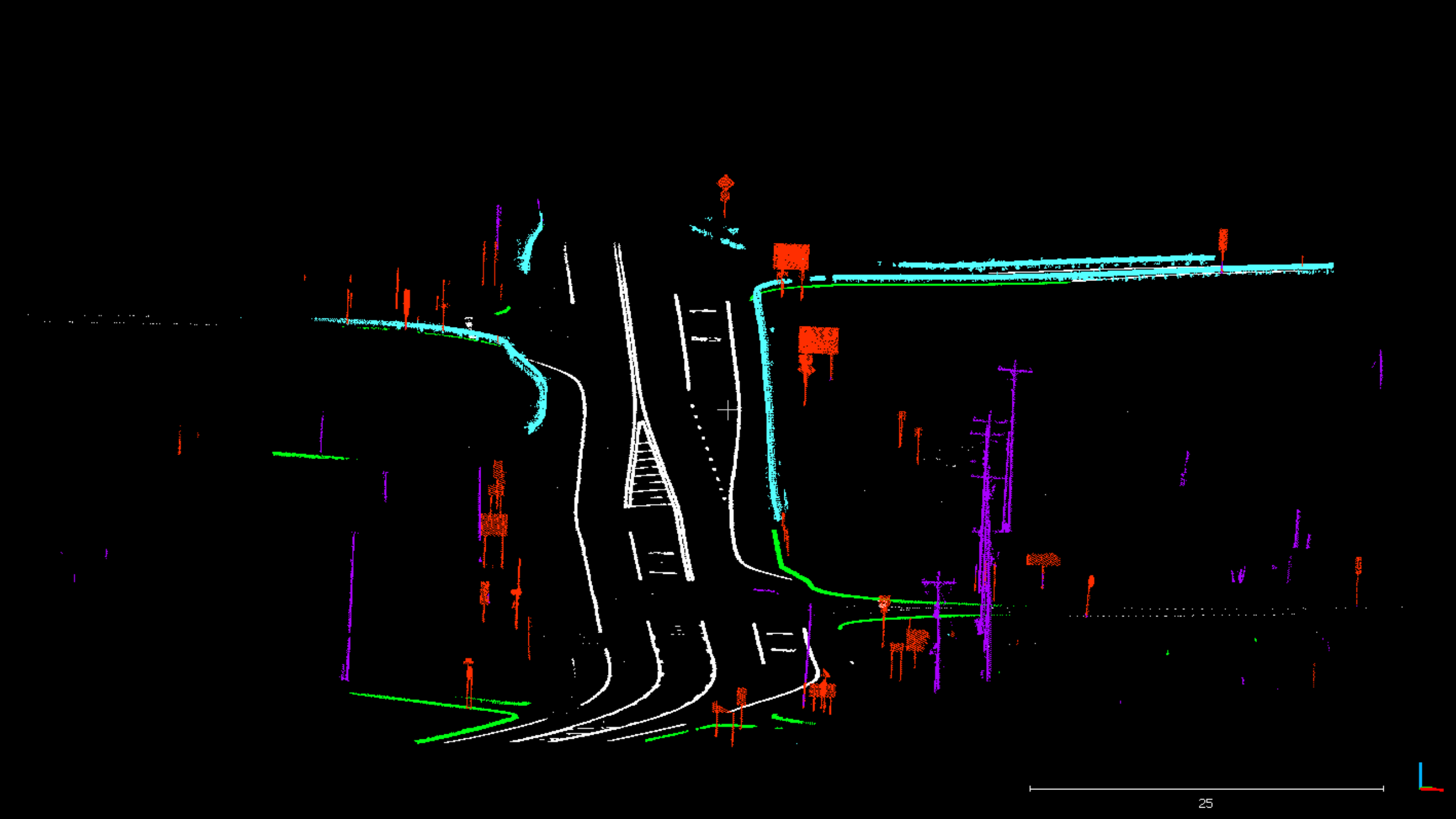
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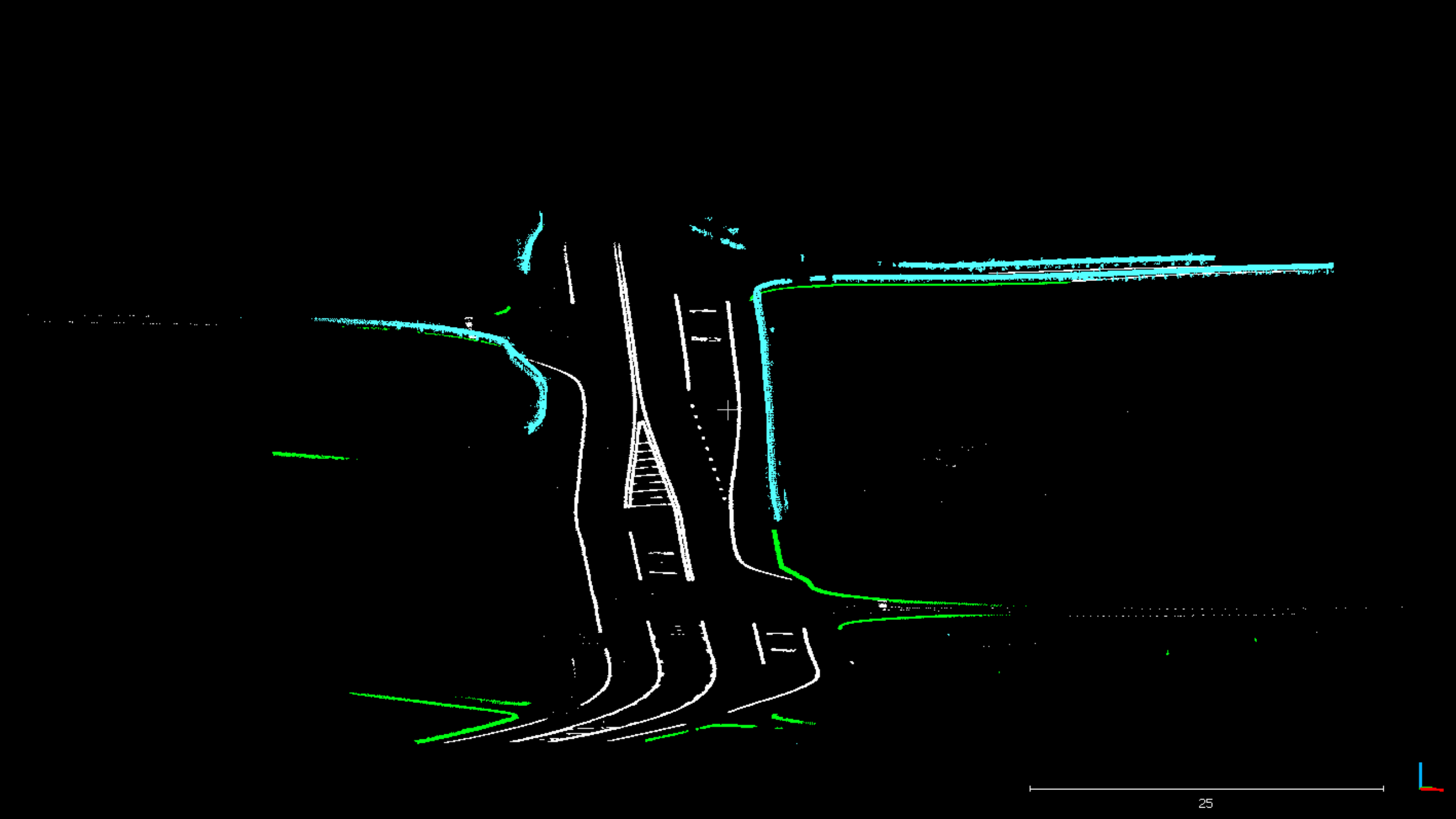
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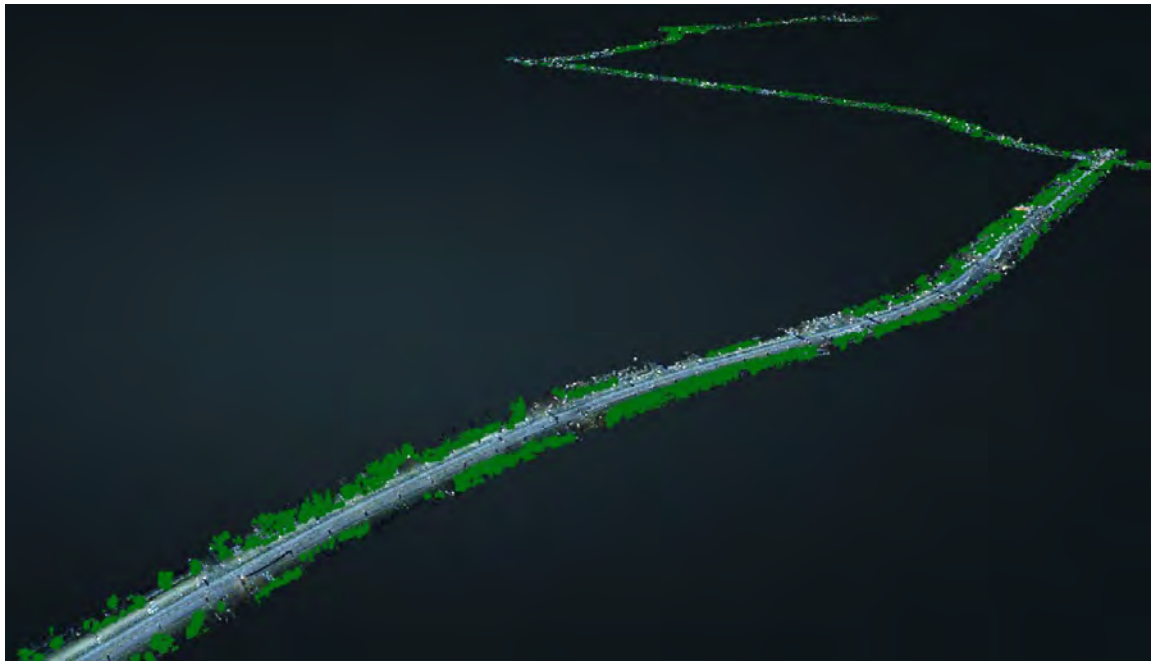
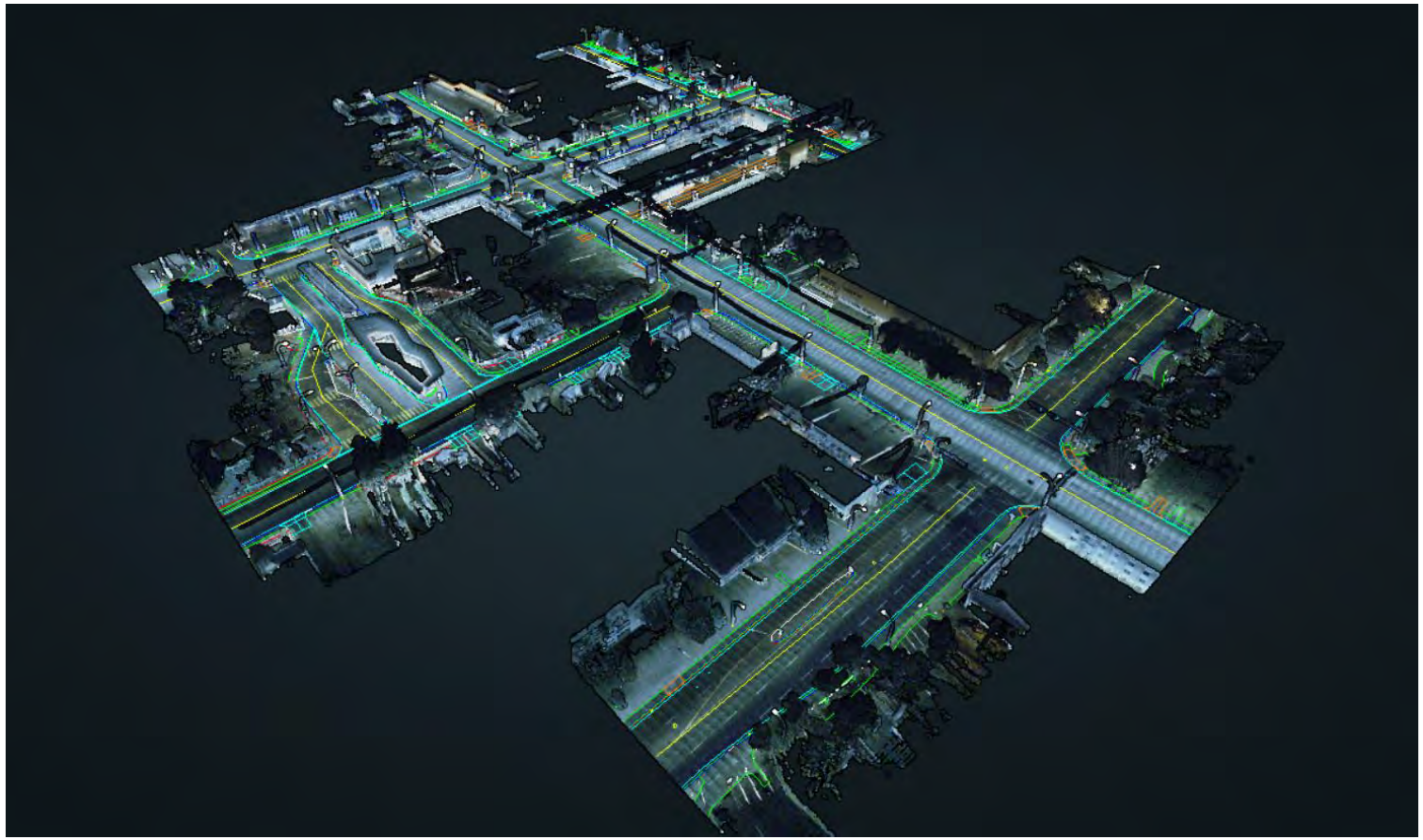
Virtual Tree Inventory



