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GEOSPATIAL WORLD FORUM

TRANSFORMING ECONOMIES IN 5G ERA

The Geospatial Way!

7-9 April 2020 /// Amsterdam

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Presentation Outline

- review modern survey methodologies available to support railway requirements
- measuring everything from whole states to tiny switches
- recent case studies showing what is possible.

Railway’s Survey Requirements

1. State: for network planning
2. Line: for design works
3. Section: for maintenance / duplication
4. Station: for upgrade works
5. Asset: for maintenance works.

Survey Technology Available

1. Large Areas / Initial Design: Satellite based
2. Medium Areas / Engineering Design: Aircraft based
3. Corridors: Vehicle based (rail or road)
4. Small Areas: UAVs and Field Surveys
5. Data Analysis: Geographic Information Systems.

1. L

30 cm Satellite Imagery of Delhi

1. Initial Design: Satellite Imagery

Features:

- Range of platforms including Cartosat, Digital Globe, …

Pros:

- No mobilisation costs
- Can provide the 3rd dimension with stereo coverage
- Suitable for design consideration of land use

Cons:

- Accuracy and resolution only suits high level planning, not engineering design.


10 cm Aerial photography

2. Engineering Design: Photos

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Features :

- Aerial survey cameras, fitted to fixed wing or helicopters

Pros:

- Provides landuse details efficiently and accurately
- Resultant orthophotos provide valuable data layer for other project uses
- Height information available from stereo photos

Cons:

- Requires field completion of areas obscured by vegetation
- Mobilisation costs make it less efficient for small areas.

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2. Engineering Design: LiDAR

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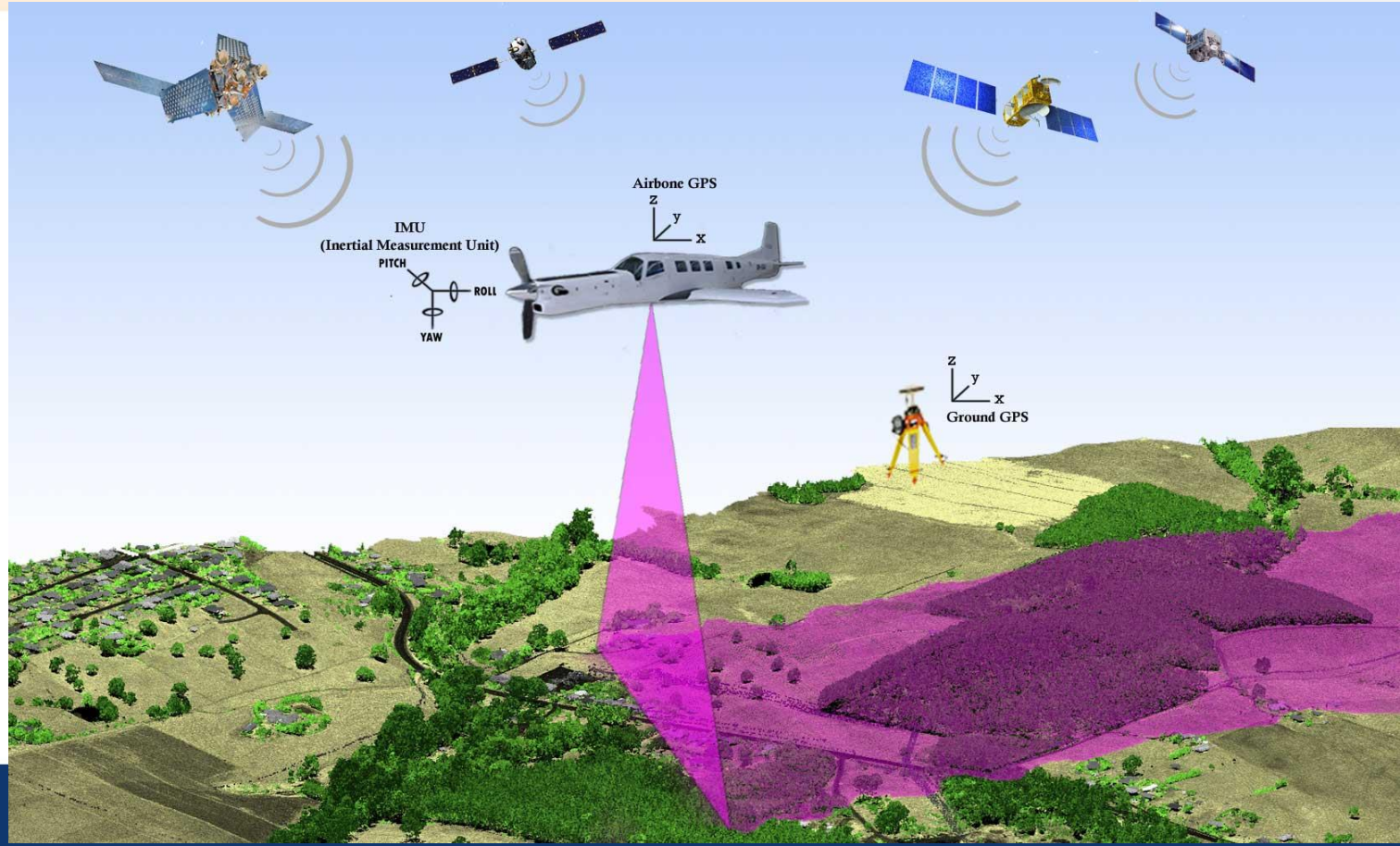
Aircraft based measuring laser



