GPR Technology and Process Improvements

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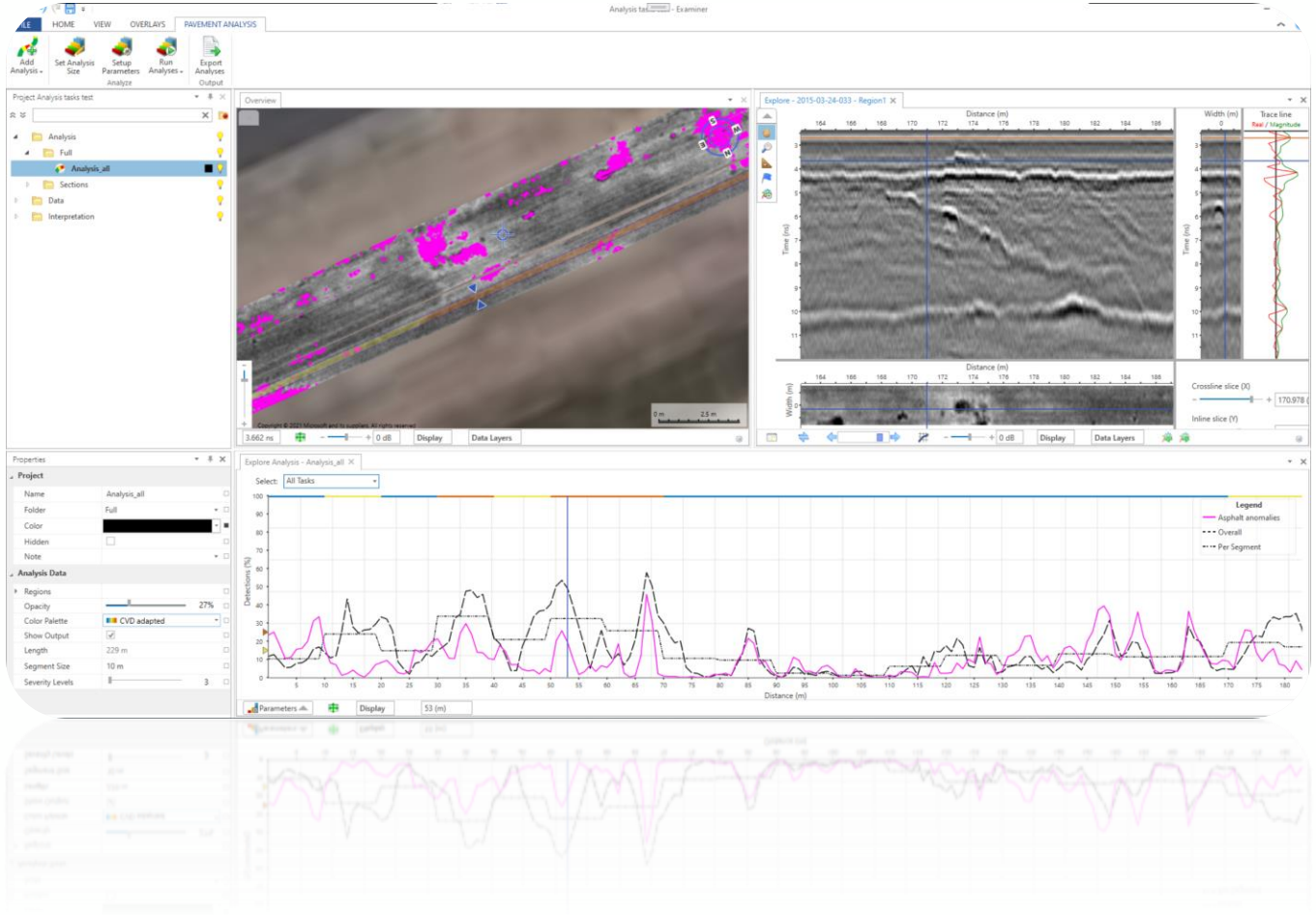
Agenda

- Global trends in GPR usage
- Latest developments with 3D GPR capabilities:
  - **Dielectric mapping** for new pavement quality control
  - Examiner Collect™ - Software capabilities for **planning and executing** pavement, bridge, and utility projects
  - **Efficiency improvements** and accelerated results using Orbit™ machine-learning software



Global trends in GPR information use

- **Rising adoption by transportation agencies** for non-destructive evaluation – move from 2D GPR to 3D GPR
- **Shift from spot-checking to full-network scanning** using high-speed, multi-channel GPR systems – intelligent coring programs are taking off!
- **Integration with asset management systems (AMS/GIS)** for long-term planning and budgeting
- **Increased focus on data-driven maintenance**—leveraging dielectric profiles, moisture detection, and layer thickness
- **Expansion in QC/QA applications** for new pavement construction (e.g., dielectric-based compaction verification)
- **Growth of AI/ML-enhanced GPR analysis** for faster, repeatable insights and pattern recognition – network level surveys are becoming a reality

