Advancing Technologies for Working with Underground Utilities: Current SHRP 2 Research

SHRP2
STRATEGIC HIGHWAY RESEARCH PROGRAM
TRB TRANSPORTATION RESEARCH BOARD

U.S. Department of Transportation
Federal Highway Administration

AASHTO

Advancing Technologies for Working with Underground Utilities

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Webinar Objectives

- How do Underground Utilities impact highway construction projects?
- What is SHRP 2 doing to reduce these impacts?
- How can I use the Products of this SHRP 2 research?

Webinar Agenda

• Background & History	Jim Anspach
• Multi-Sensor Platforms	Gary Young
• Locating Deep Utilities	Chris Ziolkowski
• Storing & Using 3-D Data	Alicia Farag
• Utility Conflicts & Solutions	Cesar Quiroga
• Q&A and Wrap Up	

What is SHRP 2?
(Strategic Highway Research Program)

- Authorized by Congress in 2005
- Conducted under a memo of understanding among AASHTO, FHWA, National Academies (TRB)
- Funds Provided through FHWA
- Program Recently Extended to 3/31/15
- Current Budget is $218 Million

Presentation Format for the 4 Projects:

- Project Objectives
- Project Schedule and Status
- Project Products
- How can the product(s) be used by the intended users?

UTILITIES & ROADS

PROBLEMS & SOLUTIONS

James H. Anspach, P.G.

J.H. Anspach Consulting

Agenda

- Utility Issues
- SHRP 2 Project R01: Encouraging Innovation in Locating and Characterizing Underground Utilities
- Value Studies
- Recommendations
- Reality Check
- SHRP 2 Project R15: Integrating the Priorities of Transportation Agencies and Utility Companies

We Don’t Know Where Utilities Are

Over 11 million miles of underground utilities exist in the U.S. (recent CGA estimate puts it at 35 million miles)

Earth to Mars is about 35 million miles;

73 round trips
between the Earth and the moon
is also 35 million miles

- Existing utilities are at varied depths, are in varied soils, made of different materials, are varied sizes, and have varied access
- More utilities are being installed daily, deeper, and with less detectable materials
- No one entity in control; hodgepodge of laws, policies, attitudes

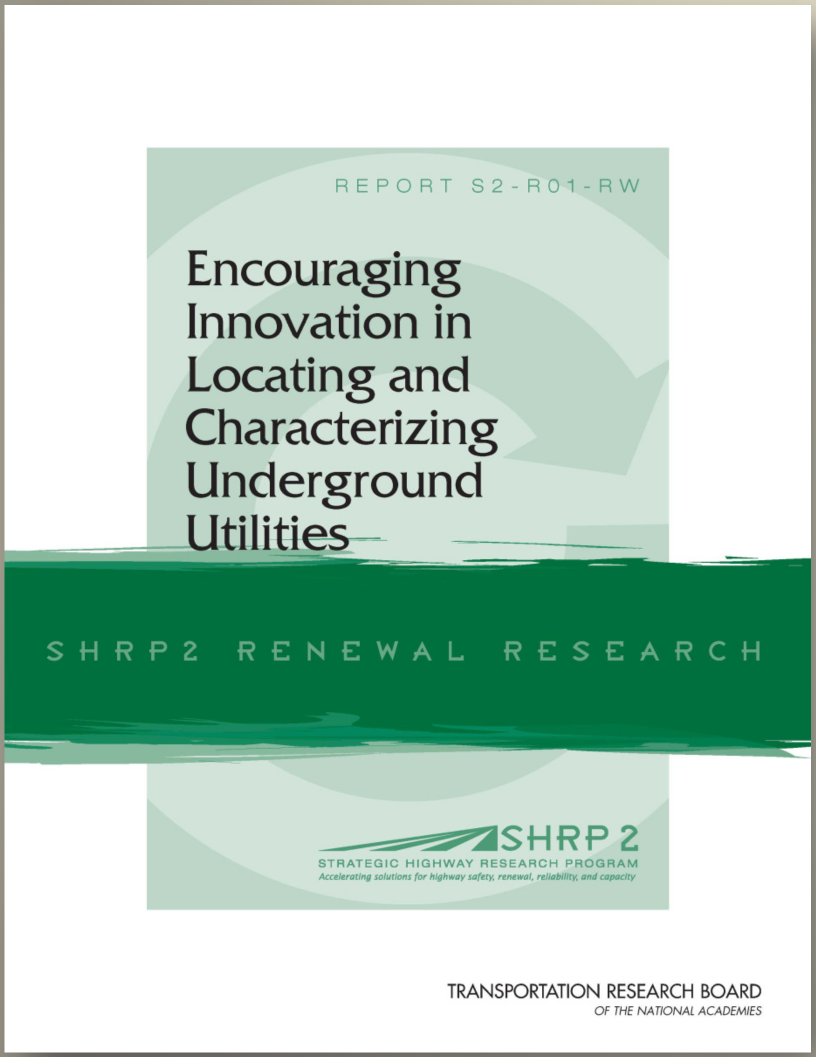
- Reliance upon utility owners for timely, accurate, and comprehensive utility location information was historically an inadequate model
- The perception of the design community is that it is a utility owner's problem and they must be the ones to bring solutions
- Historically, utilities are dealt with at the end of design and during construction
- Designers in the past were not aware of utility issues and their costs