2. Engineering Design: LiDAR

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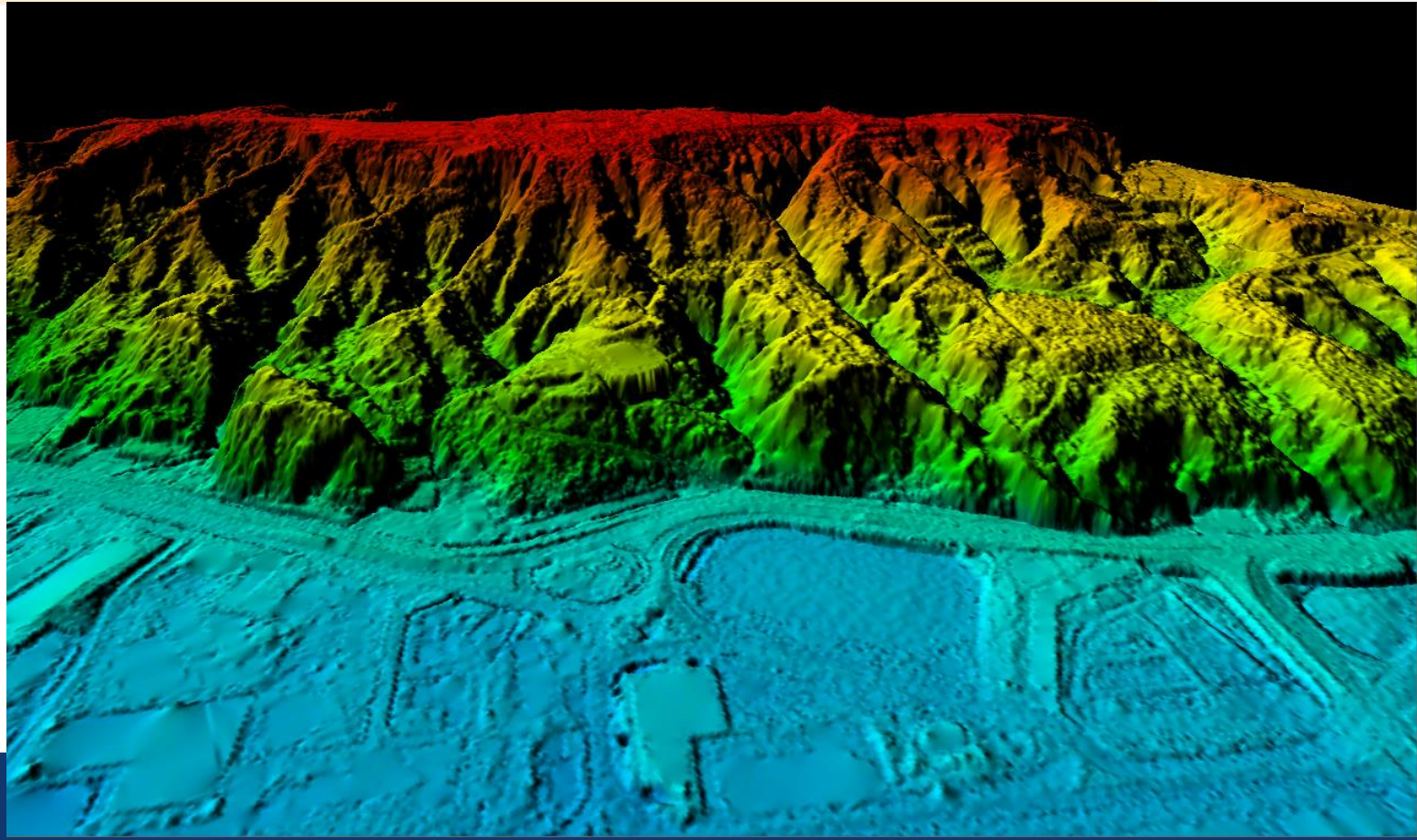
Defines terrain under vegetation and all above-ground features



2. Engineering Design: LiDAR

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Features:

- Aircraft based (helicopter or fixed-wing)
- Laser defines surface with many points per square metre (1 to 60 pt/m^2)
- Often operated with aerial camera

Pros:

- Very dense definition of terrain and everything on it
- International technology of choice for engineering-grade terrain definition

Cons:

- Mobilisation costs make it less efficient for small areas.

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3. Corridor: Mobile Mapping

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Vehicle mounted laser and image measurement

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3. Corridor: Mobile Mapping

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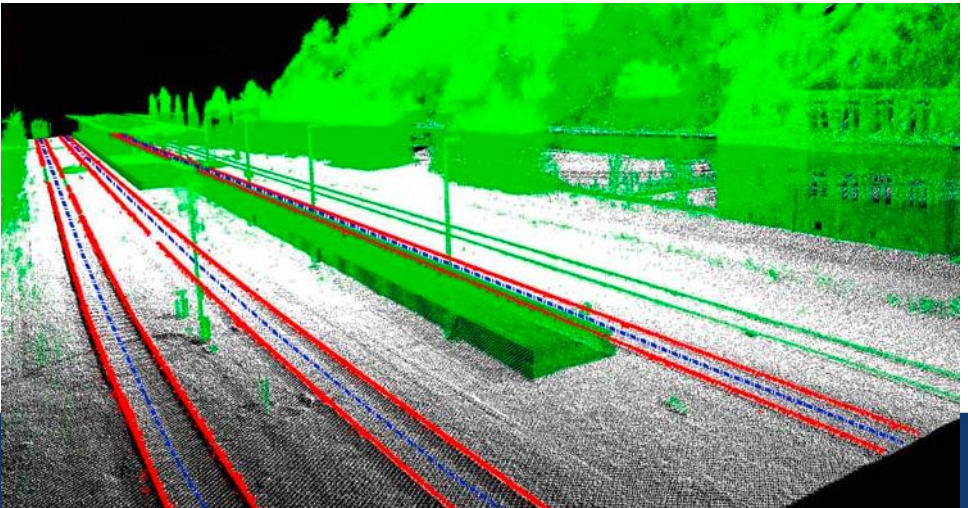
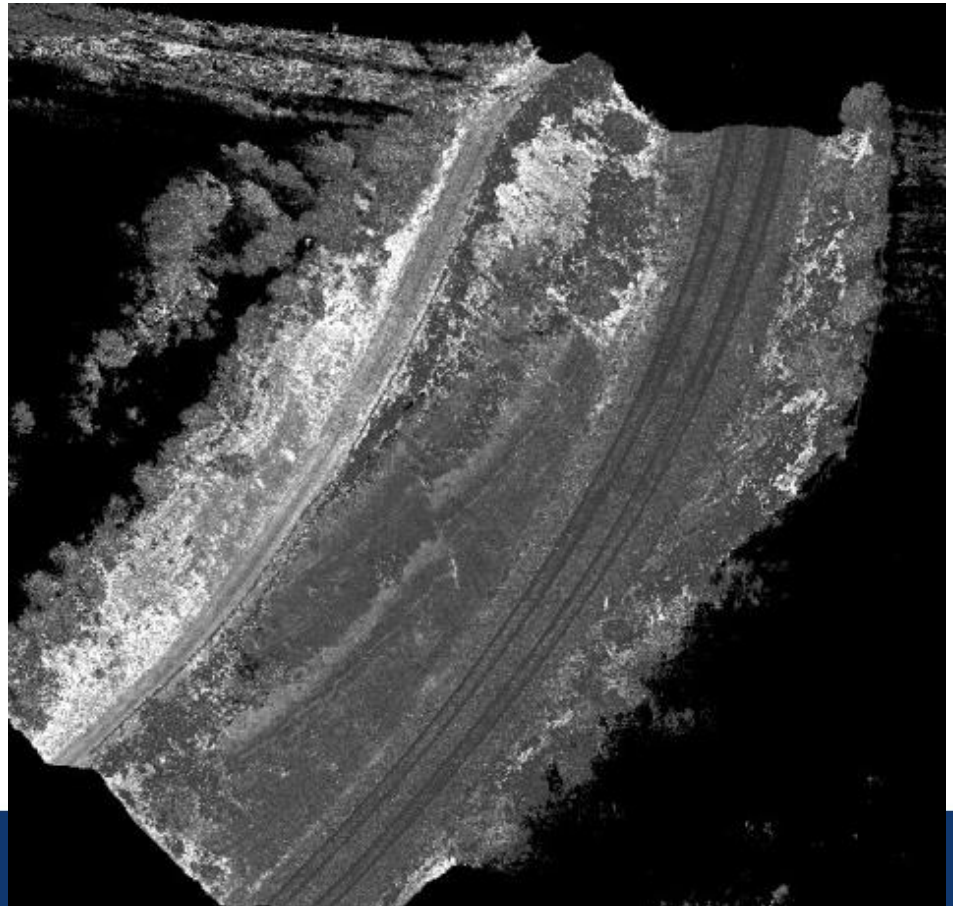
Single pass records location of every visible feature to cm accuracy