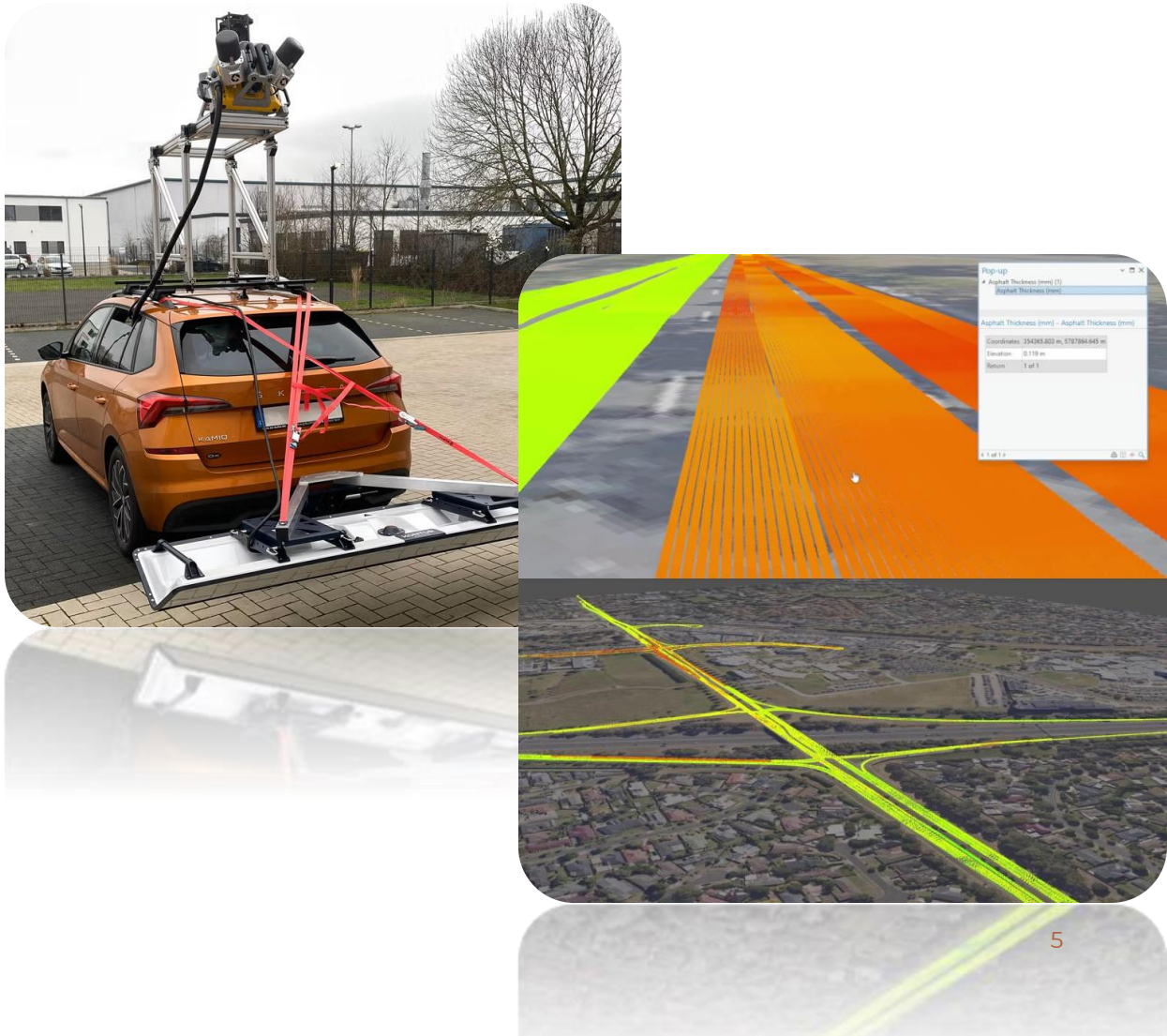
Global trends in GPR information use

- Standards, initiatives & research continue to develop
  - **ASTM D4748** –Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar
  - **ASTM D6087** –Test Method for Evaluating Asphalt-Covered Concrete Bridge Decks Using GPR
  - **ASTM D6432** – Standard Guide for Using GPR for Subsurface Investigation
  - **AASHTO PP 98-19** – GPR for Estimating Pavement Layer Thickness
  - **AASHTO T 342-21** –Method for Dielectric Profiling System for Determining Asphalt Pavement Density
  - **ASCE 38-22** – Standard Guideline for Investigating and Documenting Existing Utilities.
  - **ASCE 75-22** – Standard Guideline for Recording and Exchanging Utility Infrastructure Data

- **CEDR** Transnational Research Projects promote harmonization of GPR use across Europe
- **COST Action TU1208** provided technical guidance and best practices for GPR in civil engineering.
- **FHWA** & **NRRA** Initiatives (U.S.)
- Research **pooled fund studies** (e.g., TPF-5(443)) support validation and deployment of GPR for network-level pavement evaluation
- Promotion of standard data formats and analysis methods