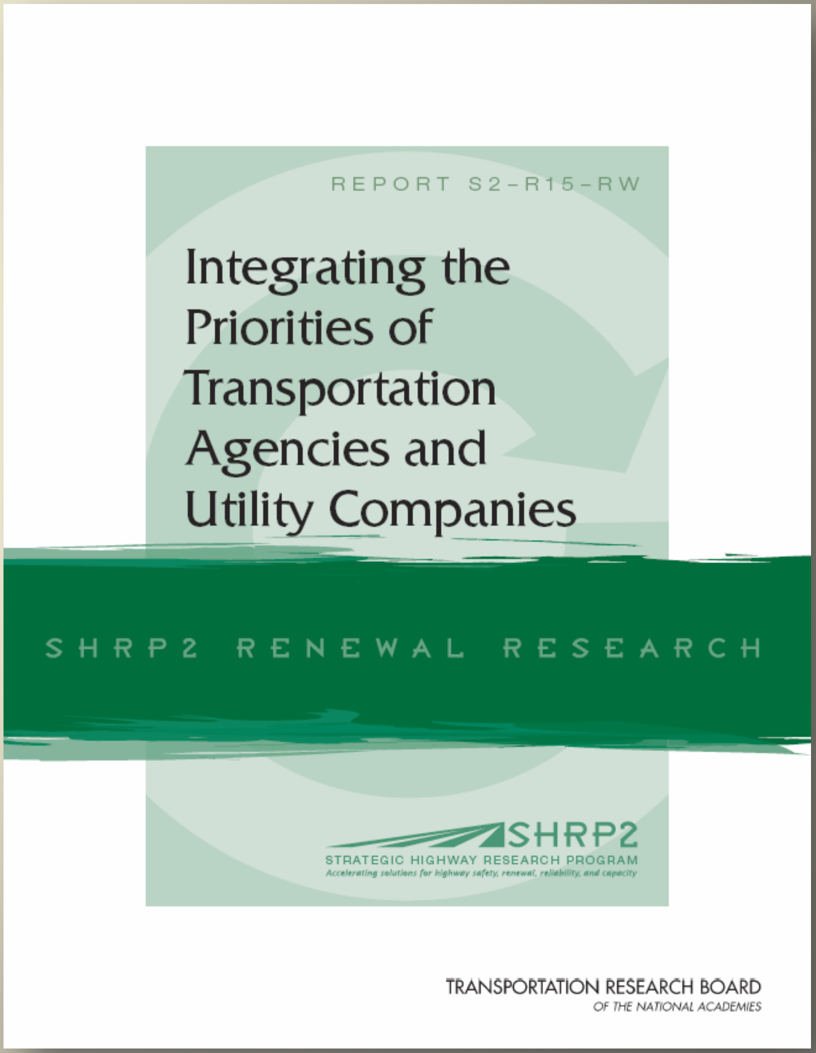
- Utility records inaccurate and incomplete
  - Referenced to changing topo features
  - Abandoned in place; re-used as conduits
  - Schematic, not positional
  - Lost, recreated, GIGO GIS
- They are expensive to move
- Contractors price some utility risk into their bids, or rely upon "Differing Site Conditions"

But when Contractors find unknown or mis-represented utilities…

- Redesign costs
- Delay costs
- Change orders
- Claims
- Damages, including death, injury, environmental releases, repairs

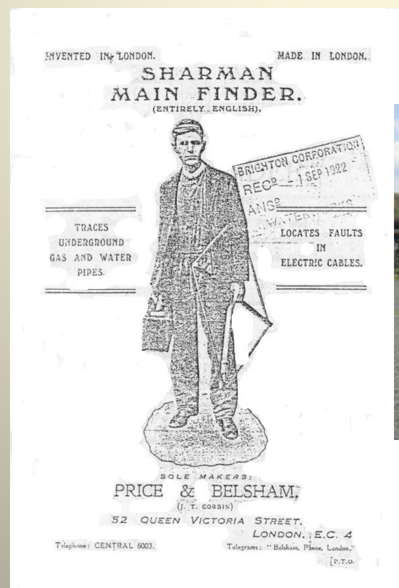
The First SHRP 2 Utility Projects





Linked Elements of Locating

Geophysical technology used to detect and image underground utilities



INVENTED IN LONDON. MADE IN LONDON.

SHARMAN
MAIN FINDER.
(ENTIRELY ENGLISH).

BRIGHTON CORPORATION
REC^{D} 1 SEP 1922
ANS^{D}

TRACES UNDERGROUND GAS AND WATER PIPES.

