Subsurface Intelligence for Undergrounding Operations: Rapid AI-Based Geophysical Imaging and Advanced Visualization

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Category 2

"Subsurface intelligence will guide and de-risk undergrounding through real-time multi-sensor fusion, cloud-based processing, and advanced visualization"

GOPHURRS
Kickoff Meeting
May 2nd, 2024
Charlotte, NC

Project Objectives

- Undergrounding carries substantial risk resulting from lack of information about subsurface obstacles and legacy infrastructure. New methods are needed to:
  - *Align the 'time to map' with the time required to support field operations and revise survey plans*
  - *Interface geophysical information seamlessly with GIS/CAD*
  - *Rapidly translate geophysical information into subsurface interpretations*
  - *Quantify risk and illuminate the path to risk reduction*

Metric	Proposed	State of the Art
Speed of survey	>10X time (>1000%)	~3 years (average project)
Accuracy of prediction (confidence level)	≥ 98%, based on the Team's case histories & projections	50-70%, reliant on site-specific conditions
Cost reduction (per unit volume)	>65%	$160K - $30M to underground per mile
Datasets compatibility	True digital twin accessed in GIS & AR/VR interfaces	Relies on data management & analyses in multi-systems

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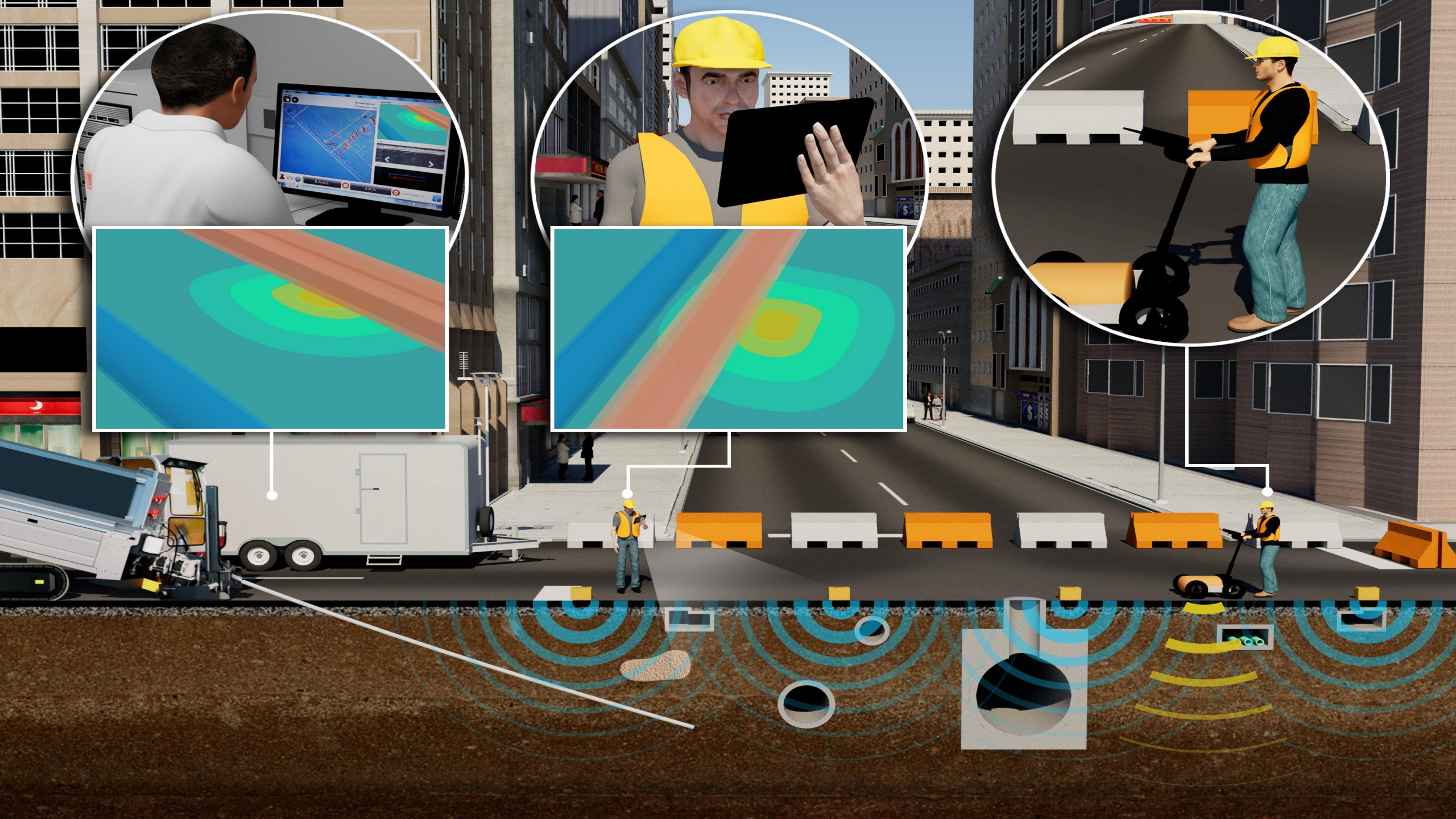
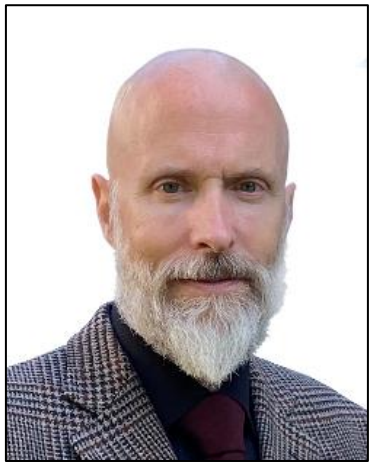