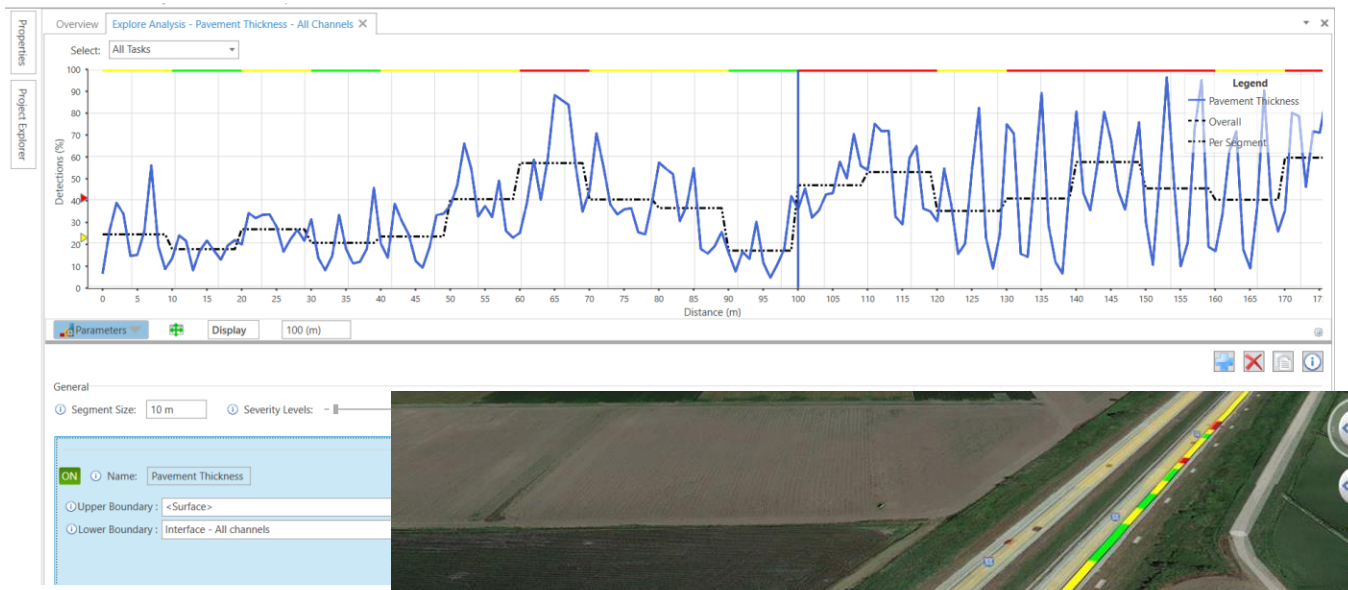
Global trends in GPR information use

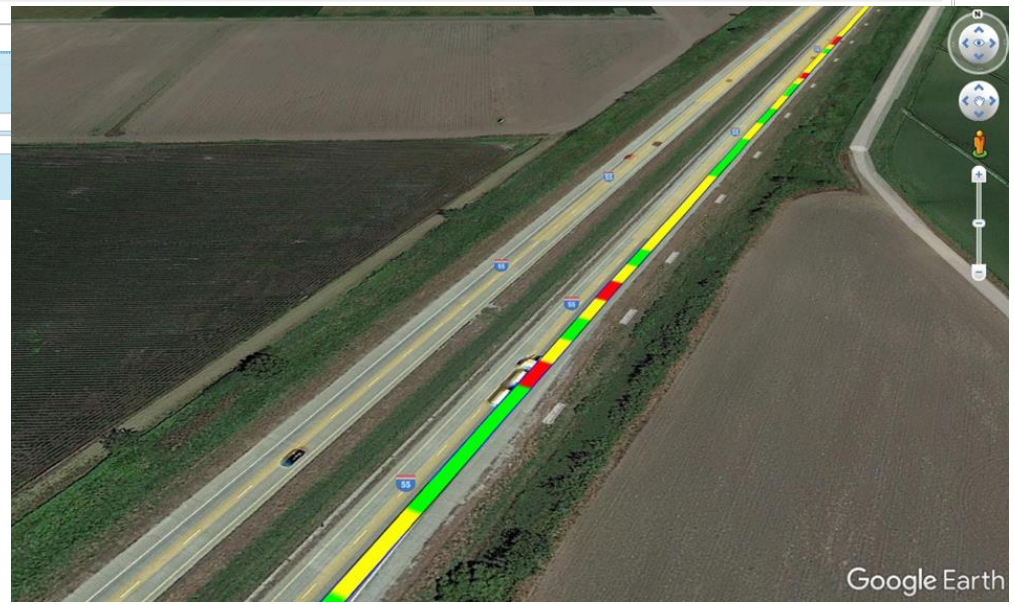
- **Multi-channel GPR systems** capture the bigger picture of the subsurface
  - Whilst more complex – in some ways, easier to relate too!
- GPR is starting to be combined with **mobile mapping systems**
- ***Pavement thickness is now mapped as 3-D point clouds***
  - ***Used in design, volumetric calculations & machine control***



Global trends in GPR information use

- Pavement Analysis tools
- Including asset health not just thickness
  - Moisture, stripping, debonding
- Summarizing sections with parameters & statistics from GPR information
  - Severity maps to help focus where to work with coordinates

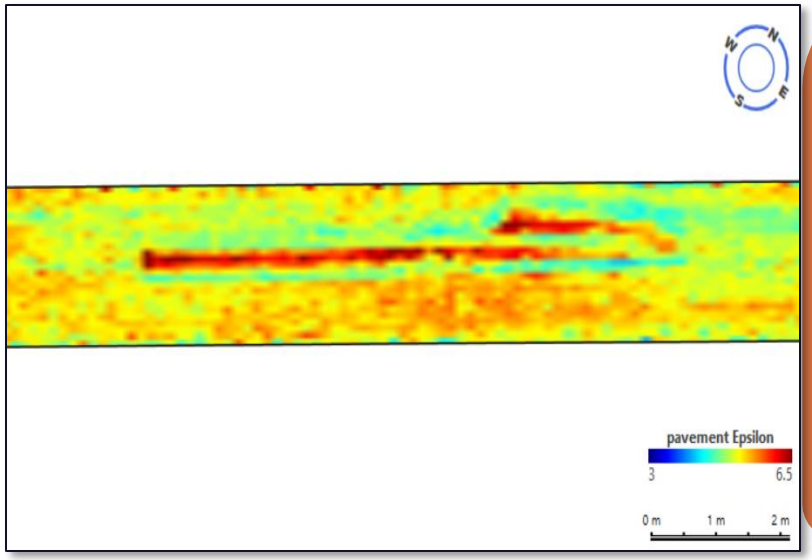


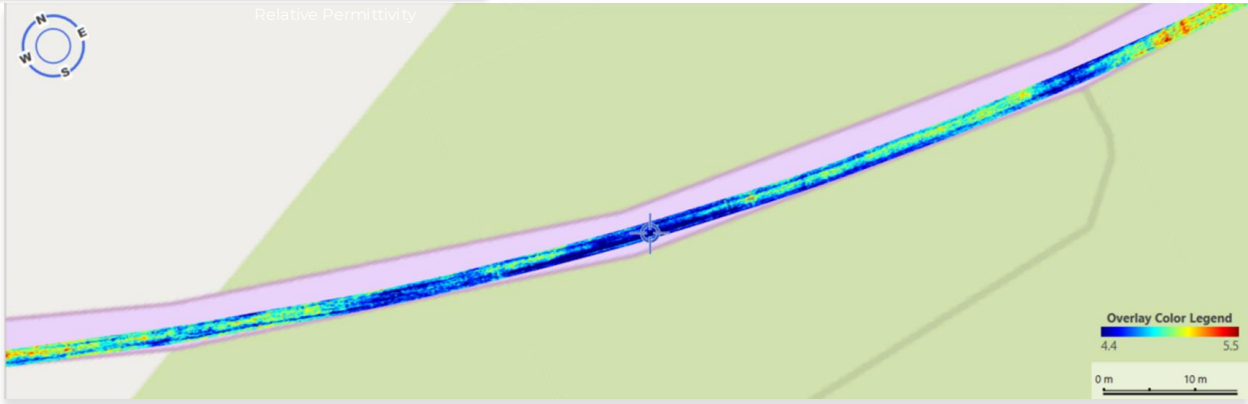


Dielectric mapping – Specific to Kontur

- Vehicle Mounted
- Traffic Speed Collection
- High density measurements
- Wide footprint coverage – full lane
- 2-D high resolution color maps

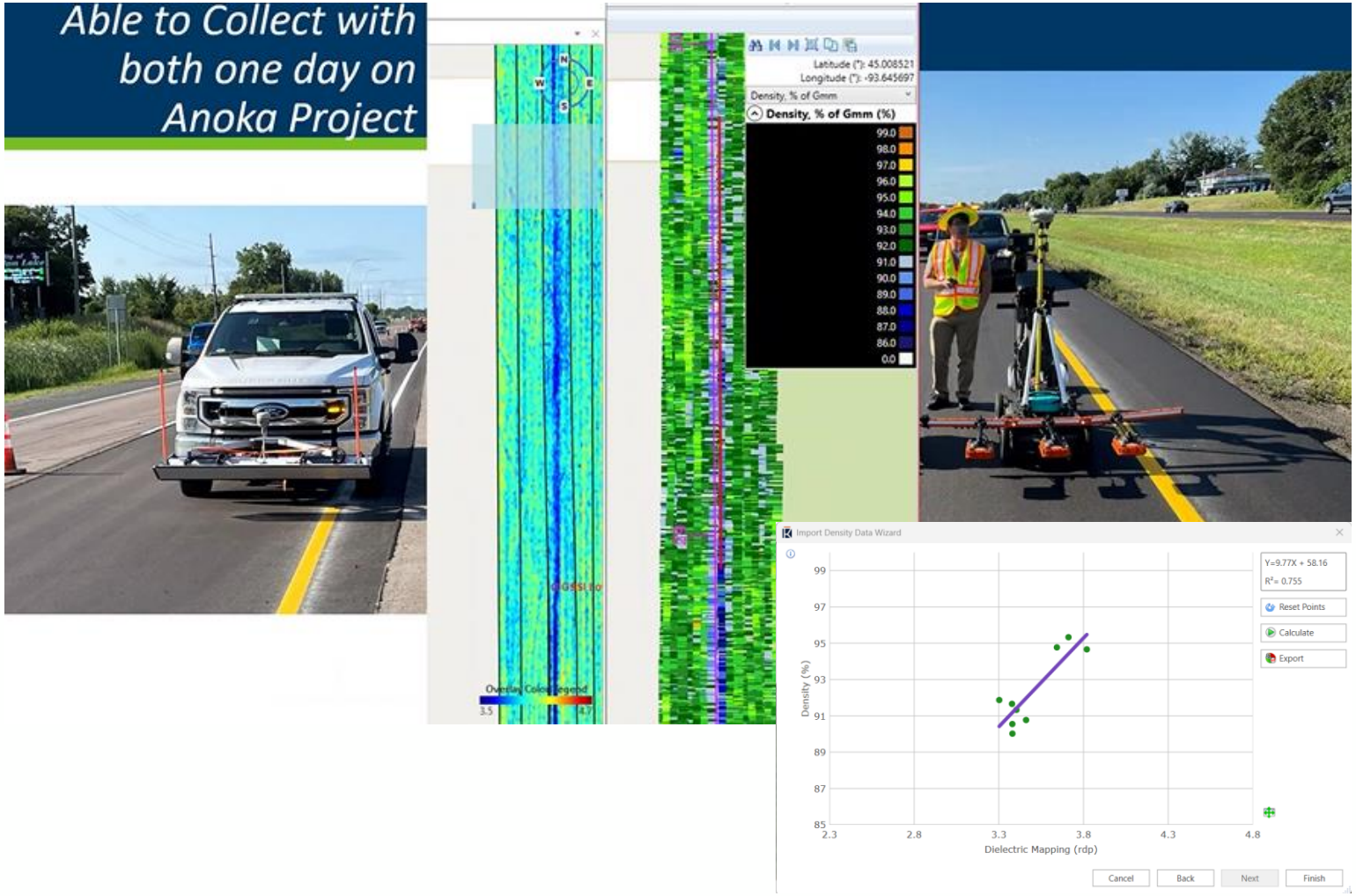
  (instead of single profiles)
- Maps show surface dielectric for asphalt
- Does not require GPR data analysis
- All depth collection in parallel to D-Map survey