LOCATES FAULTS IN ELECTRIC CABLES.

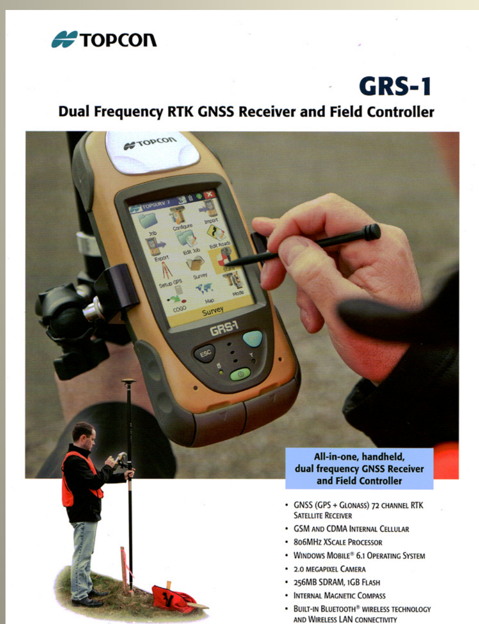
SOLE MAKERS:
PRICE & BELSHAM,
(J. T. CORBIN)
52 QUEEN VICTORIA STREET,
LONDON, E.C. 4

Telephone: CENTRAL 6003. Telegrams: "Belsham, Phone, London."

[P.T.O.

Linked Elements of Locating

- Processes, procedures, and techniques used by the field technicians in collecting the geophysical data in the field
- Means and methods of transferring data from the instrumentation to the data users



Linked Elements of Locating

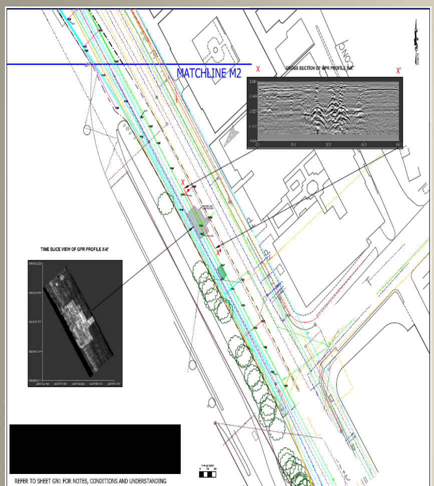
Other sources of information regarding utility location, such as visual observation and/or existing records