3. Corridor: Mobile Mapping

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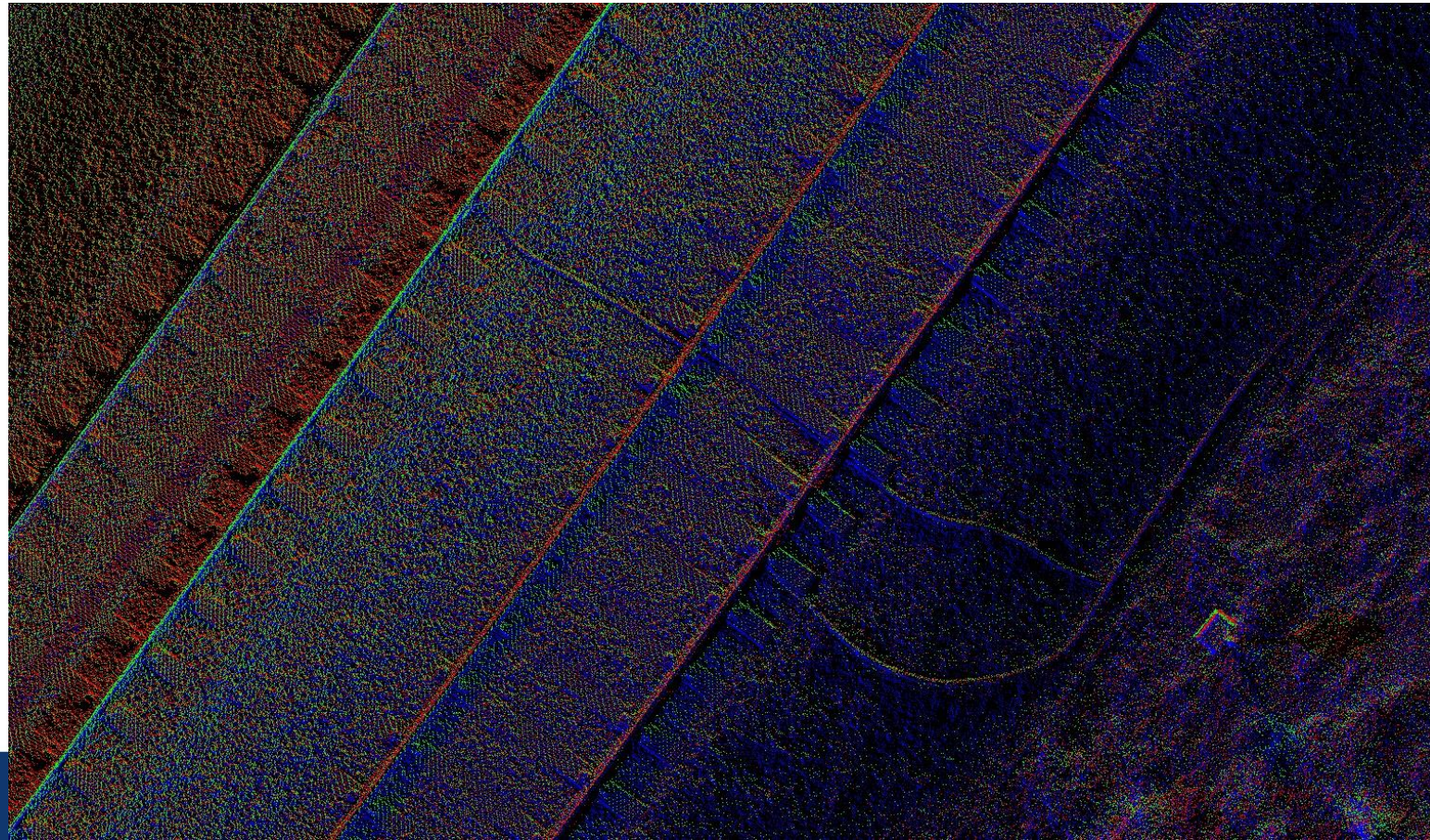
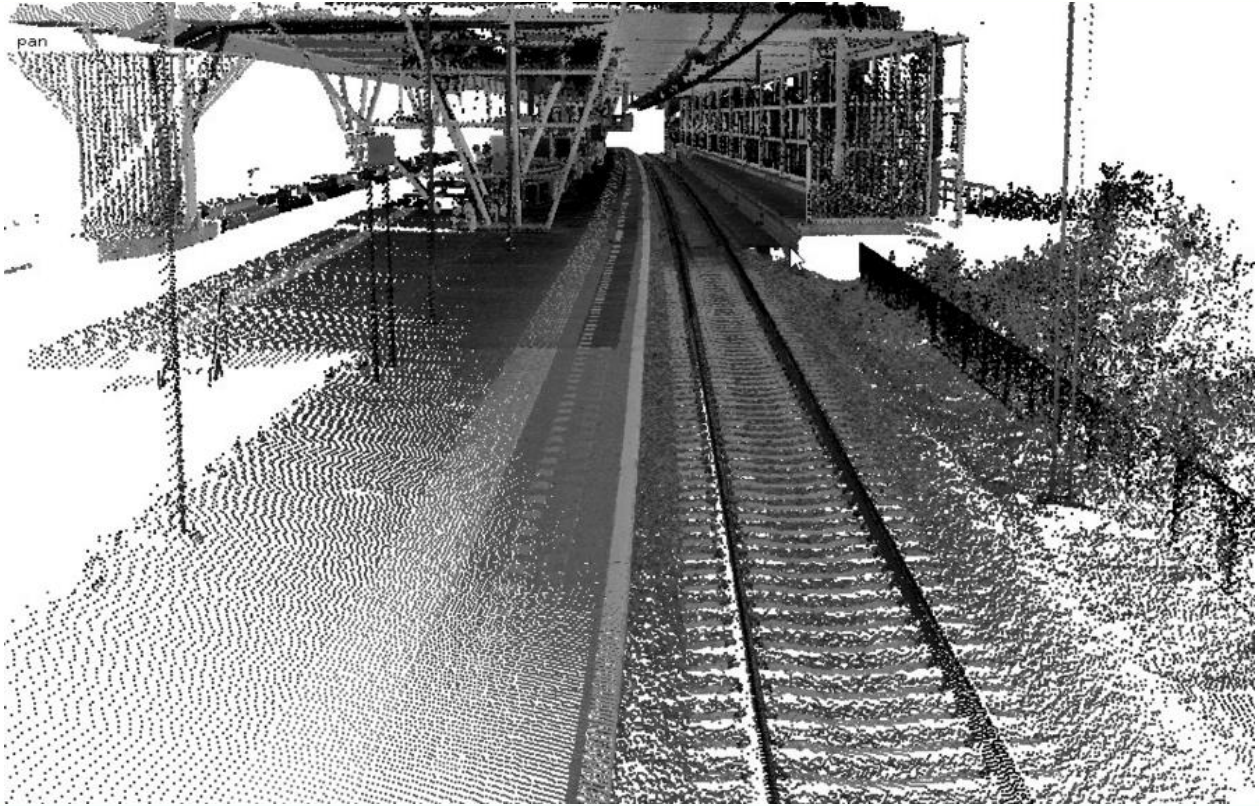
Complete definition