Project Team



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Project Team

- *PNNL: Fred Day-Lewis (PI), Piyoosh Jaysaval, Patrick Royer, Tim Johnson, Judy Robinson, Martin Pratt, Kirsten Chojnicki, James St. Clair, Parker Sprinkle*
- *Exodigo: Jeremy Suard, Bret Simon, Casey O'Brien*
- *Rutgers – Newark: Lee Slater, Dimitrios Ntarlagiannis*

Task 1. PNNL, Exodigo, RUN

Project Management, quarterly reporting, tracking of work toward milestones, documentation for Go/No-Go

Task 2. PNNL

AI-based geophysical processing and inversion for automated and autonomous data analysis

Task 3. PNNL

AI-based geophysical anomaly detection and classification with uncertainty quantification

Task 4. PNNL

Construction and near real-time updating of the digital twin, with access through GIS and AR interfaces

Task 5. Exodigo, RUN

Provision of training data including field-based (Exodigo) and synthetic (RUN) datasets

Task 6. Exodigo, RUN, PNNL

"Laboratory Testing," commercialization and advancement of technology to market

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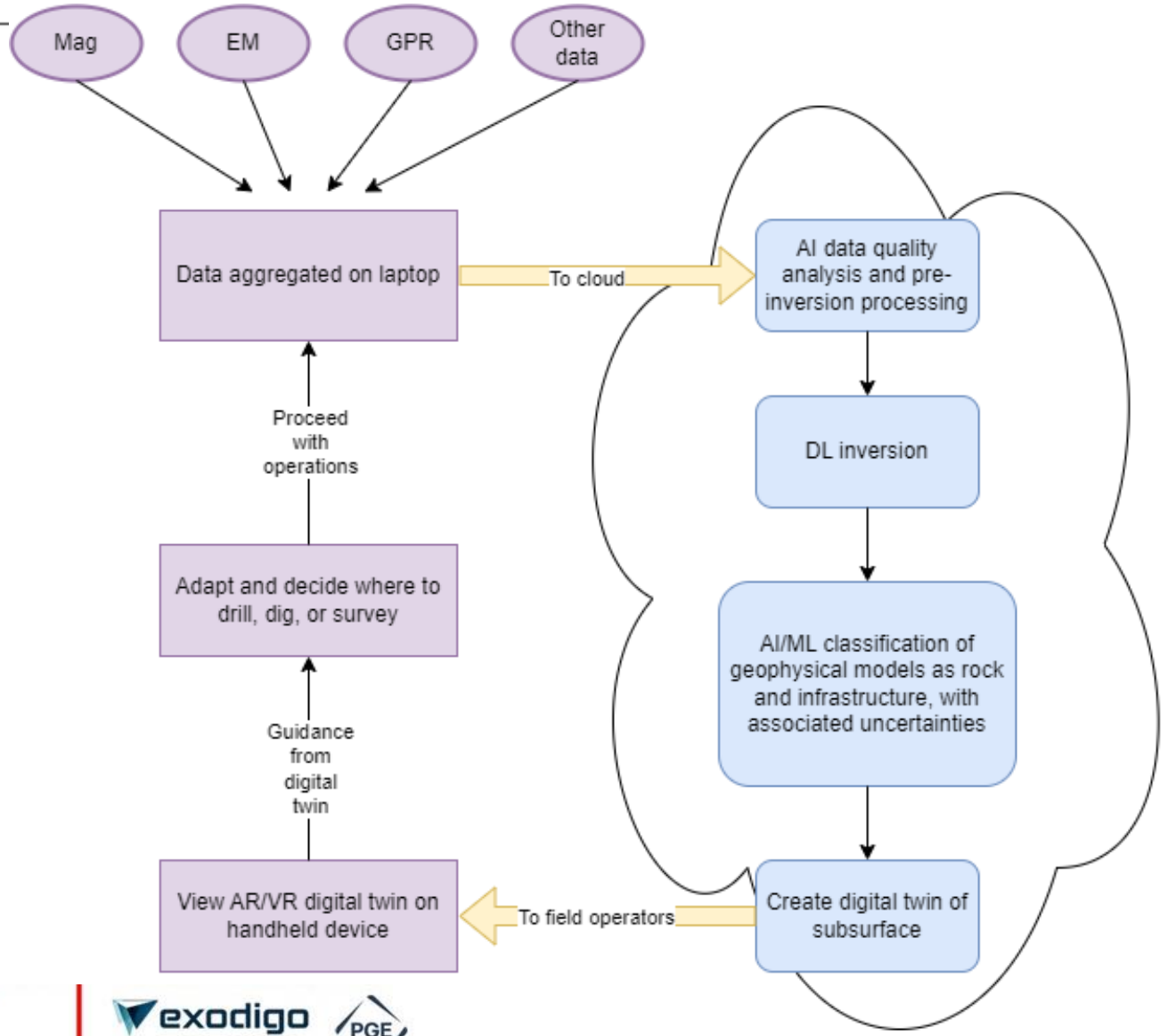
Overview of High-level Tasks