Dielectric mapping – key benefits

- Quality management of new asphalt construction
- Monitor dielectric consistency from production to placement
- Dielectric converted to density
- Research by MnRoad

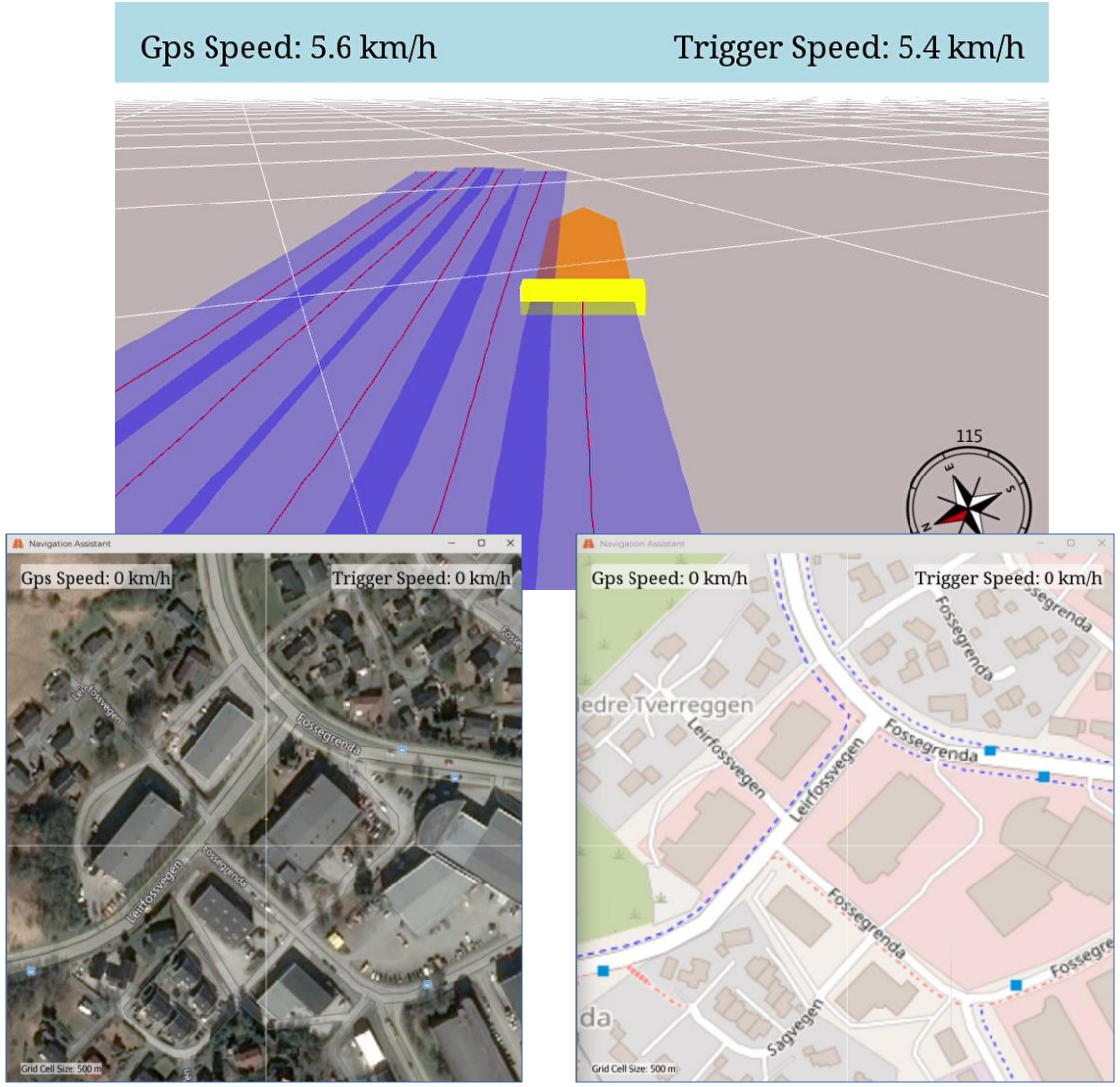


Examiner Collect – Survey Collection Software

- Installed on the hardware – nothing to download in advance
- Used by survey team in vehicle
- Controls survey parameters
- Monitors & provides real-time feedback
- Configurable for each survey task:
  - Bridges, Utility Detection, Pavements…
  - Change the grid of measurements (more measurements for smaller detail such as bridge decks)
  - Depth