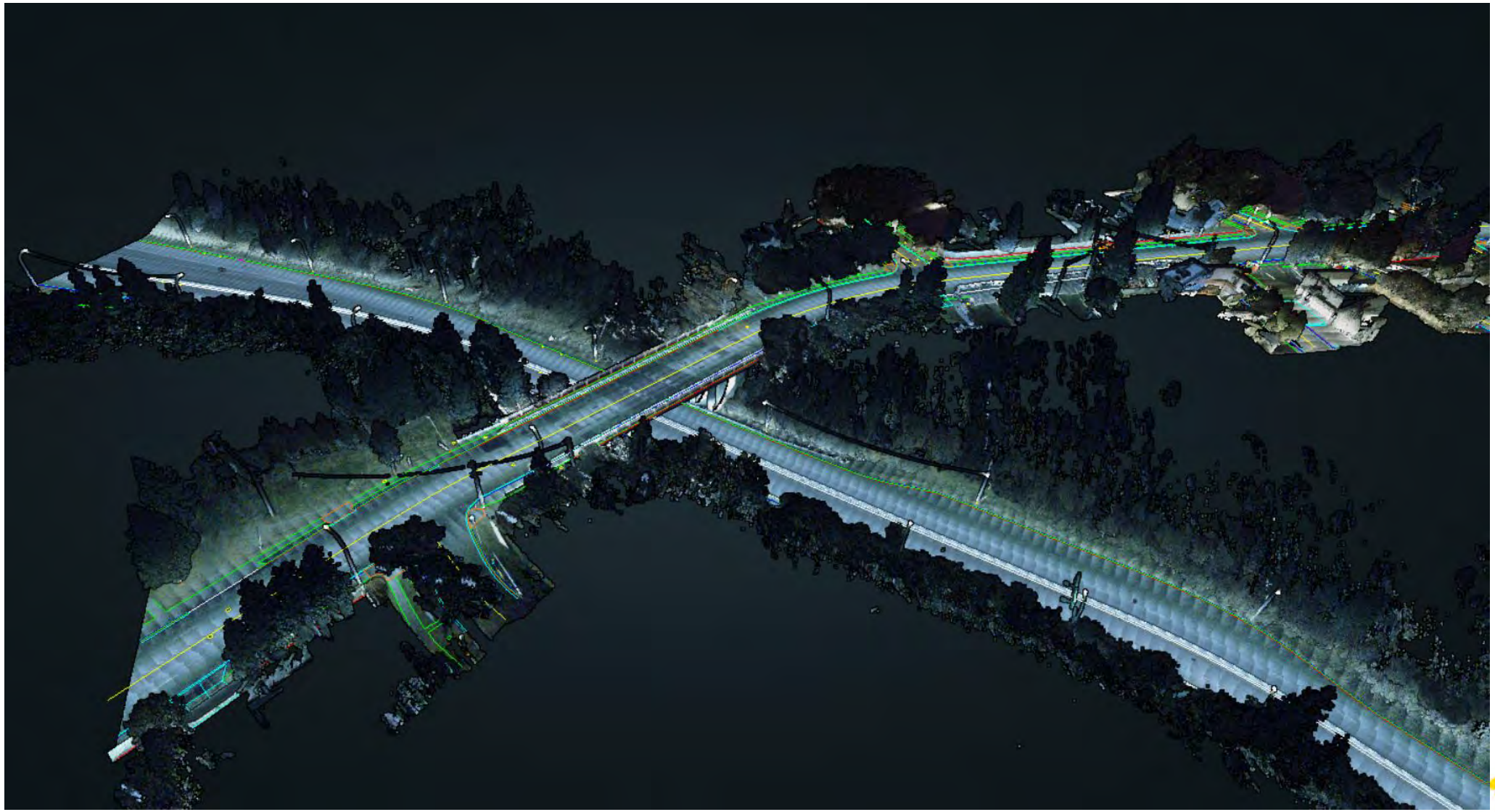
3D CAD-based Documentation of Existing Conditions