3. Corridor: Mobile Mapping

Complete definition in 3D



3. Corridor: Mobile Mapping

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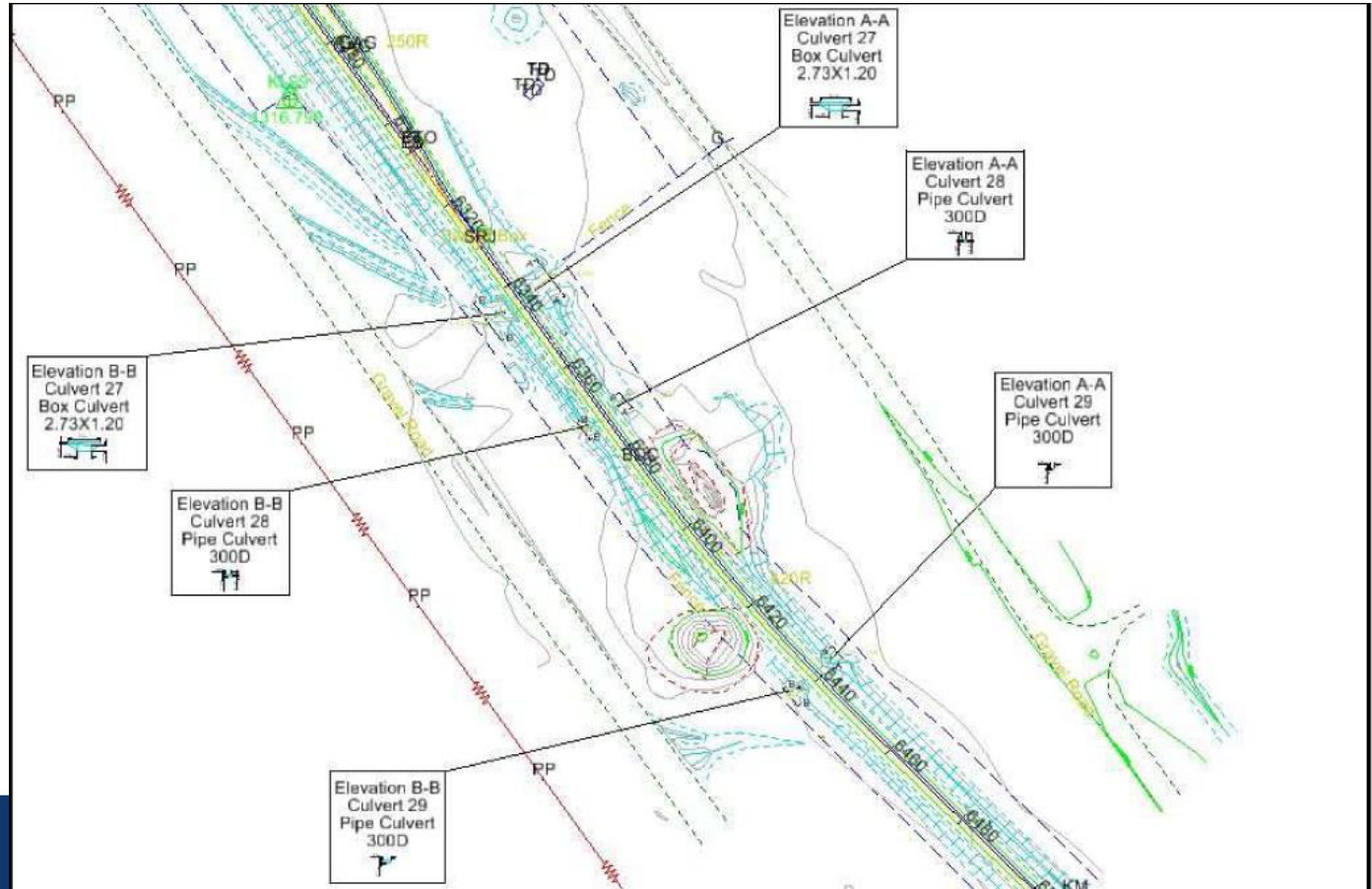
Features extracted from the laser data :

- Rail centreline
- signs
- stanchions
- crossings
- signals
- rail furniture,
- trees,
- overpasses ….