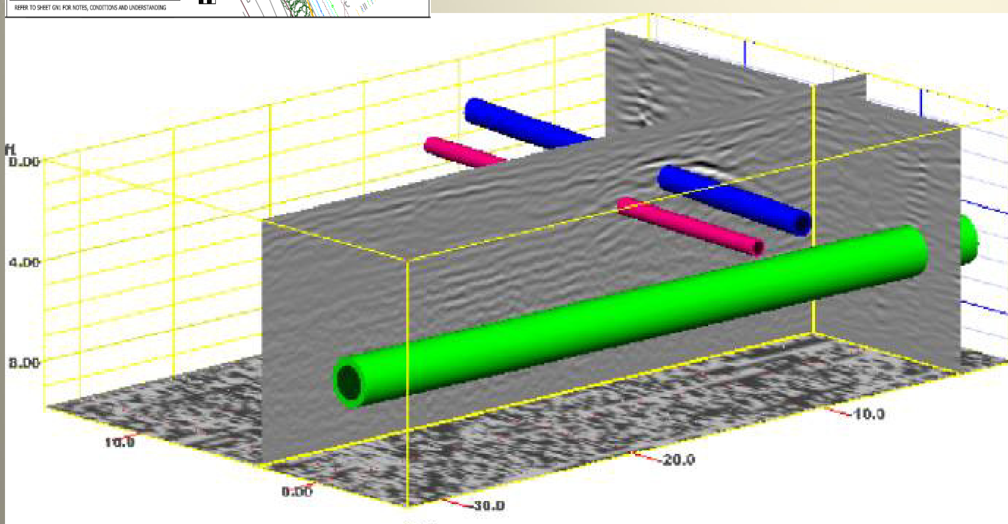
Linked Elements of Locating

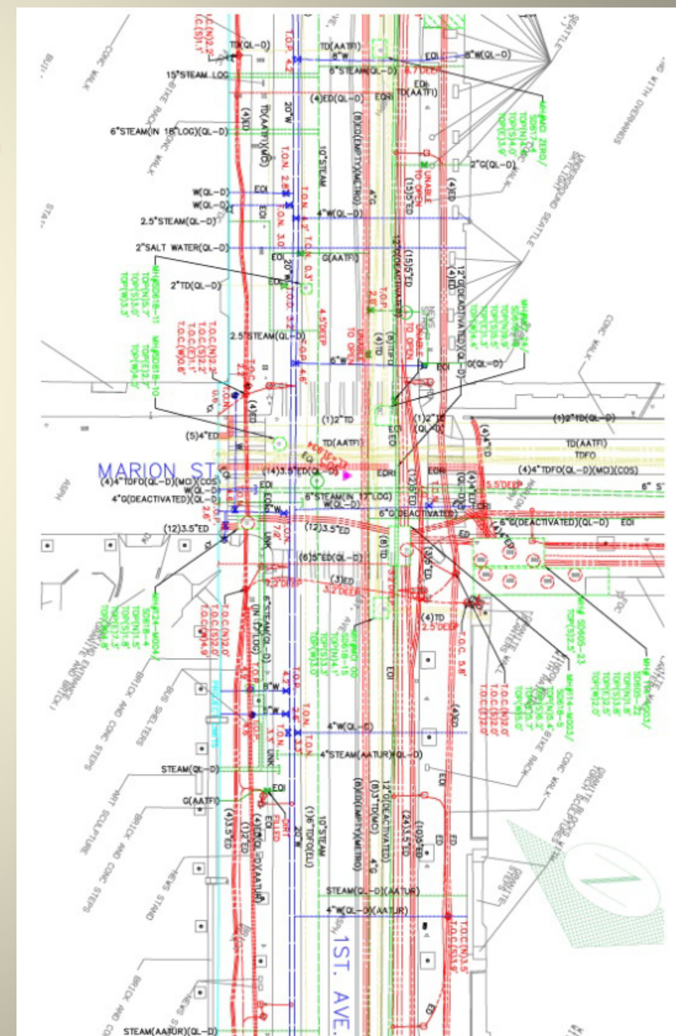
Integration and validation of data sources, e.g. ASCE 38 Utility Quality Levels, GPS grade accuracies, technician qualifications, etc.

Linked Elements of Locating

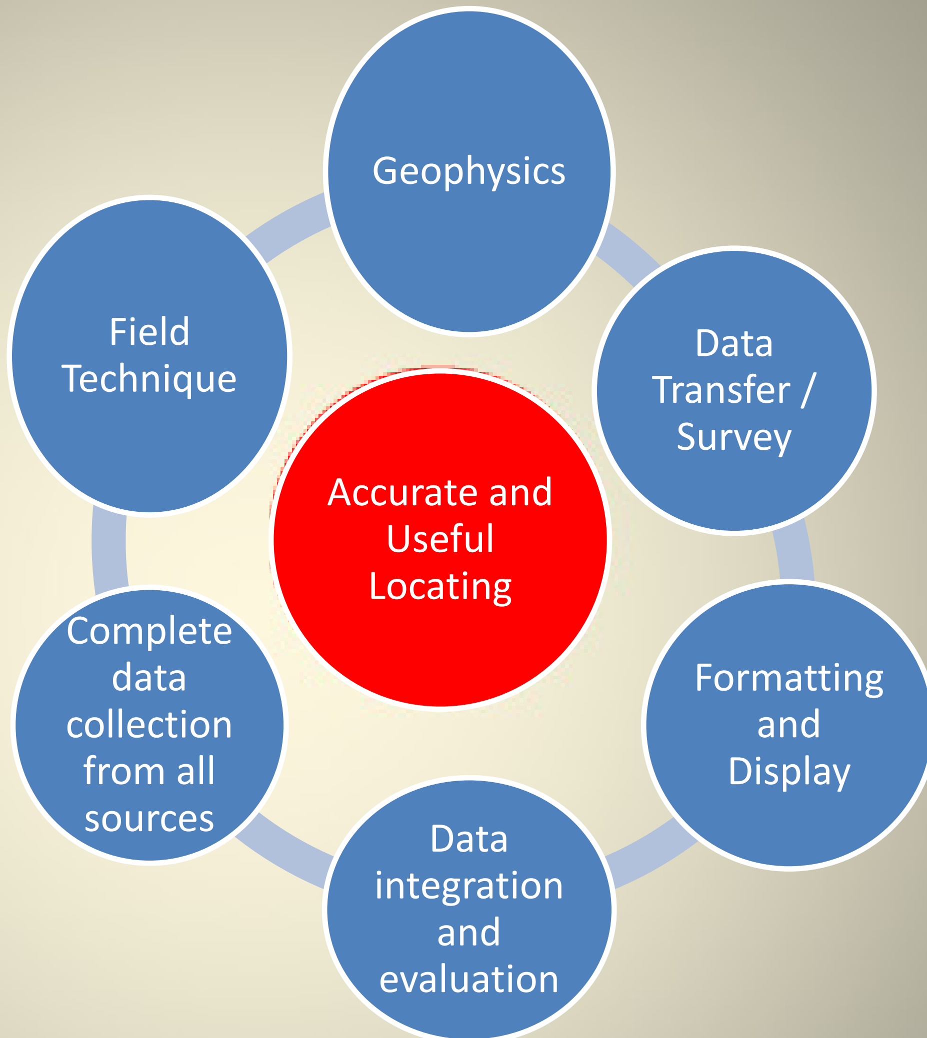
Formatting and display of data to the data users