Existing Design Documentation

- The data was then used to generate a full as-built of existing conditions
- The consist of 3D CAD Models of existing conditions including
  - Curb details
  - Sidwalks, Ramps
  - Lip of gutter
  - Building line



Existing Design Documentation



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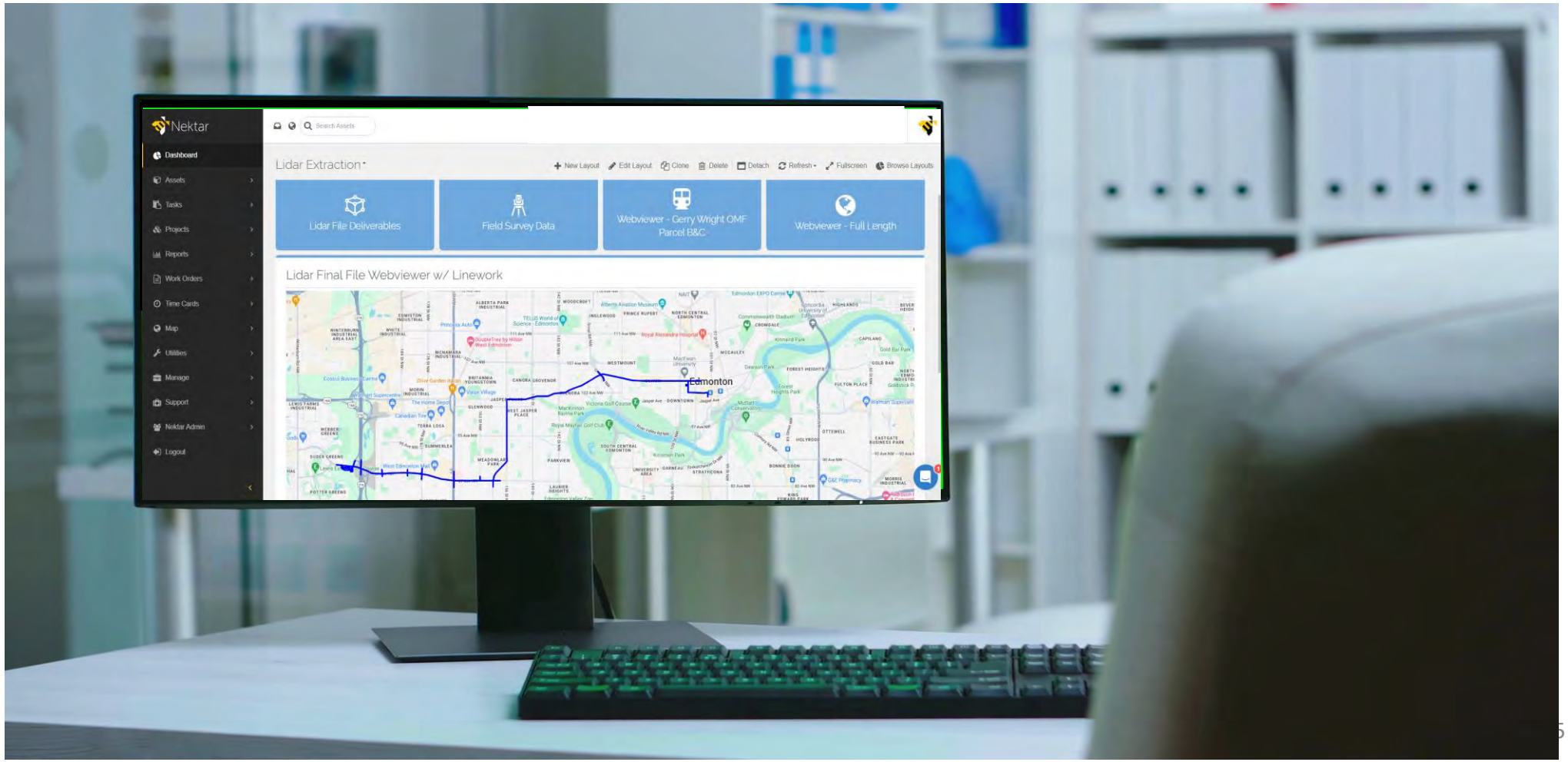
Digital Twinning and Cloud-Based Data Management

THE Nektar3D PLATFORM

Digitalized Regions in Client Dashboard

- Full Project Digitalization (2D and 3D)