3. Corridor: Mobile Mapping

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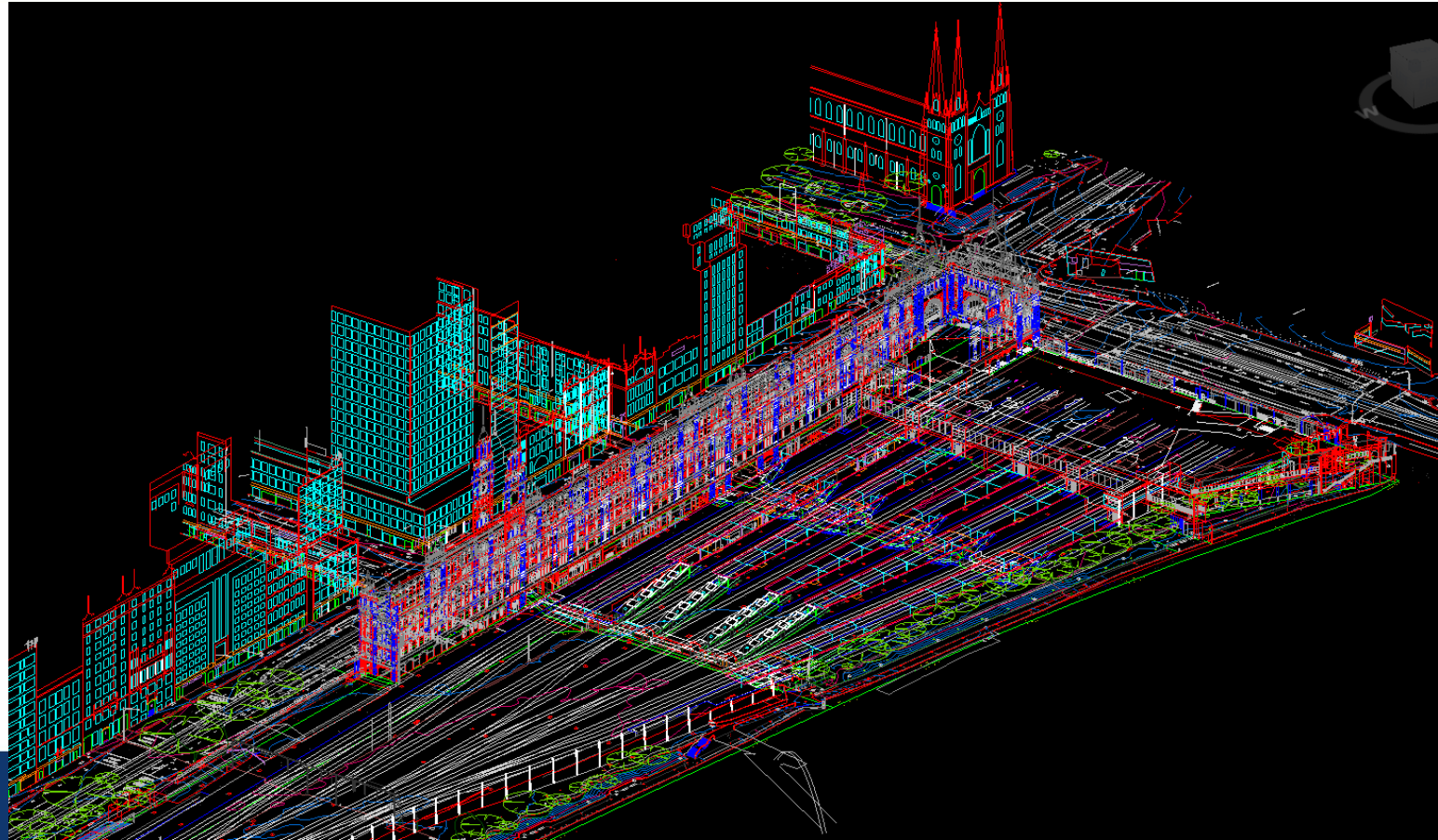
Complete rail model extracted from LiDAR pointcloud



3. Corridor: Mobile Mapping

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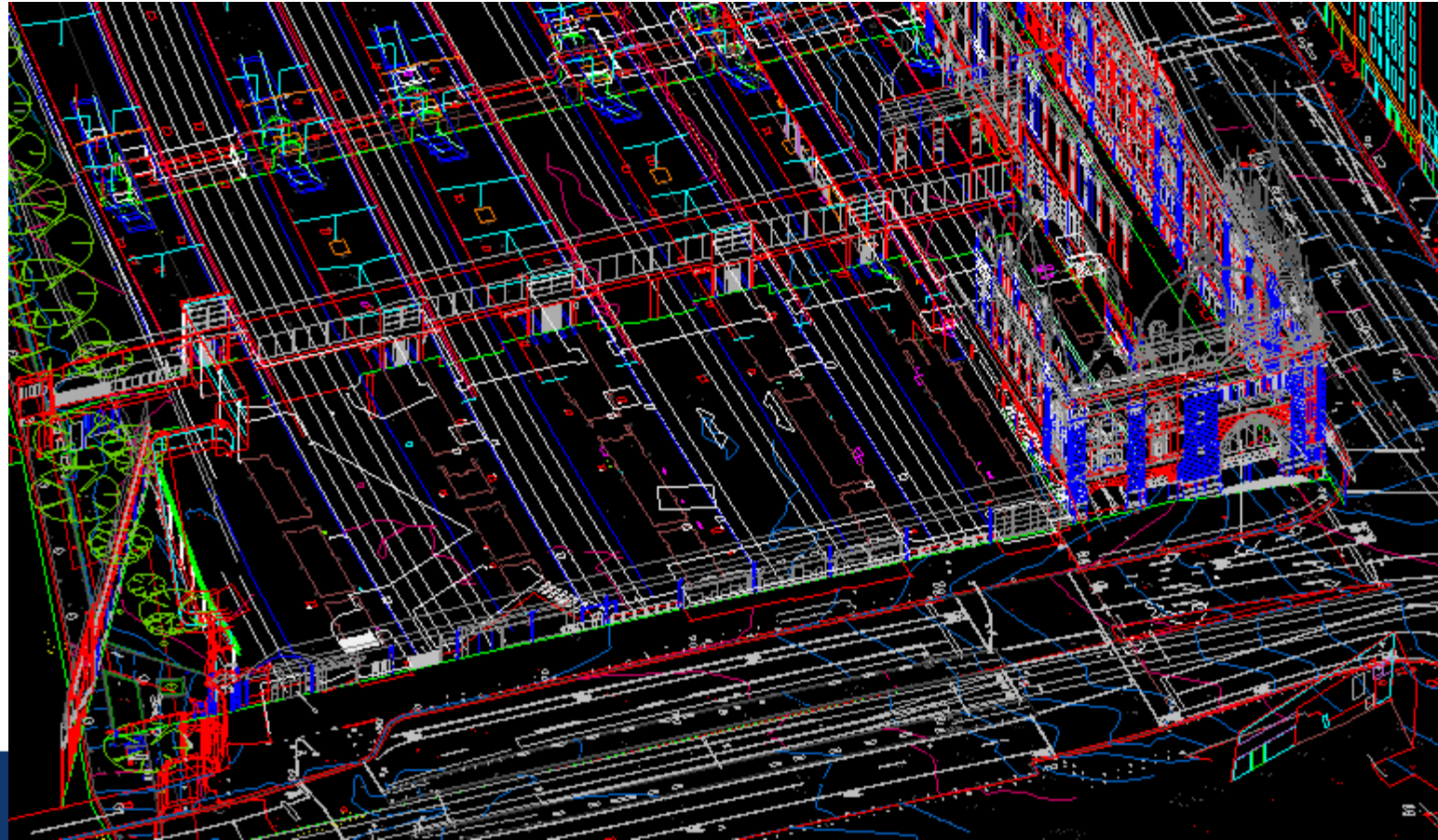
Complete rail model extracted from LiDAR pointcloud