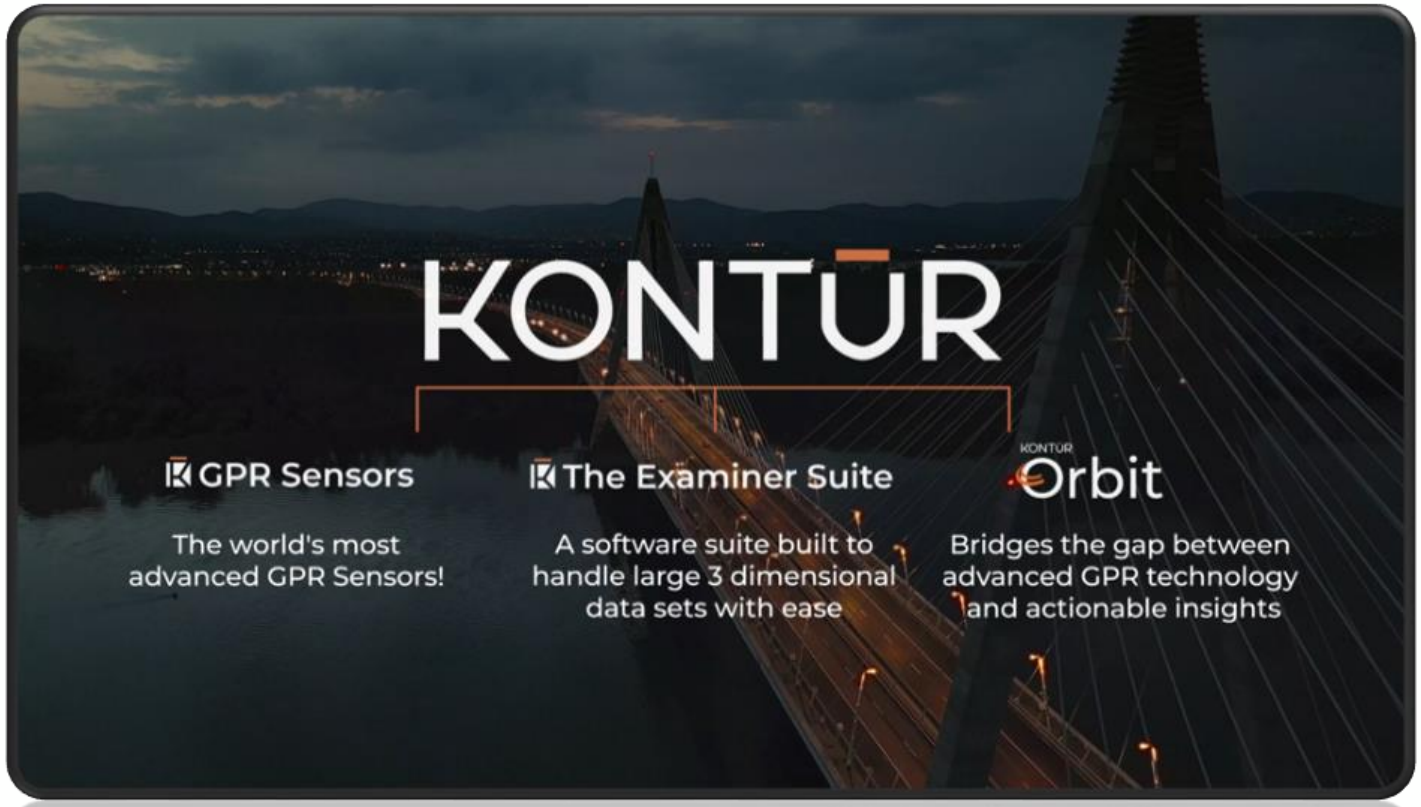
Examiner Collect – Survey Collection Software

- View where data is being collected
- Overlapping scans
- 2D & 3D Views with Bing Maps
- Load georeferenced images (such as aerial drone surveys)
- Import Shapefile – survey plans, boundaries, marker posts, utilities…
- Create survey plan in advance and provide to the survey team to execute
- Full Application Programming Interface & More



Kontur Orbit™ - machine learning software

- Concept:
  - Software solution for faster data interpretation
  - Reduction in manual interpretation
  - Increase ease of use and accessibility of GPR surveys
  - Support project & network level
- **Analyze – Compare – Trend**
- Automatically analyze data collections with focus on selected features. Compare the results of several analyses identifying changes and trends in an asset over time

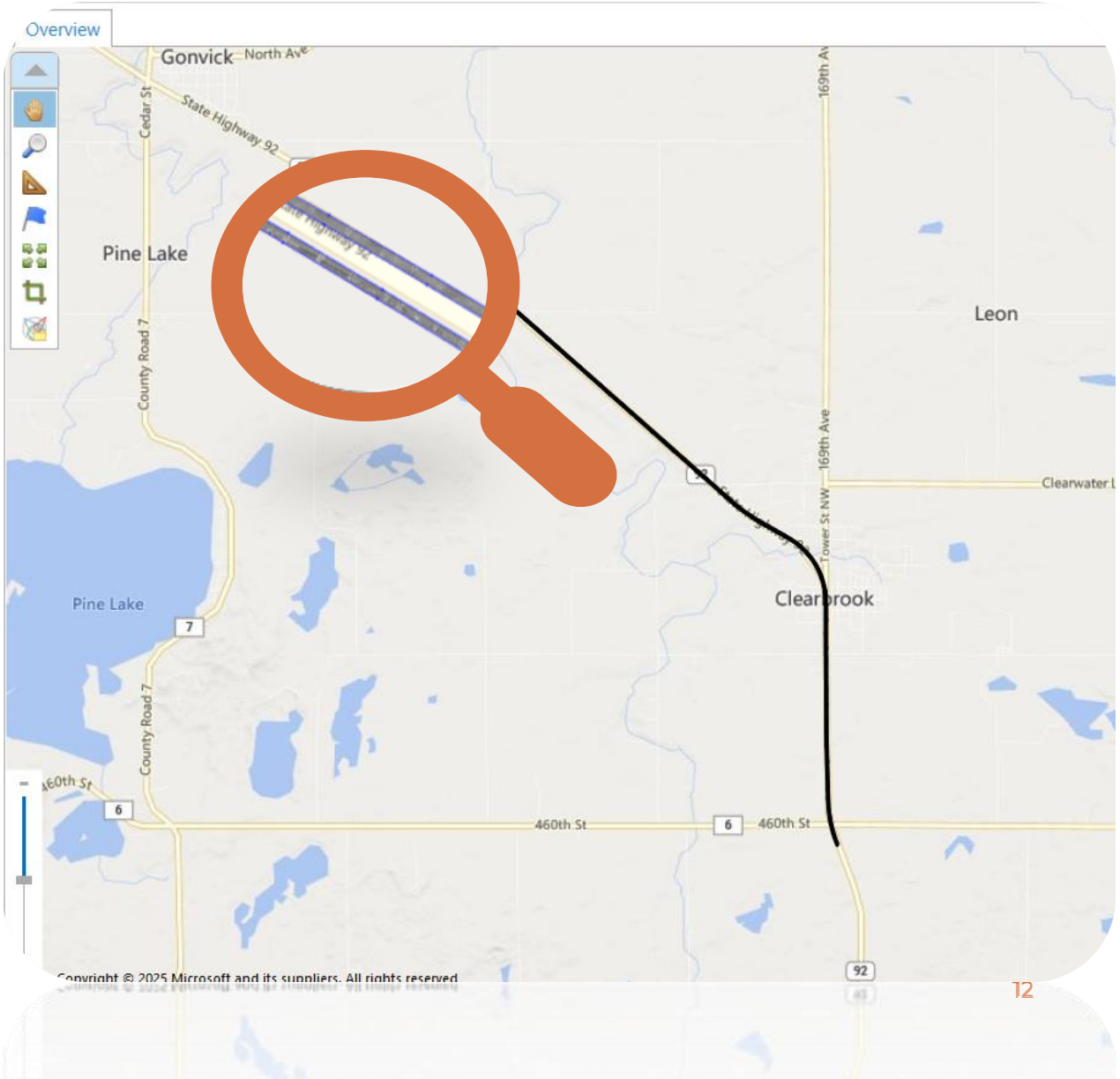


Kontur Orbit: Project Example

Overview

- Collected with AIR Sensor
- 1 Mile of data collected by 21 channel 6ft footprint