- A Break-Down in Quality of any of these elements creates problems for the end result
- Therefore, we must consider them as a system



3 Studies illustrating the value of geophysics to map utilities on highway projects

- Penn State: 2100% ROI over records and topo survey
- Purdue: 462% ROI over records and topo survey
- University of Toronto: 341% ROI over records and topo survey

Objectives of SHRP 2 Utility Research

- Stop the problem from getting worse
- Leverage on-going research efforts by others and technology changes in other fields
  - MTU
  - ORFEUS
  - GTI / VUPS / ProStar
  - UIT / Witten
- Obtain significant results in the short to medium term
- Build the potential for radical improvements in the long term

Realities

- With existing tools and highly trained people, we can find about 80-90% of existing utilities; Getting the remaining 10-20% will require new tools
- Once we spend the effort to get good information, we don't keep it current
- We rarely develop accurate as-builts as we put utilities in the ground
- Utility mapping is thought of as too expensive (in direct opposition to relevant "value" studies)
- Comprehensive utility mapping takes a lot of time and is somewhat disruptive to traffic
- These new tools will be expensive and require highly skilled experts and as such will be used by specialty service providers

Follow-On R01 Projects

- R01-A: Technologies to Support Storage, Retrieval, and Utilization of 3-D Utility Location Data
- R01-B: Utility Locating Technology Development Utilizing Multi-Sensor Platforms
- R01-C: Innovations in Expanding the Locatable Zone

Process

Tools

<u>Common Elements</u>

RFID

GPS

Data Reliability / Pedigree

MTU On-Going research

SHRP2 R-15 Recap: **Best Practices**

- **Advance Relocation of Utility Work**
- **Early Involvement of Utilities in Planning and Design Phase**
- **Training of DOT Designers on Utility Relocation Process**
- **Development of a Geographic Information System Database**
- **Preconstruction and Progress Meetings**
- **Incentive for Early Relocation**
- **Development of Utility and ROW Management Systems**
- **Inclusion of Utility Relocation Work in DOT Construction Contract**
- **Subsurface Utility Engineering**
- **SUE Rating Procedures**
- **Utility Coordination Meeting Held During Design Phase**
- **Work Site Utility Coordination Supervisor**
- **Utility Impact Matrix**

R01-B:
Utility Locating Technology Development Utilizing Multi-Sensor Platforms

Prime Contractor: Underground Imaging Technologies, LLC

Gary N. Young, Principal Investigator

Colin M. Kennedy, Project Manager

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Outline

- Project goals
- Reasoning for the multiple sensor approach
- What is available already
- Technology being developed in the project
- Project deliverables and schedule

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Project Rationale

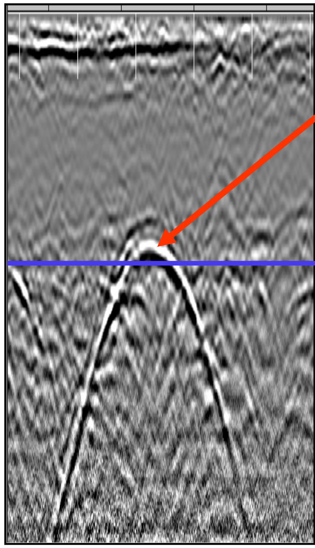
Top 5 Ranked Issues From the SHRP2 R01 Study:

1. Storage, Retrieval and Utilization of Utility Data
2. Multi-sensor Platforms
3. Development of Guidelines …for the conduct of utility investigations
4. Smart Tagging
5. Education and Training

Project Objective

- What does this ranking mean?
  - Standard utility mapping tools have limitations
  - No one tool can be totally successful in any situation due to variable utilities, surface conditions, soils and other factors
  - Limitations of physics of sensor systems that have been used
  - SHRP2 and UIT believe that developing a tool box that contains multiple types of mapping tools (sensors) gives the best chance of success on every project
  - The RFP also envisioned using an engineering context via the ASCE 38-02 standard for collecting and depicting utility data