3. Corridor: Mobile Mapping

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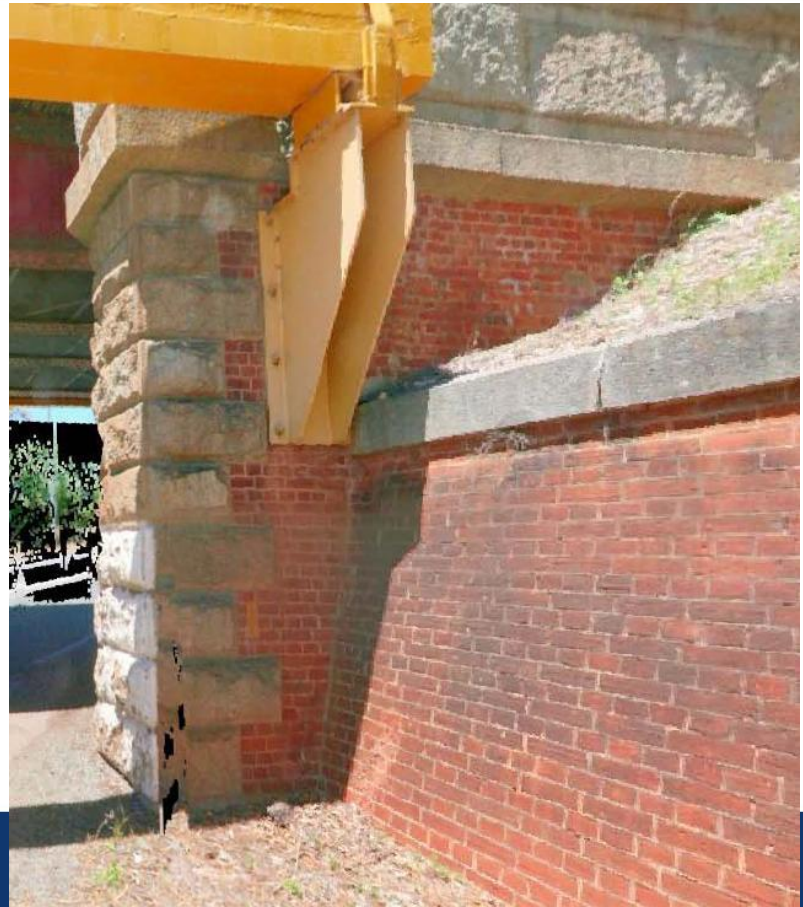
Concurrent imagery adds:

- Condition
- Clarity
- Understanding

to location provided by LiDAR.



3. Corridor: Mobile Mapping

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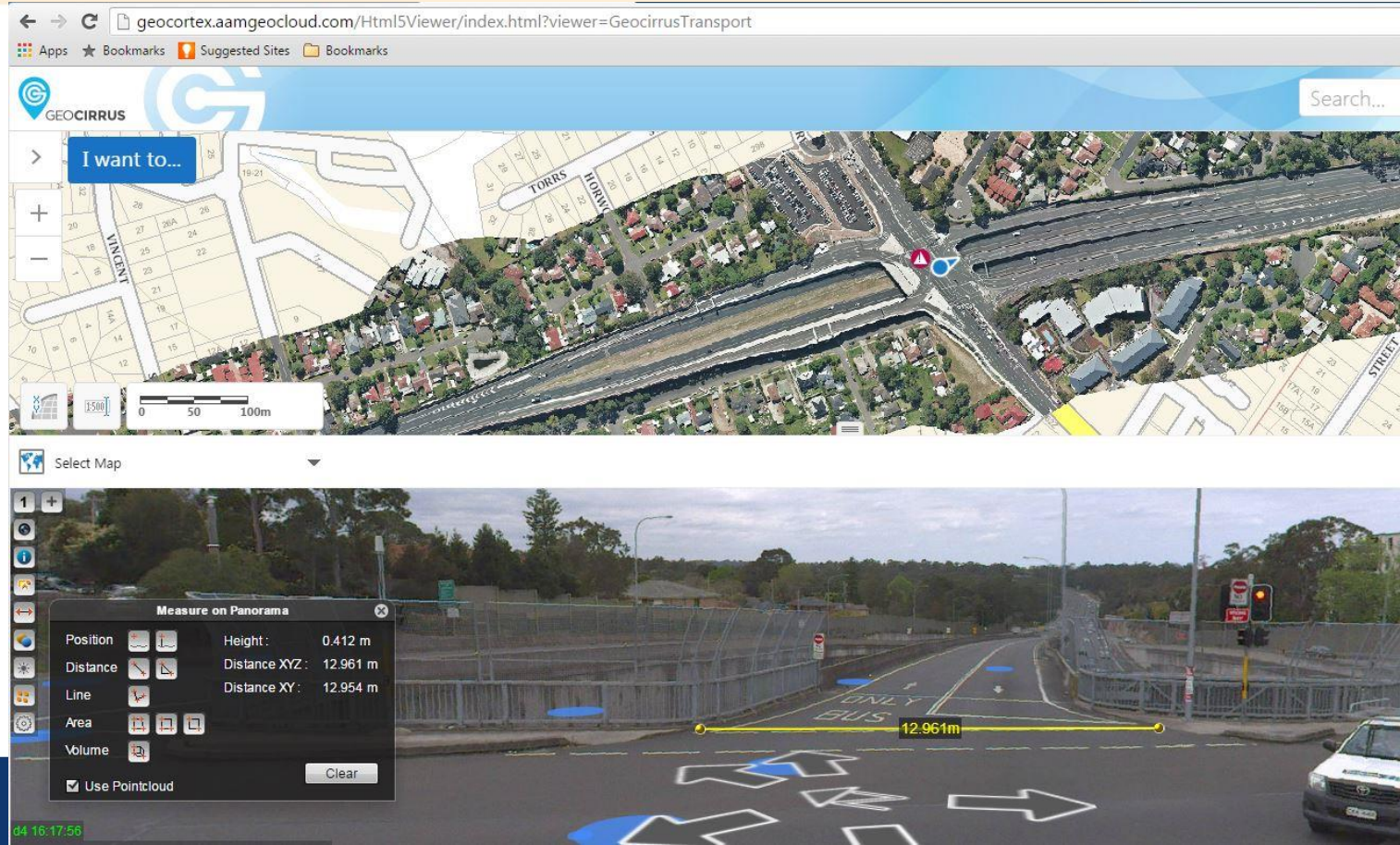
Complete clarity provided by combining LiDAR and Imagery