- **Project Flowchart**

- **Timeline summary/Key Milestones: (*G/N*)**
  - M3.1/M3.2 Field & synthetic training data assembled (Q3)
  - *M3.3. Anomaly detection algorithm completed & tested (Q4)*
  - *M4.1. Real-time updating of digital twin tested (Q6)*
  - *M4.2. Integration with GIS (Q7)*
  - M5.2 Lab-scale validation completed (Q10)



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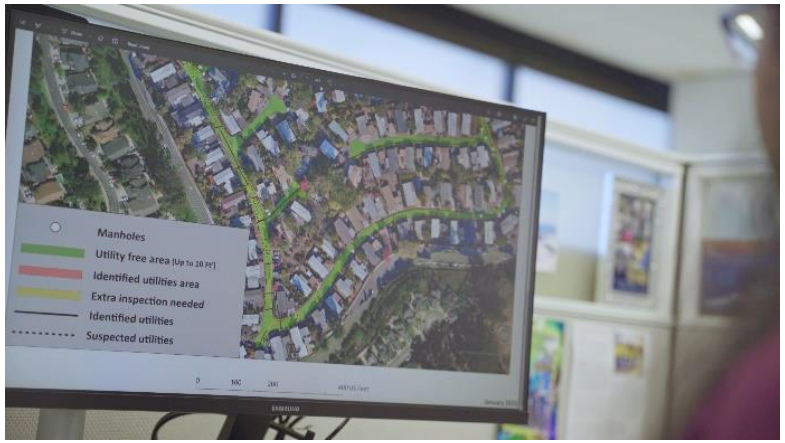
Technical R&D Details

- Multi-sensor geophysical field surveys (EM, mag, GPR, etc.)
- Rapid AI-based inversion (analysis) of geophysical data
- Autonomous and automated geophysical interpretation
  - Probabilistic framework
  - Training to field & synthetic data
  - Uncertainty quantification
- Construction and real-time updating of a subsurface digital twin
  - GIS interface
  - AR visualization of the subsurface
  - Guidance for additional surveying, sampling, etc.
- Cloud-based processing and delivery of results



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Technical R&D Details

- Novel aspects of the work:
  - Real-time updating of the digital twin
  - Uncertainty quantification guiding further surveys, testing, etc.
  - User interaction with the subsurface digital twin using AR
- Key performance metrics:
  - Cost reduction ≥ 65% per unit volume
  - Speed of survey increased by ≥ 10X per unit volume
  - Accuracy of prediction ≥ 98% confidence of detection
- Key tests:
  - Outdoor “lab-scale” testing and validation over known targets with updating in < 15 minutes from completion of data acquisition

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Technology-to-Market Approach