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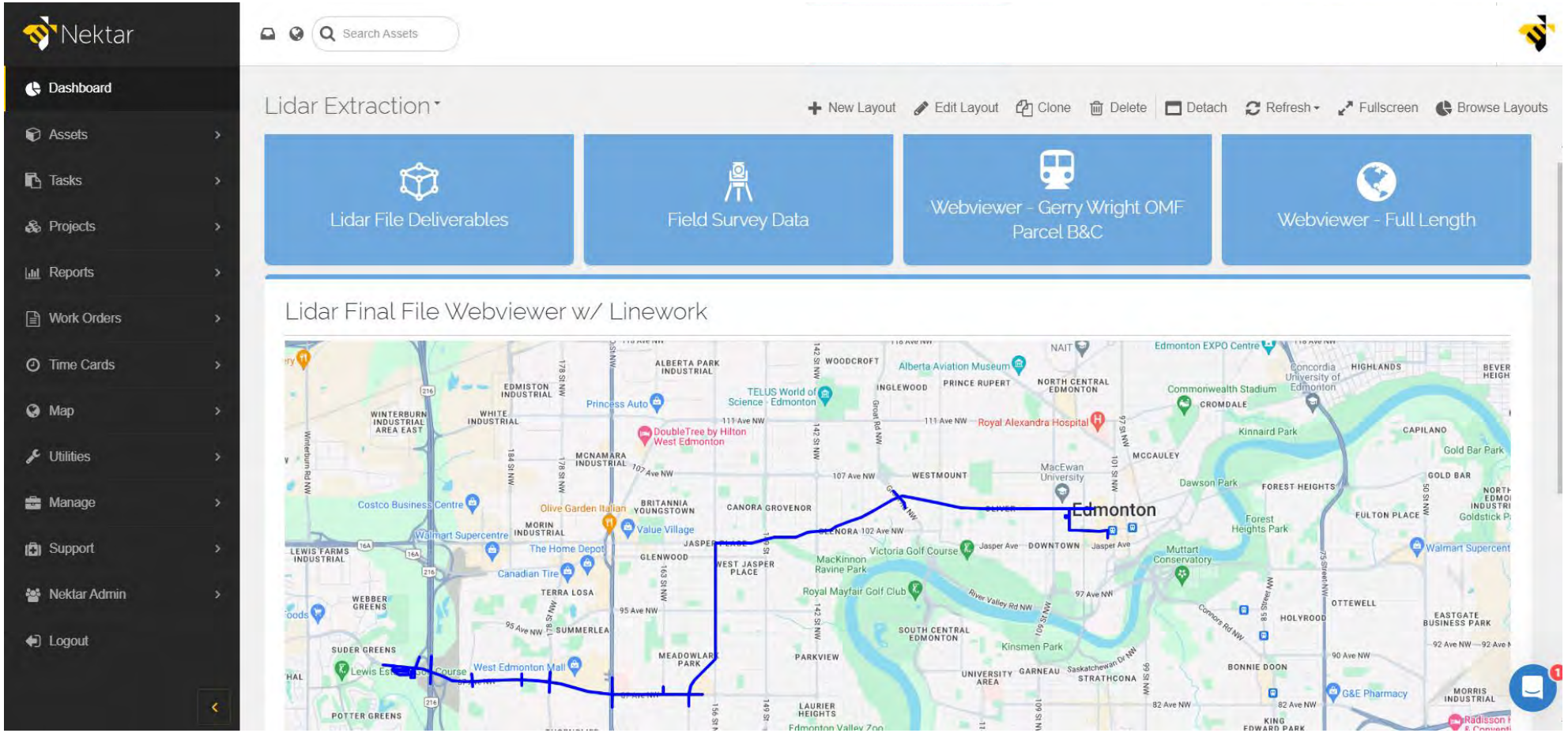
Digitalized Regions in Client Dashboard



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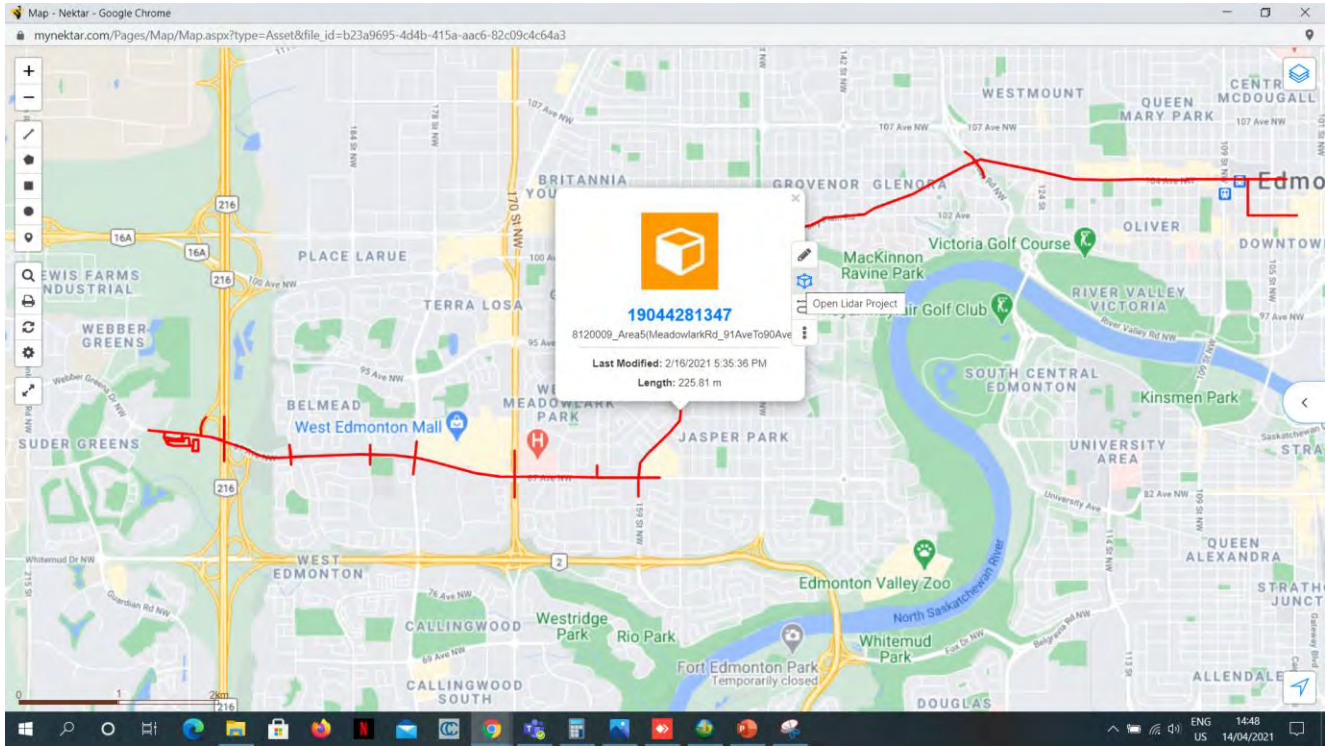
Virtual Site Visits

- All scan files and CAD design files were linked to 2D polylines in a Cloud-Based GIS Platform.
- This facilitated ease of access to different sections of the project corridor.
- Many activities that would typically require conducting a physical site visits were conducted virtually.