3. Corridor: Mobile Mapping

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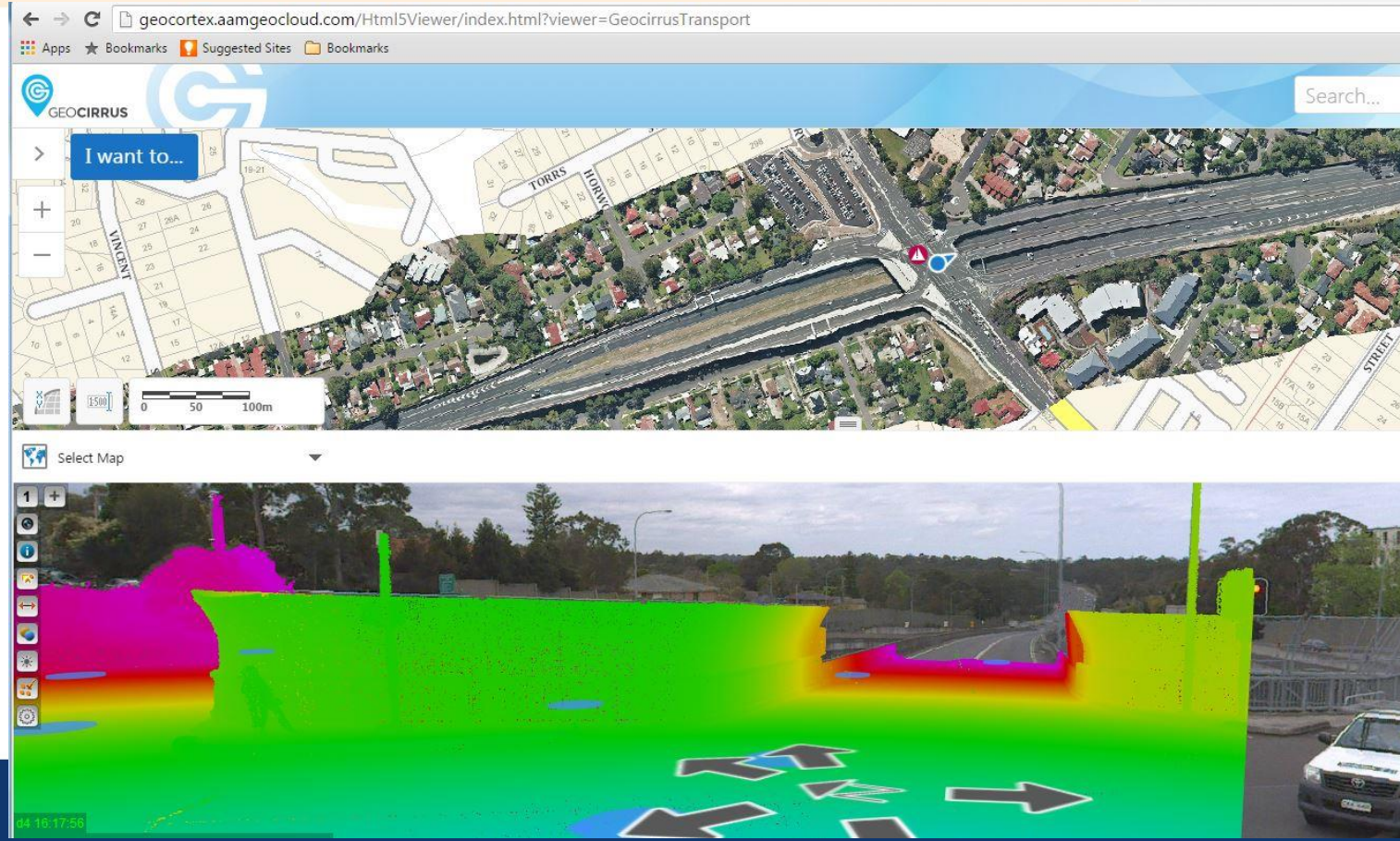
Complete clarity provided by combining LiDAR and Imagery



3. Corridor: Mobile Mapping

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Features:

- Vehicle based, usually car or train, but also boat, rickshaw, trolley, backpack
- Laser defining surface with many points (50 to 1000+ pt/m^2)
- Often operated with camera (to add “what” to the LiDAR’s “where”)

Pros:

- Acquisition at vehicle speed
- Very efficient means of defining roadside boundaries

Cons:

- Accuracy deteriorates in urban canyons (GCPs can assist)
- Mapping limited to that visible from sensor.

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3. Corridor: Mobile Mapping

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High accuracy available with experienced survey design

Accuracy The accuracy of the data depends on a number of variables including time of day, latitude of survey, solar conditions, ionospheric conditions and GPS obstructions. However, here are some typical accuracies:	**Conditions**	**Example**	**Without GCPs***	**With GCPs***
	Good	Open highway	<3cm	<1cm
	Average	Urban environment with occasional tall buildings	<6cm	<2cm
	Bad	City environment with tall buildings	<100cm	<10cm

**GCPs = ground control points*

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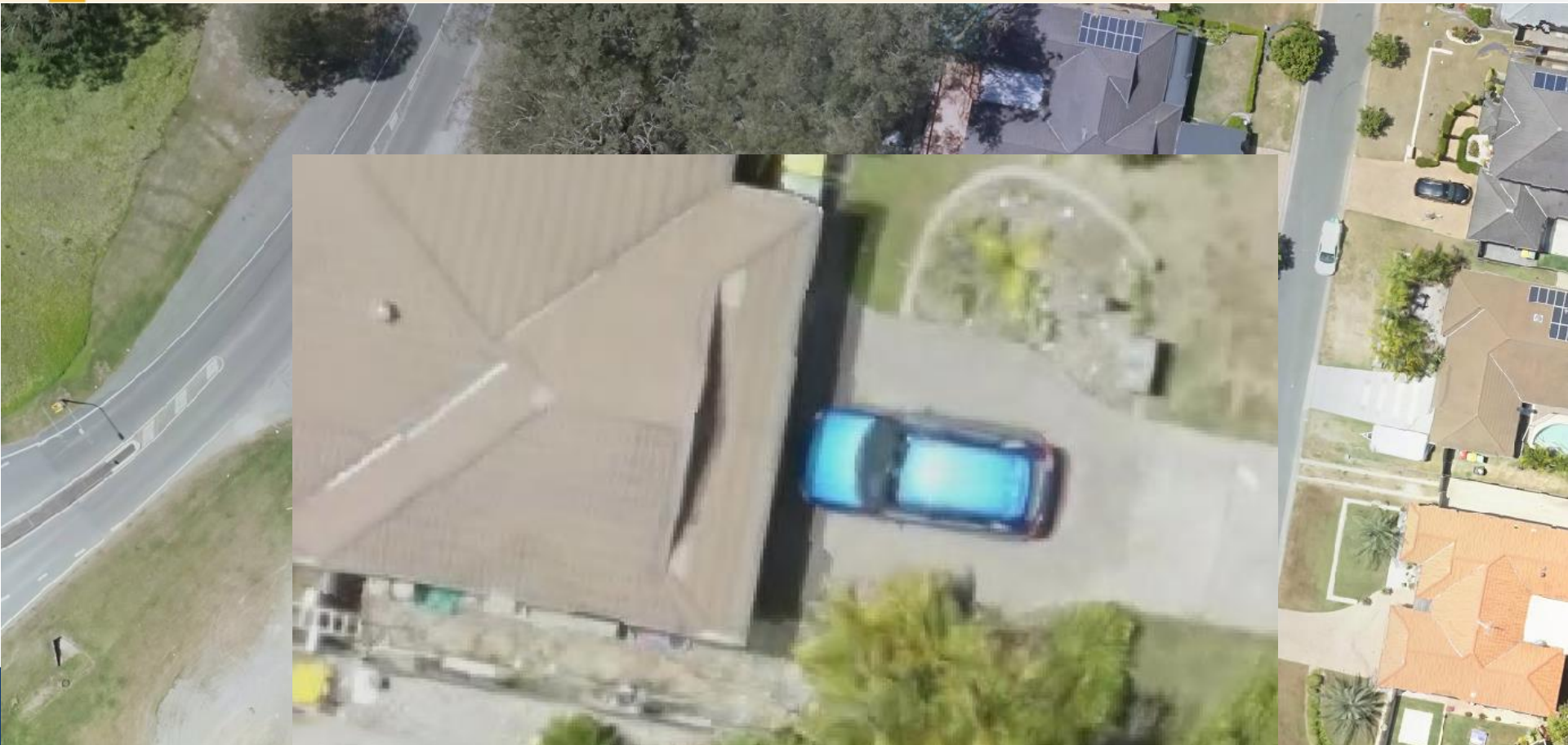
4. Small Areas: UAVs



4. Small Areas: UAVs

Features:

- Small format camera,
- mounted on small un-manned aircraft

Pros:

- Easy to mobilise
- Low cost equipment
- High resolution available, typically 2 to 5 cm
- Automatic software can build 3D surface models

Cons:

- Short sortie duration, typically supporting 1 to 2 km^2 per day capture
- More problematic (less safe) over urban areas.