The Case for Multiple Sensors



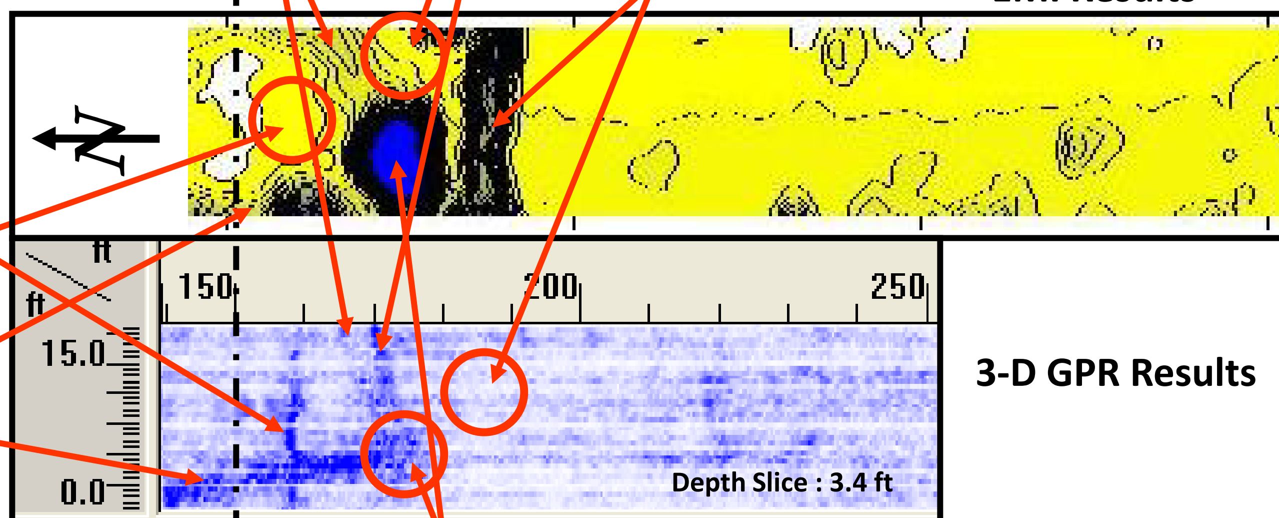
Hyperbolic 2D GPR Target

Storm Drain (Active) (not detected w/ EM)

Storm Drain Pipe

Street Light Power (not visible on GPR)

EMI Results



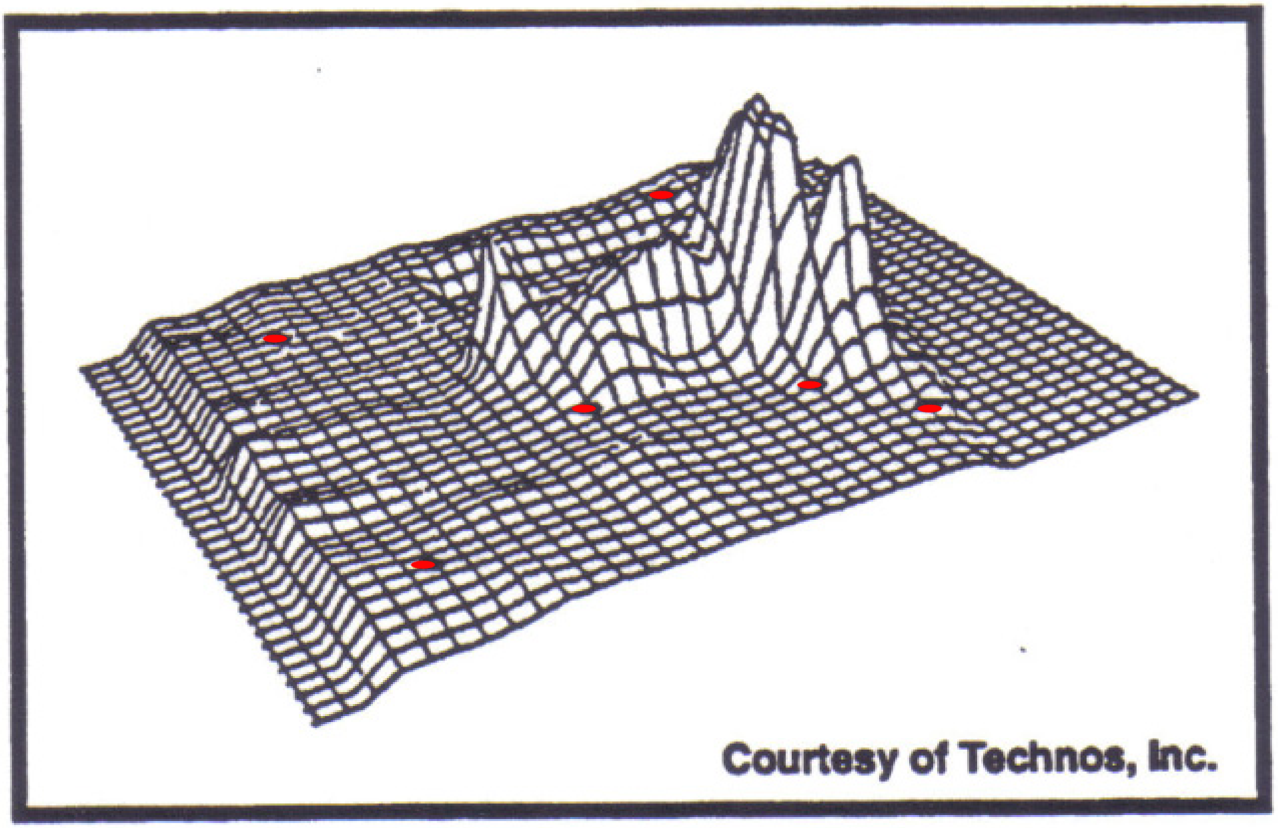
3-D GPR Results

Unknown Target (not detected w/ EM)