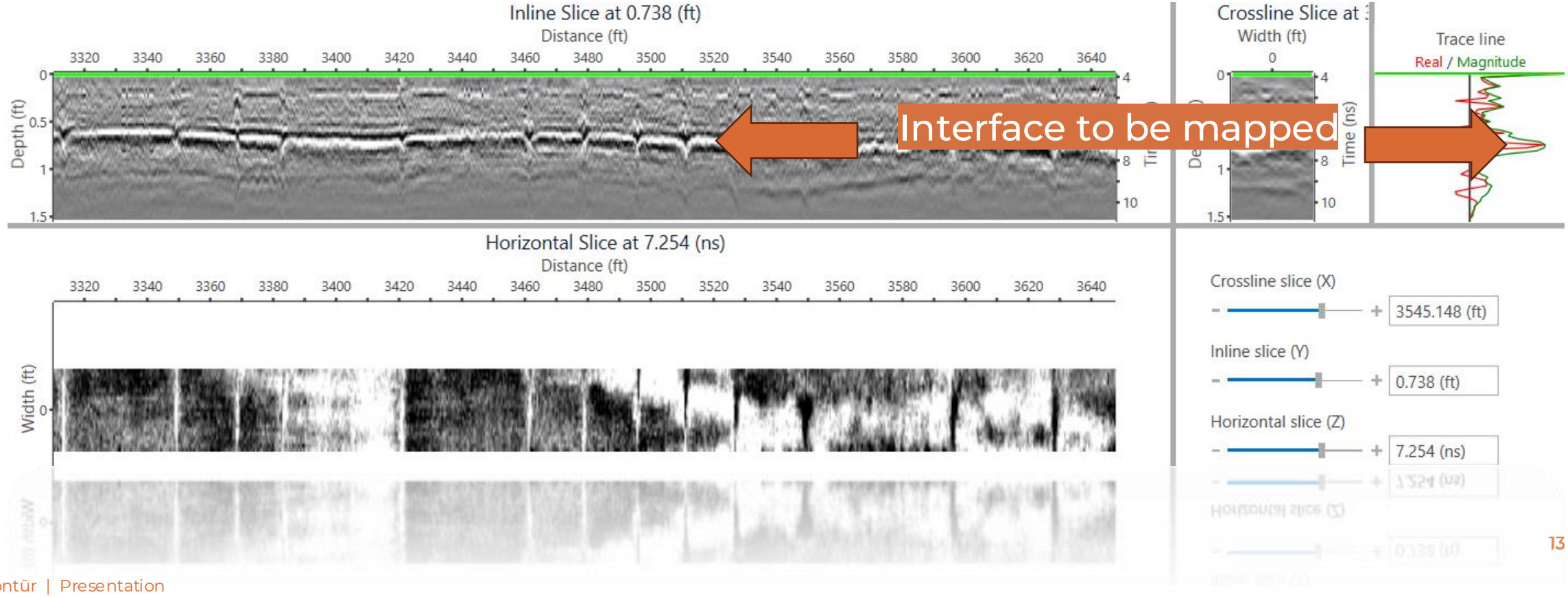
- **Goal**: Map base interface
  - Use Kontur Analyze to generate **reference model**
  - Compare the process time process of existing to new methods



Workflow – Step 1

Create Reference Data Interface – Select Interface

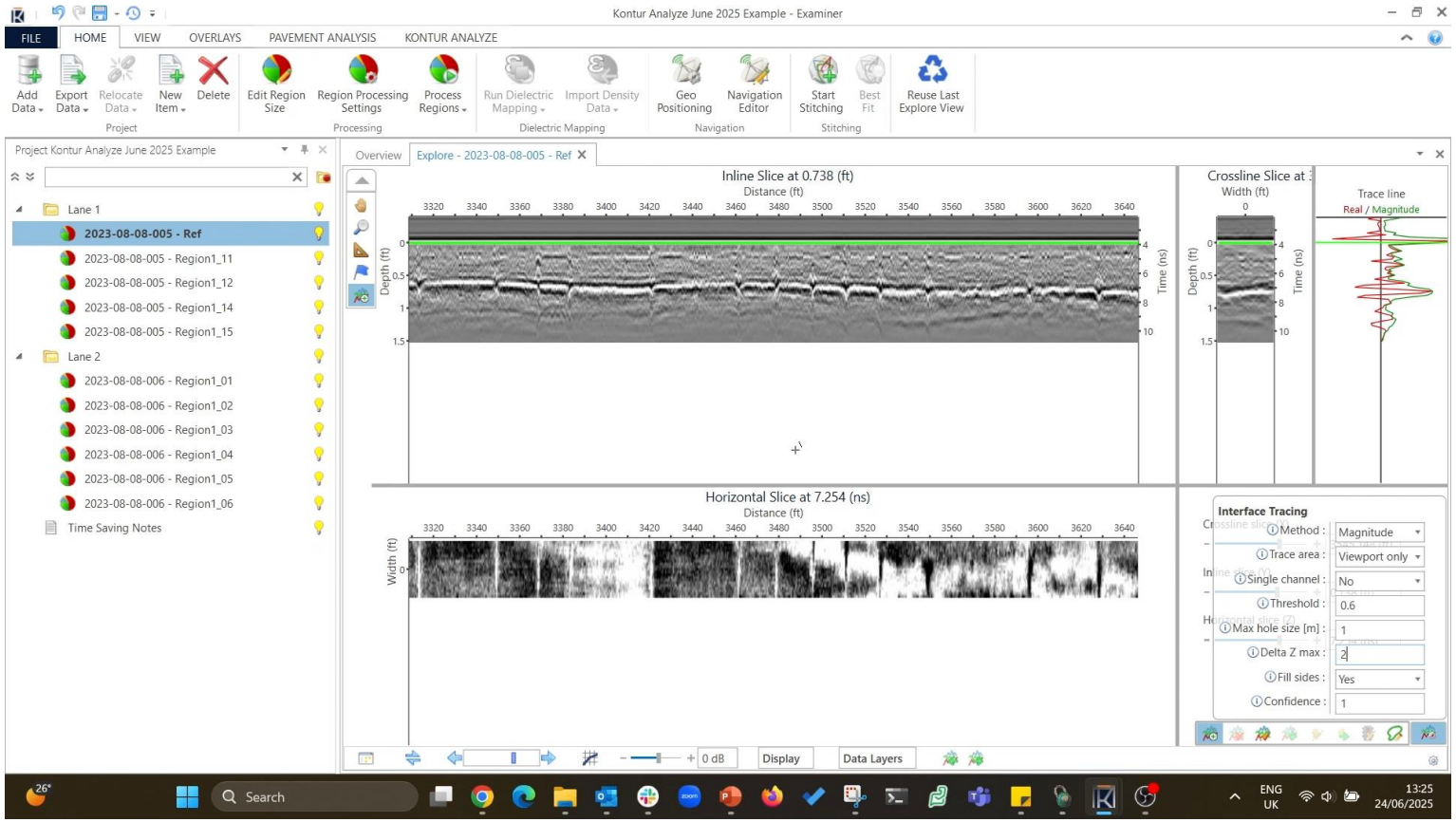
- Select region that represents pavement structure
- Use interface tracing tools to map the interface