- Commercialization Plan Elements:
  - Cost/benefit analysis
  - Market outreach and partnerships
  - T2M products: E.g.,
    - a virtual utility round-table
    - interviews with utilities interested in undergrounding and resiliency
    - interviews/panels with industry experts.
    - videos, webinars, fact sheets, trade journal articles, patents, or web pages.
  - Software commercialization plan & licensing
  - Business model based on selected markets and competitive landscape
  - Data as a service (DaaS) and Analytics as a Service (AaaS)

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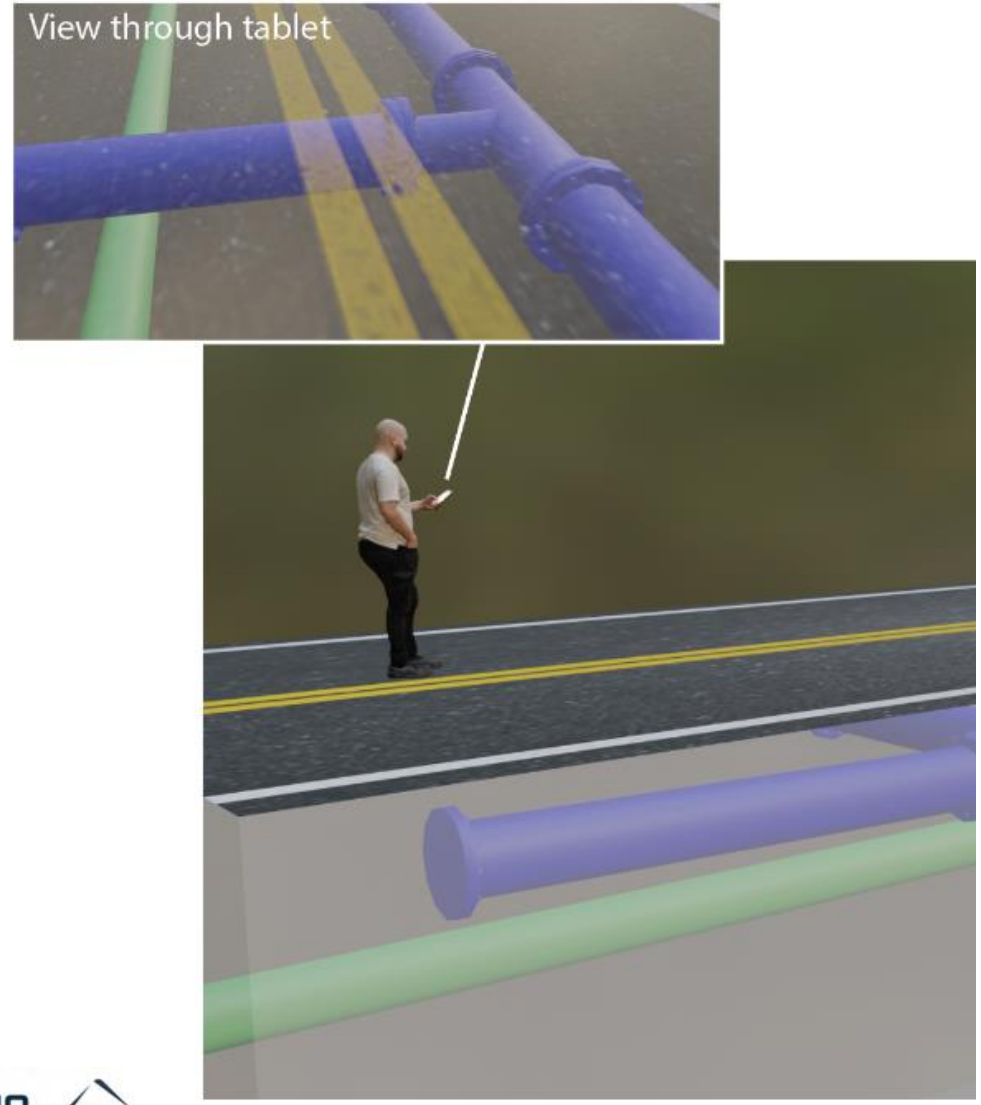
Needs and Potential Partnerships

- Additional current needs:
  - Integration/communication with other GOPHURRS projects responding to different categories
  - Possibly additional training data?
- Anticipated needs following the completion of the award to continue to move technology towards commercialization:
  - Full-scale field demonstration in a variety of geographic environments
- Capabilities or resources to others in the program:
  - Opportunities for collaboration around testing
  - Information about subsurface imaging technology, capabilities, and limitations



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Q & A

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