Storm Drain Pipe

Manhole

Finding Missed Targets Quickly with Continuous Coverage



- First six exploratory boreholes at Love Canal
- Geophysical map of the dump site

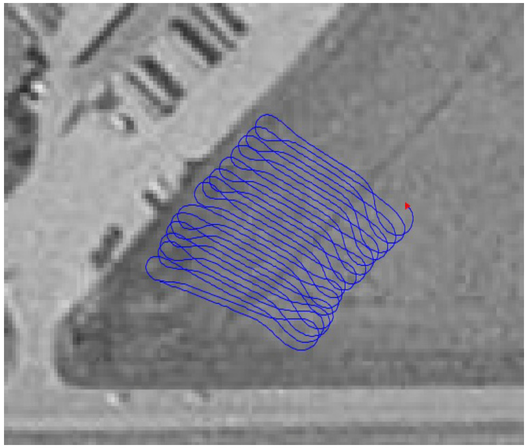
Advanced Multiple-Sensor Site Coverage:

- Cover site quickly
- High quality positioning
- Ensuring quality and complete site coverage

Project Strategy

Aim for continuous mapping and 3D results:

1. Start with what is already available



2. Knit data together with excellent positioning and good software

3. Develop new sensors to fill the gaps

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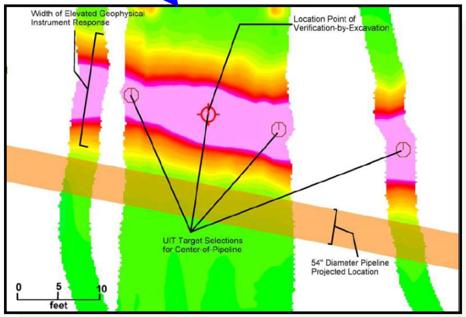
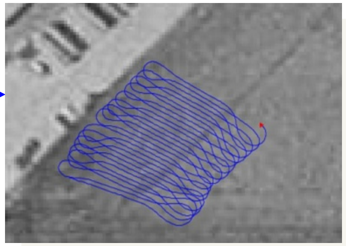
Regularly Used Advanced Geophysics

In addition to standard pipe & cable locators, etc.

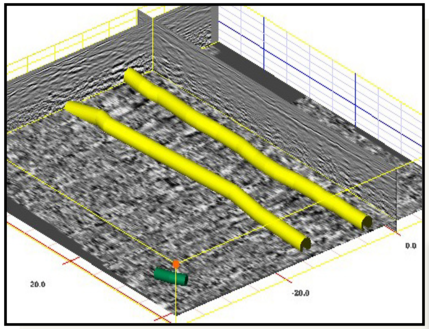
- **14-channel GPR**
  - Produces 3D subsurface images
- **3-channel EMI**
  - Aids in most soils
  - No connection to utility
- **Choice of positioning**
  - Depends on needs of the job



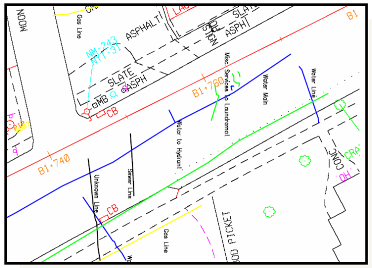
- **In-field system integration**
  - GPS with GPR and EMI