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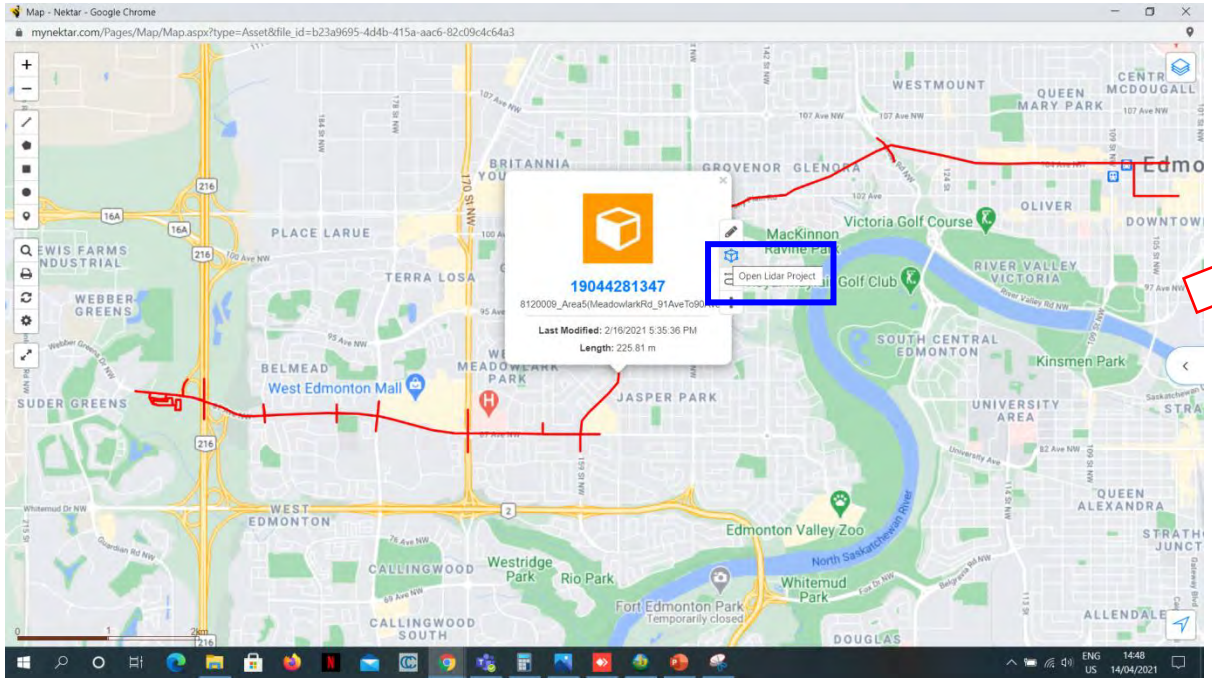
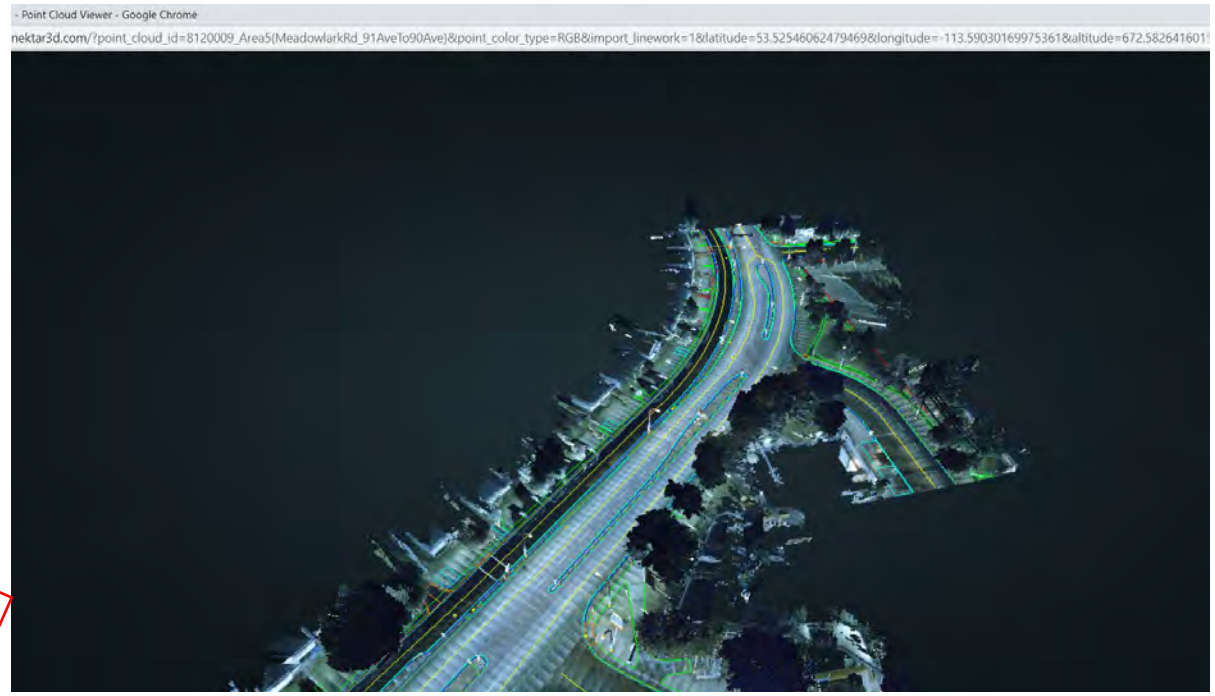
Virtual Site Visits



2D view



3D view

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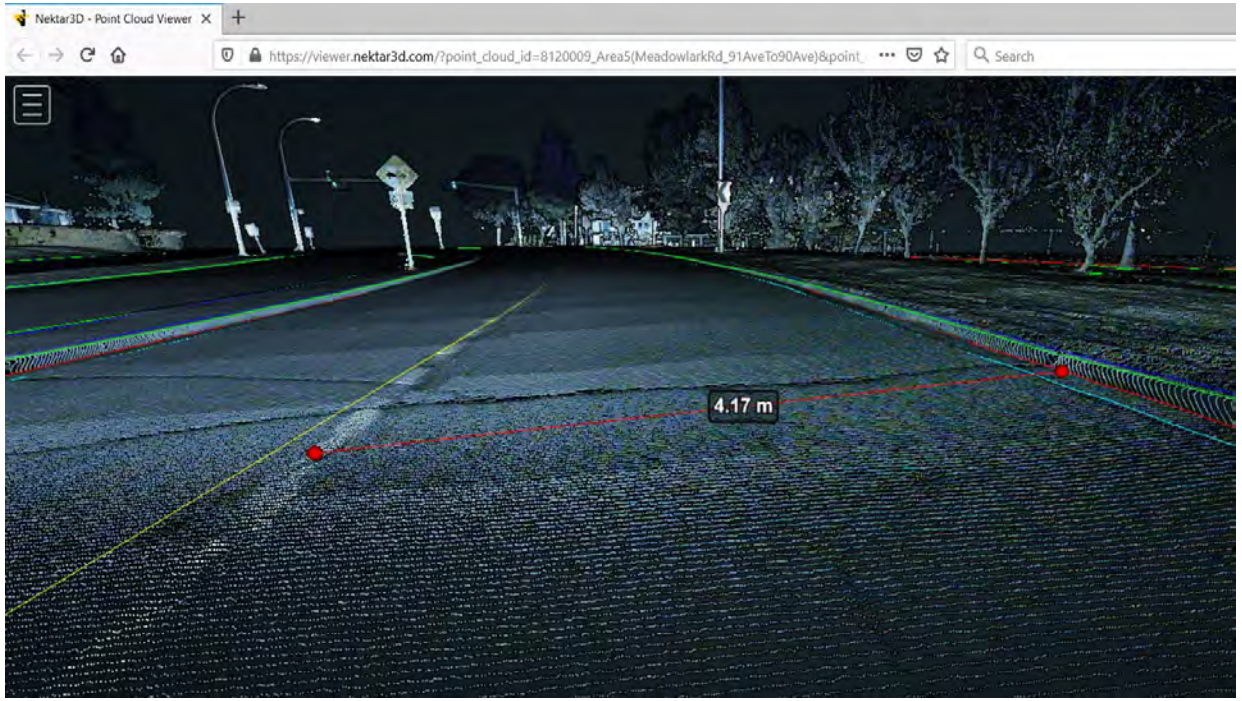
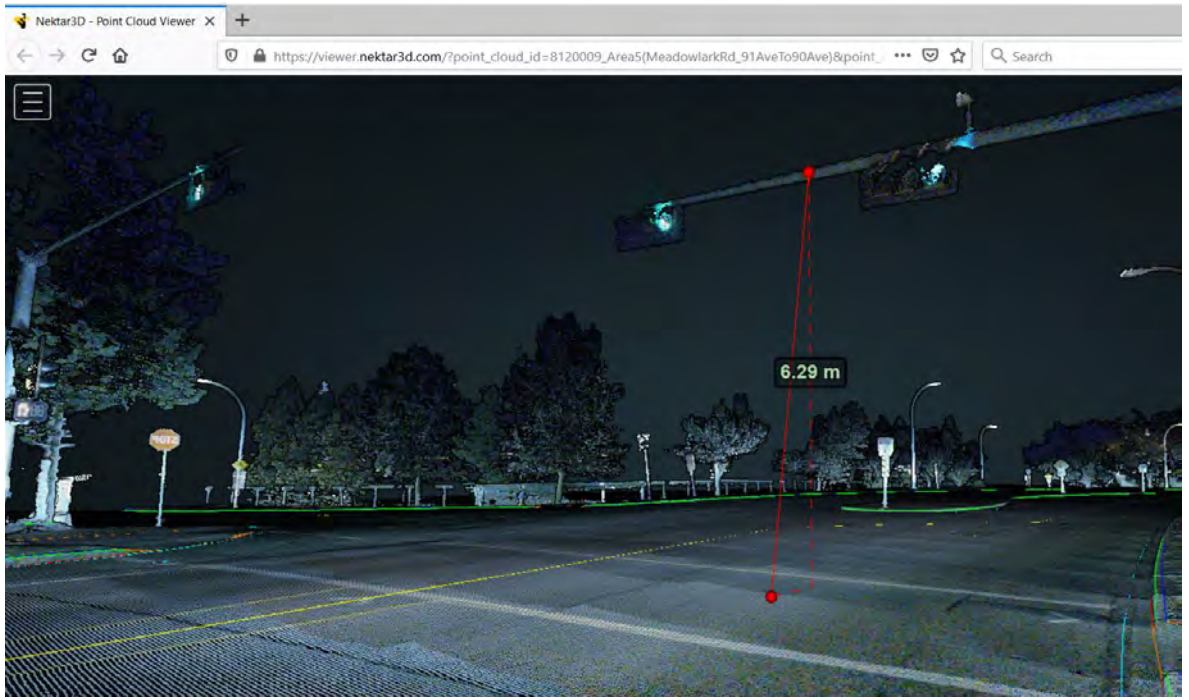
Virtual Site Visits