Workflow – Step 1

Create Reference Data - Interface Example

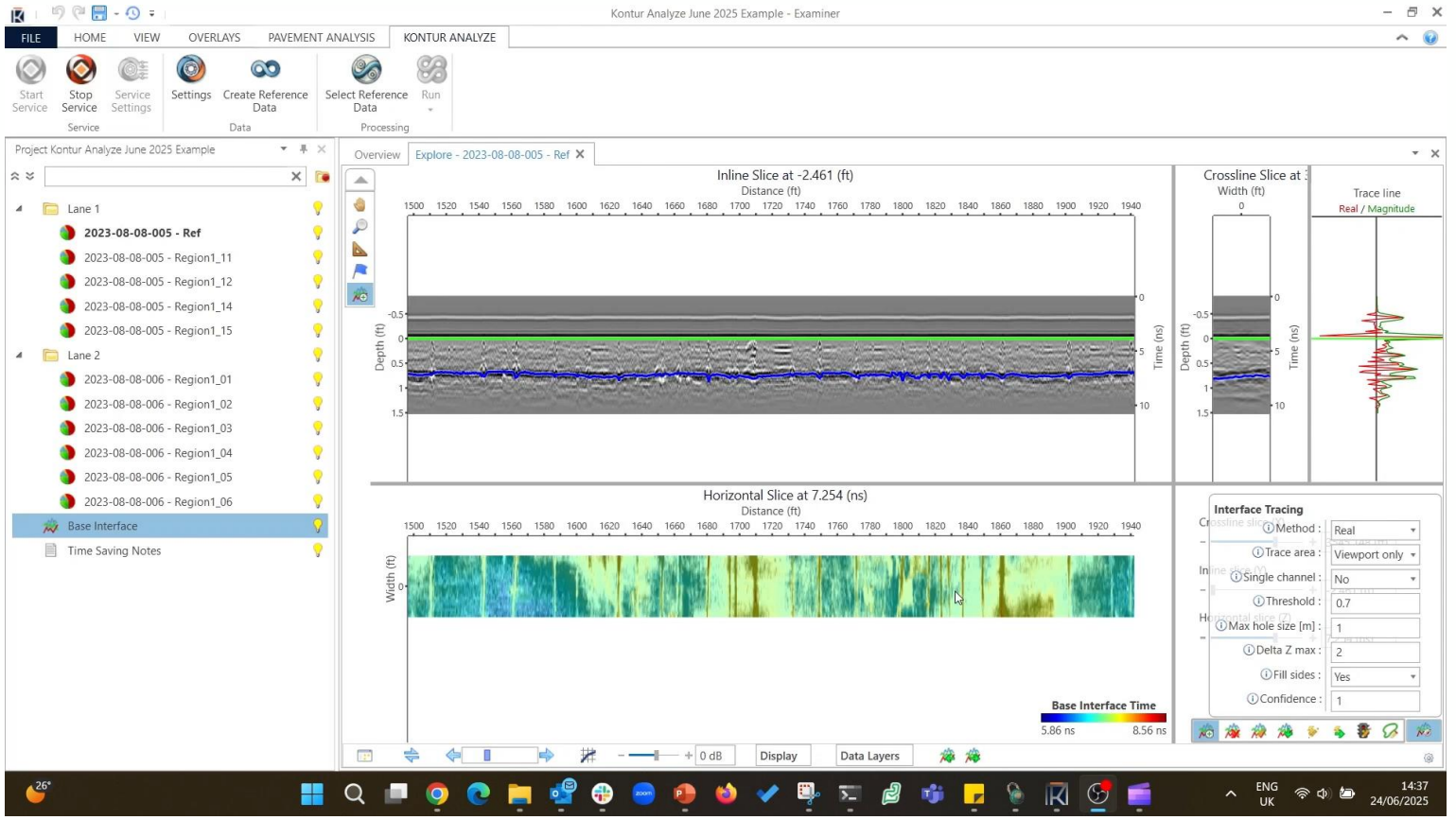
- Example of Interface Mapping
- Time taken to complete 15mins