4. Small Areas: Field Survey

Features:

- Features mapped by brief GPS occupation, or ETS radiation

Pros:

- Highest pointing accuracy

Cons:

- Very slow: survey undertaken at walking pace
- Higher safety risk / cost.

Case Study 1: Whole Line

Task:

- Design major new rail corridor – accuracy required
- 1700km long – rapid acquisition required
- 8km wide – to provide design flexibility

Case Study 1: Whole Line

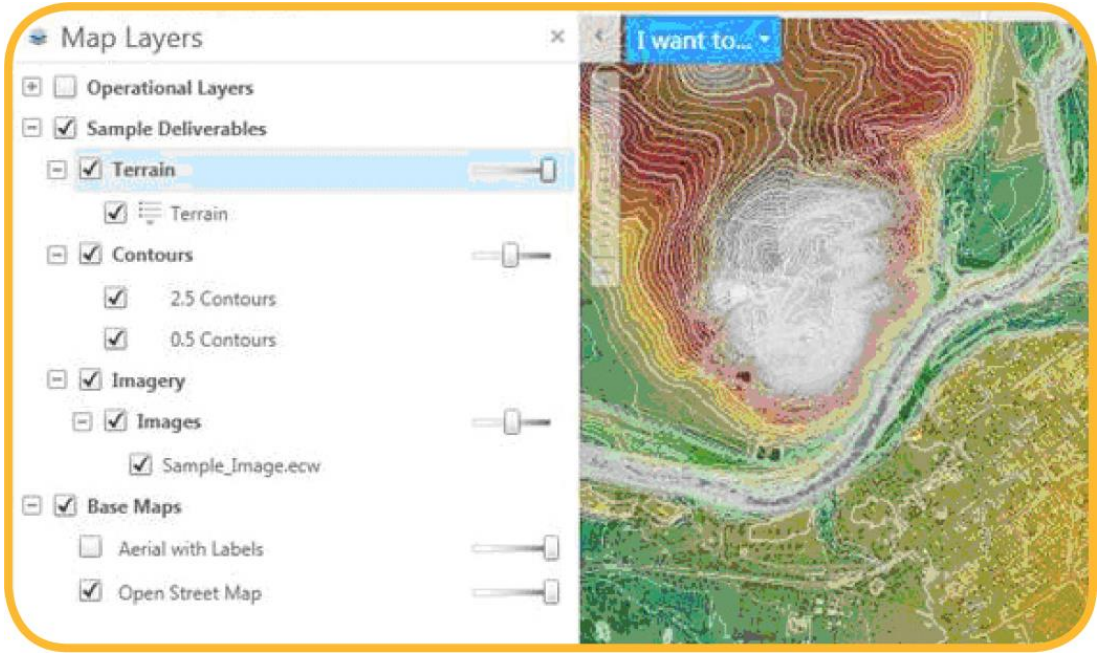
Client Requirement:

- refinement of the proposed route
- preliminary engineering design
- environmental impact assessments
- engagement with a diverse range of stakeholders
- base mapping for the future planning, construction and management of the rail line.

Case Study 1: Whole Line

AAM Project:

- Survey control
- 10cm imagery
- DTM by aerial LiDAR
- Project website to provide data access to stakeholders



Case Study 2: As Built Survey

Task:

- 188km of mainline track with various loop lines & sidings
- Define track related infrastructure and services :
  - Level crossings
  - Signals
  - Switches
  - Bridges
  - Culverts

Case Study 2: As Built Survey

Client Requirement:

- spatial data along the rail and surrounding infrastructure of the newly completed track work to assist in closing out contracts
- As-built to confirm the construction is to design without significant variation.
- Validate any variation claims.

Case Study 2: As Built Survey

AAM Project:

- Survey control
- MLS survey from rail vehicle
- Extract vectors
- Data accuracy: 2cm XY, 3cm Z

Case Study 2: As Built Survey

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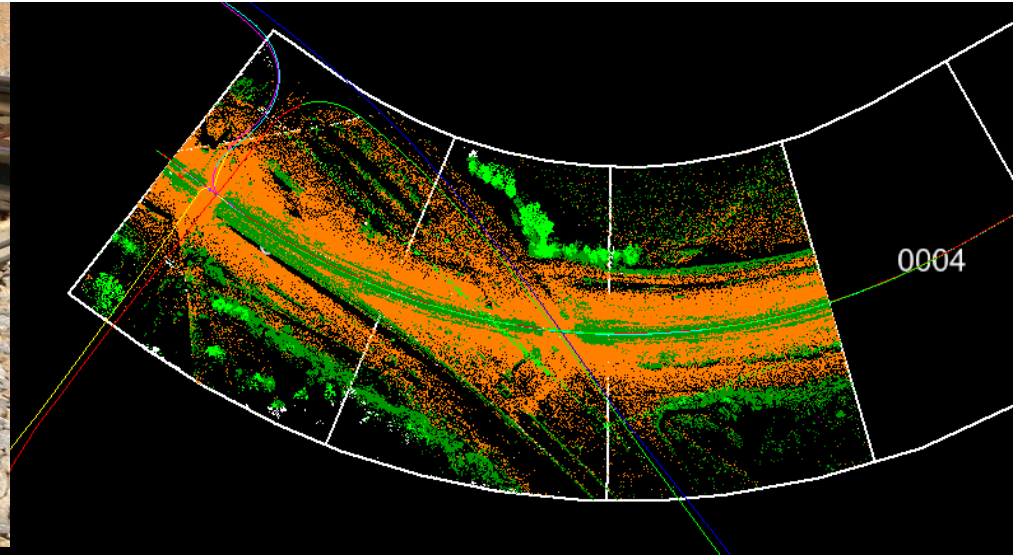
Control at 500m intervals

Pointcloud data



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Close

- New rail infrastructure requires new survey support
- Technology from satellites, aircraft and ground
- Correct mix required to meet project requirements
- Elongated geometry means corridor surveys high risk
- Expertise and experience available to ensure successful completion.