Virtual Measurements of Road Dimensions



Virtual Assessment of Clearances

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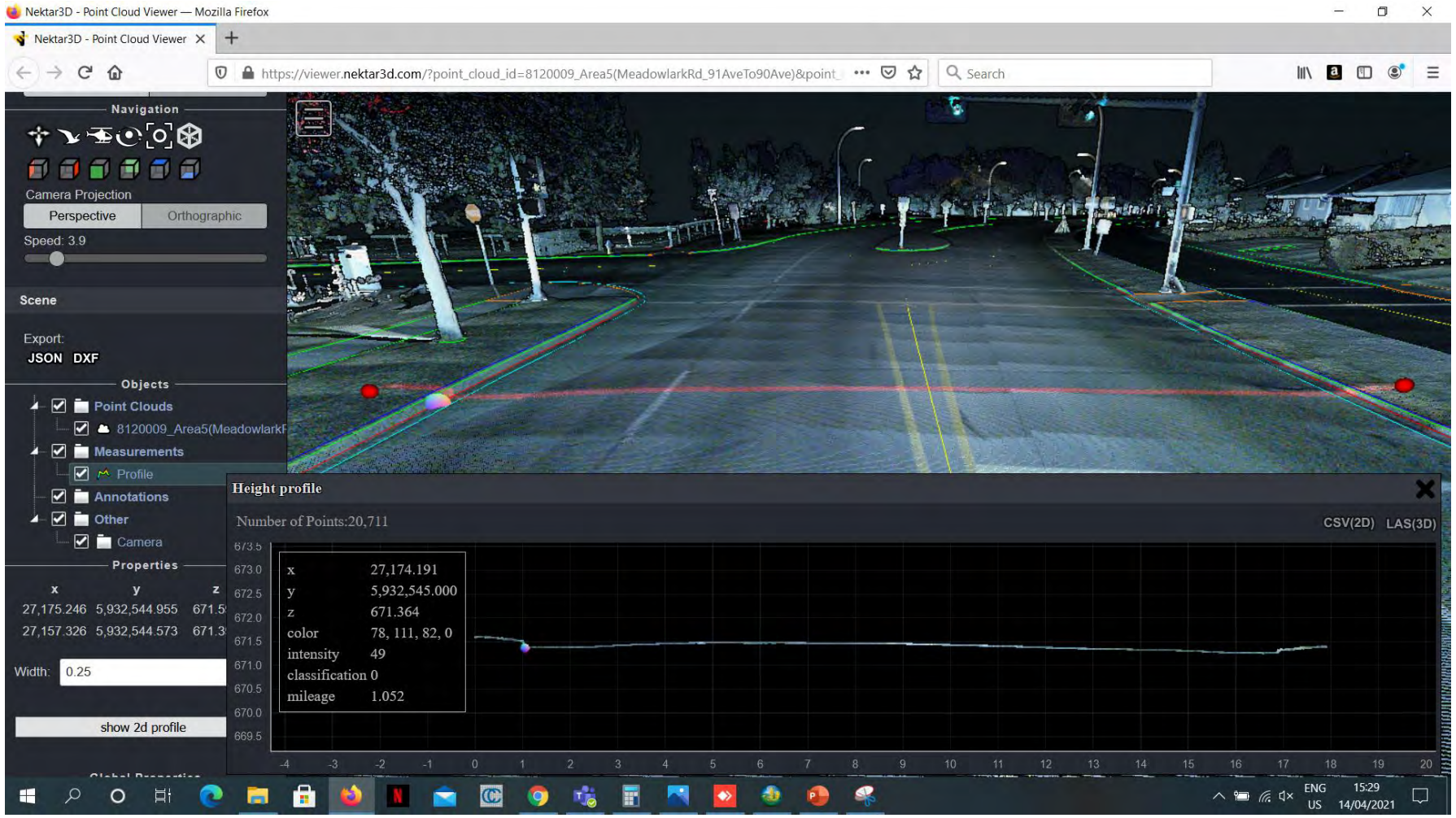
Virtual Site Visits