Workflow – Step 2

Create Reference Data from Interface Example

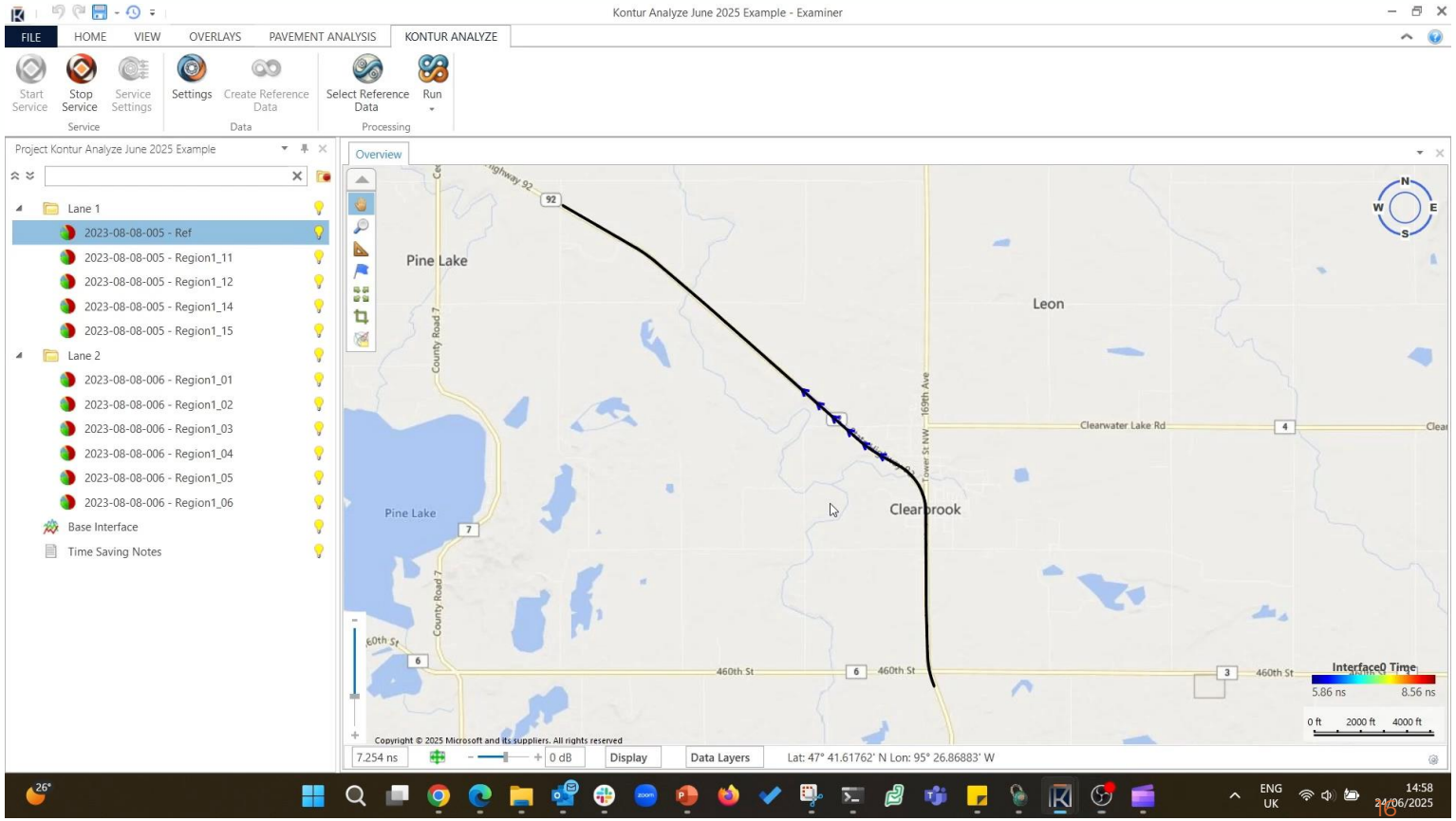
- **Time taken 5min** to create Kontur Analyze Reference Data



Workflow – Step 3

Select & Run Reference Data

- Select reference data
- Run reference data to complete measurements using Kontur Analyze
- Total time to complete Analysis for remaining project = 10mins



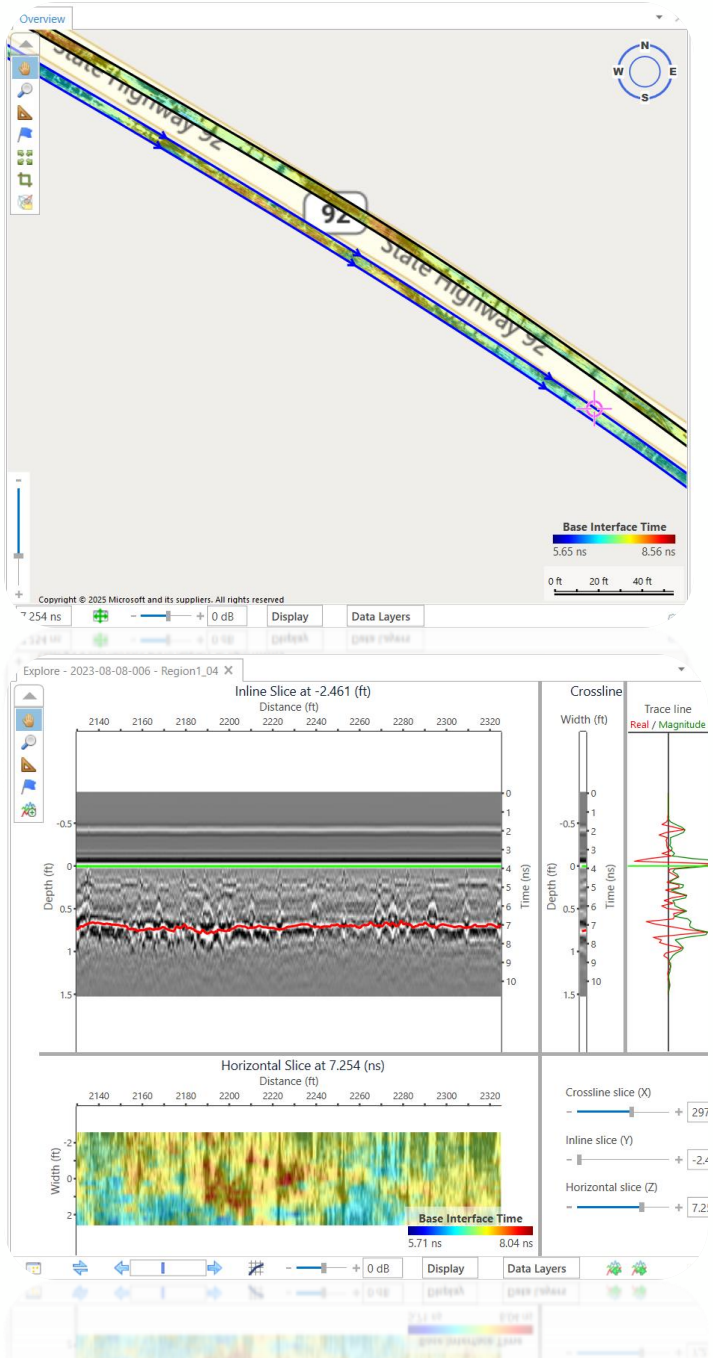
Summary

Time Saving

- Spent 15mins measuring reference interface in 1 region
- 5 mins creating reference model
- 10 mins running Kontur Analyze to complete remaining 10 regions
- ➢ Time to complete without Kontur Analyze – 11 x 15mins = 2hrs 45mins
- ➢ Time to complete with Kontur Analyze – 30mins
- ➢ Time saved – 2hrs 15mins

Key Benefits

- Reduce manual effort, save time & increase efficiency
- Create reference data to be applied to project
- Import & Export reference data for use in similar project environments



Summary

- Global trends in GPR usage
  - **Rising adoption by transportation agencies**
  - **Shift from spot-checking to full-network scanning**
  - **Expansion in QC/QA applications**
  - **Faster processing for network level work**

- Latest developments with 3D GPR capabilities:
  - **Dielectric mapping**
  - Examiner Collect for **planning and executing** pavement, bridge, and utility projects
  - **Efficiency improvements** and accelerated results using Orbit™ machine-learning software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