Virtual Extraction and Assessment of Profiles and Cross Sections

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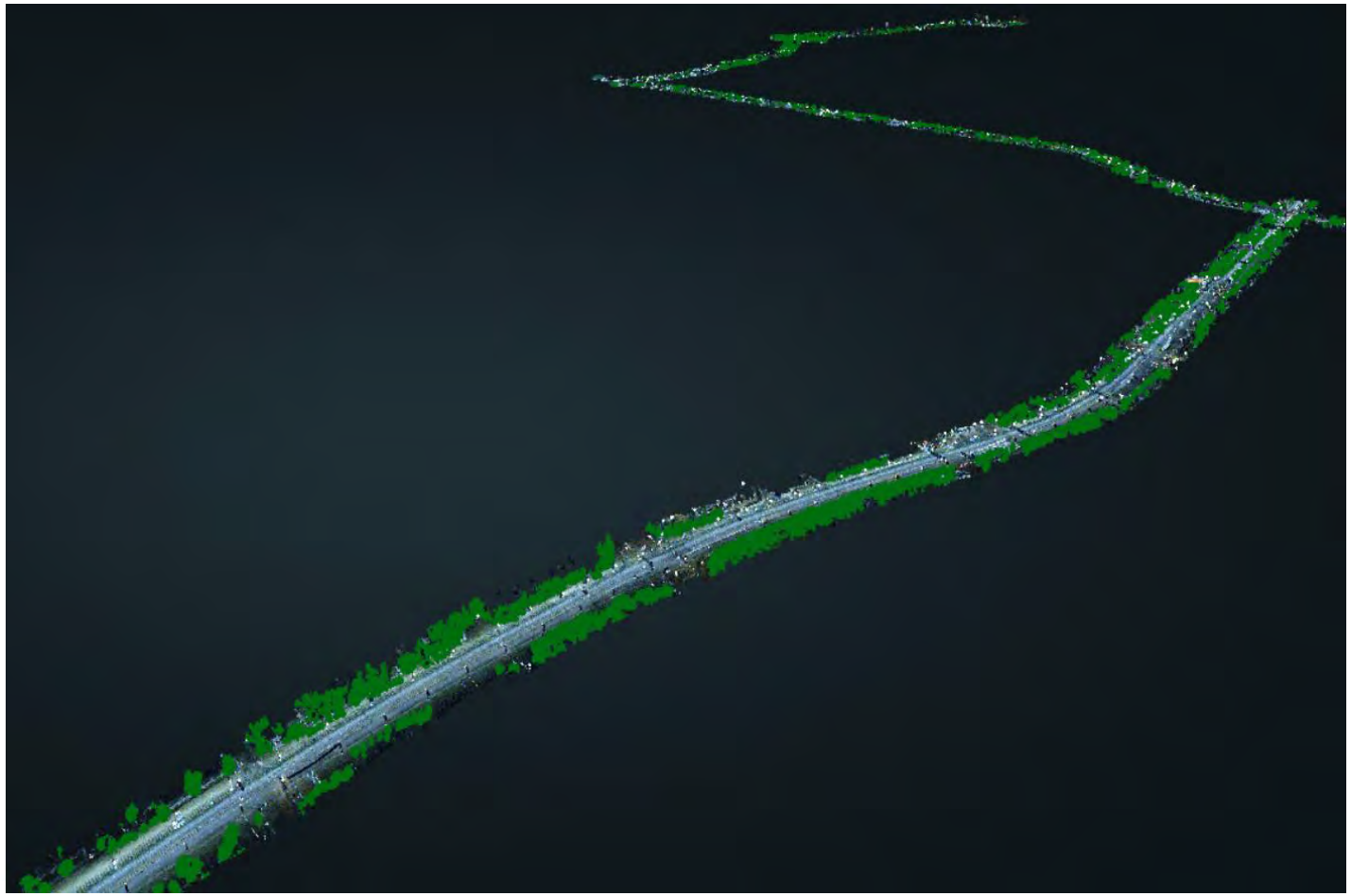
Early Works

Early Works (Tree Conflict Assessment)

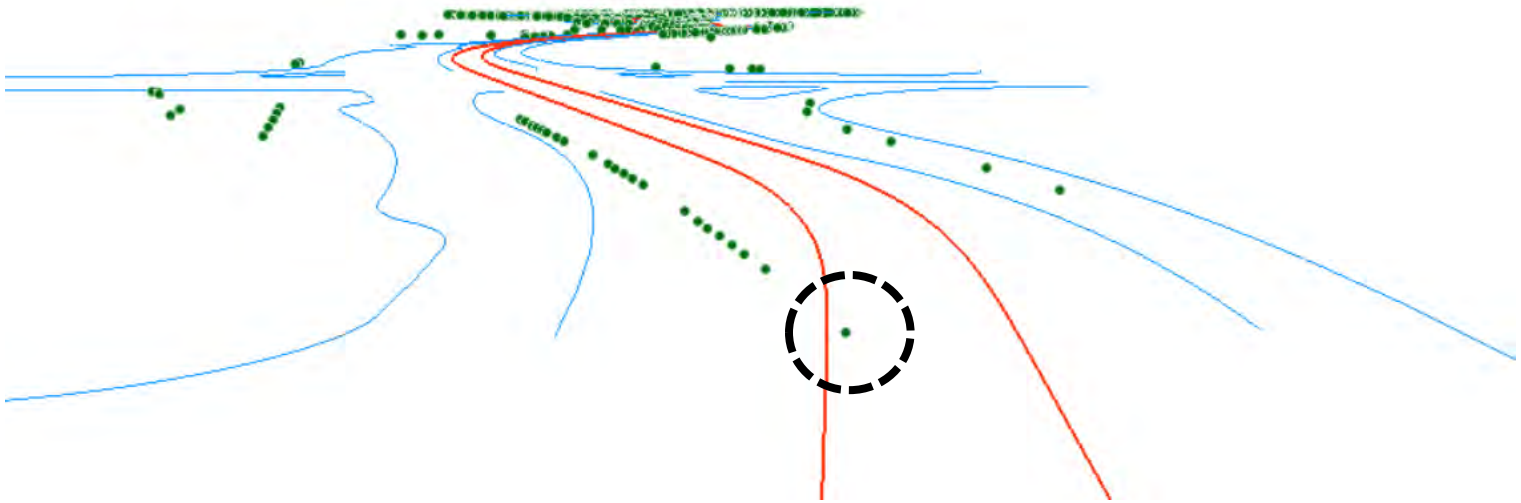
- The tree data extracted from the LiDAR point cloud and the field survey was used to assess conflicts between existing trees and proposed design

- A fully automated script was written to automatically perform the assessment.



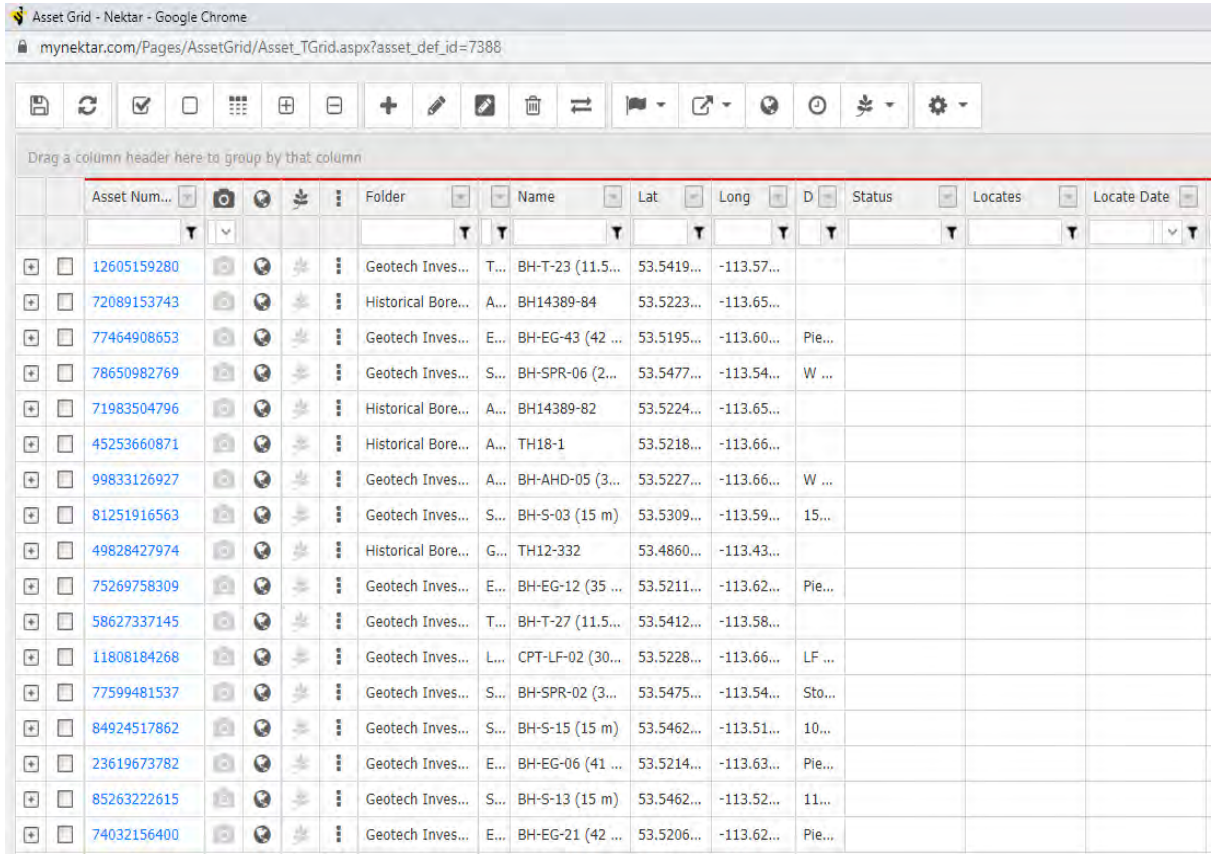
Early Works (Tree Conflict Assessment)

- The algorithm measures distance from all trees to the design lines and flags trees within a specific distance threshold
- The following figure shows an example of a tree in conflict with proposed rail tracks.



Early Works (Borehole Planning)

- The point cloud was also used to map and visualize borehole drilling locations
  - This helped identify potential conflicts
- Drilling boreholes was required to check the ground conditions, which helps project participants with detailed design.



Asset Num...	Folder	Name	Lat	Long	D	Status	Locates	Locate Date
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72089153743	Historical Bore...	A... BH14389-84	53.5223...	-113.65...				
77464908653	Geotech Inves...	E... BH-EG-43 (42 ...	53.5195...	-113.60...	Pie...			
78650982769	Geotech Inves...	S... BH-SPR-06 (2...	53.5477...	-113.54...	W ...			
71983504796	Historical Bore...	A... BH14389-82	53.5224...	-113.65...				
45253660871	Historical Bore...	A... TH18-1	53.5218...	-113.66...				
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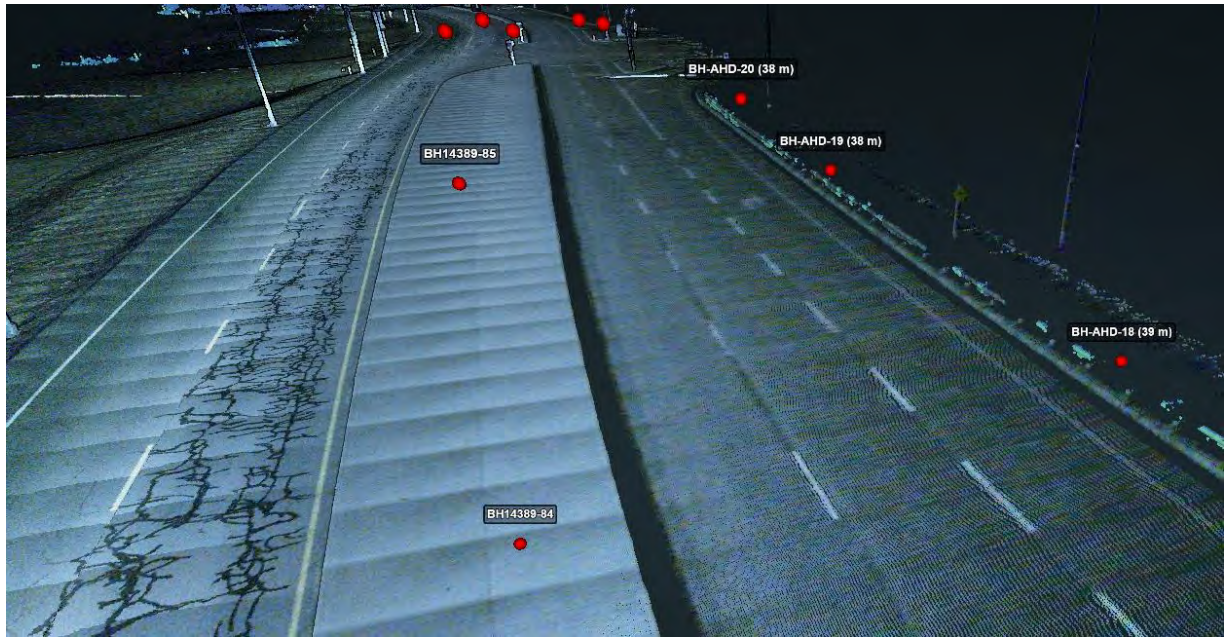
74032156400	Geotech Inves...	E... BH-EG-21 (42 ...	53.5206...	-113.62...	Pie...			

List of Borehole Locations Imported into the GIS Platform

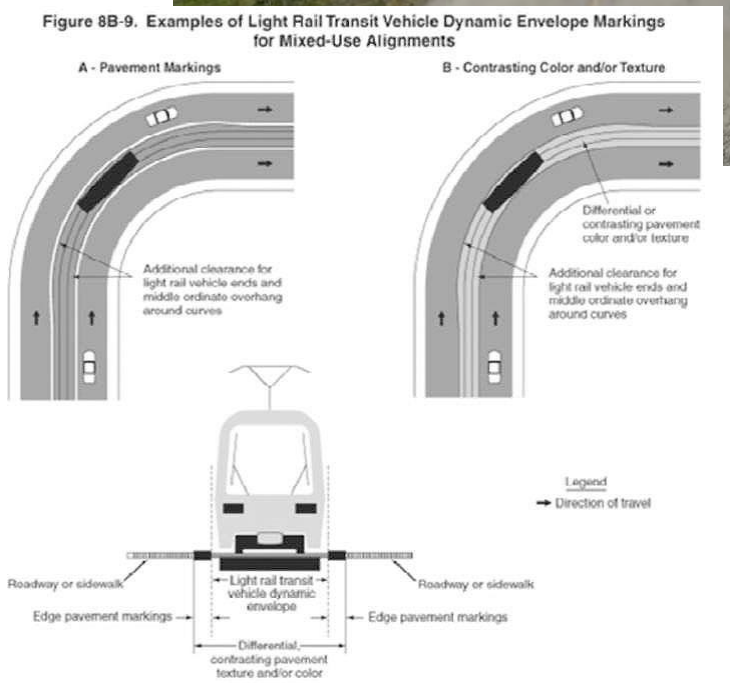
Early Works (Borehole Planning)



Planning Borehole Drilling in the 3D point cloud

Other Work

- Construction Quantity Estimates
  - *Using a combination of mobile LiDAR and RTK Drone Technology, the Project team could efficiently assess construction quantities.*
- Line of Sight Assessments
  - *Assessing sight distance along the corridor is also possible in the 3D point cloud.*
- Clearance Assessments
  - *Assessing conflicts between LRT vehicles and existing overhead assets.*



Conclusions & Future Work

- This presentation demonstrates how mobile LiDAR scans can be fully utilized beyond being a simple replacement to traditional survey
- Machine learning, AI, geospatial analytics were employed to help in:
  - **Cleaning and processing** the point clouds.
  - Documenting **3rd Party Assets**
  - Producing **3D CAD models** of existing conditions for **design**.
  - Facilitating **virtual site visits** in a cloud-based platform.
  - Supporting the projects **early works** including *tree inventory* and *tree conflict assessment* and *borehole mapping*.
- Besides improving the efficiency of project activities, the technology also provided the project team with more details about the project.

Acknowledgements

COLAS CANADA

THE CITY OF Edmonton

PARSONS

Stantec

Questions ?

CONTACT:

Dr. Suliman Gargoum

Cofounder and Advisor,
Nektar 3D Consulting,
Edmonton, Alberta, Canada
Tel: 780-200-0161
Office: 780-221-6159
suliman.gargoum@nektar3d.com

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