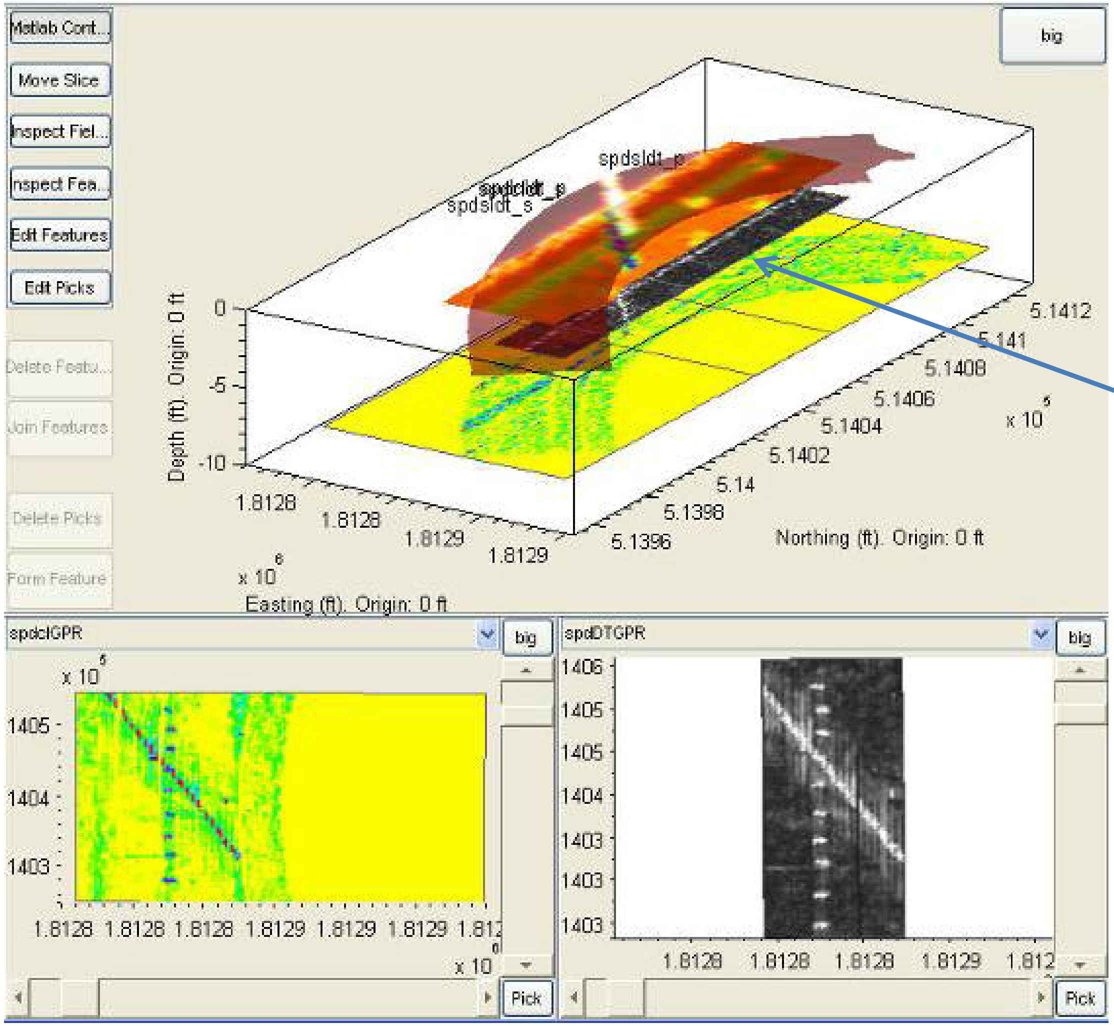
- **3-D processing, visualization and interpretation**
  - This piece is critical and difficult



- **Final digital output**
  - CAD in client's format
  - Dataset for Machine Control and Guidance



3D Software Interpretation Environment



Multiple data sets in the same 3D workspace

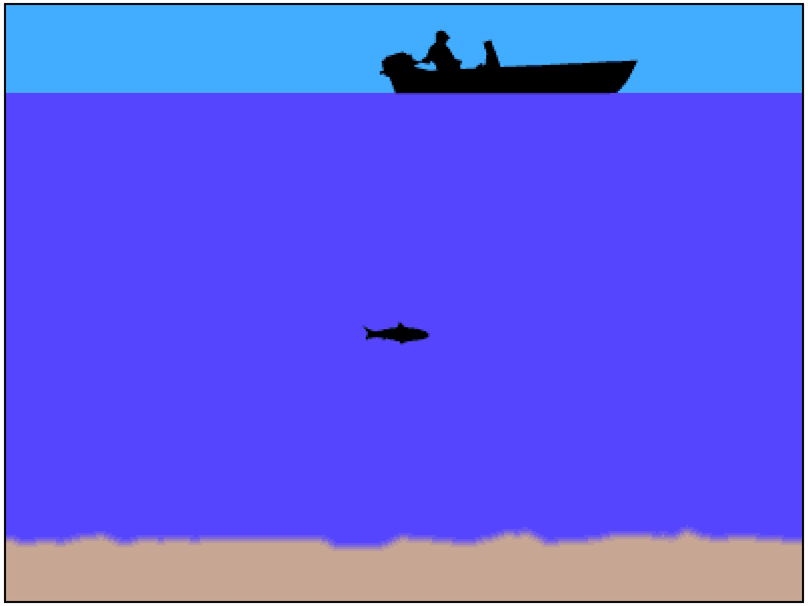
Where are the Gaps?

- Current systems
  - Low freq. and radio freq. electromagnetic
  - Locators and EM mapping
    - Target must be metallic
  - High freq. electromagnetic (GPR)
    - Severe depth limitations in clay soil
  - Thermal and acoustic listening
    - Must be something to look for other than the pipe, i.e., thermal or acoustic signature
  - Magnetometer
    - Target must be ferrous metal

- Gaps:
  - Non metallic utilities
  - Clay soils
- Needed improvement in interpretation software

New Technology: Seismic

- Addressing the clay soils issue with GPR
- Seismic (acoustic) imaging
  - Plastic and metal utilities provide good targets
  - Acoustic waves favor sticky soils such as clay
- The challenge
  - New science must be developed
  - No previously developed systems to work in the depth or frequency range necessary for utilities
- The major development of the R01-B program



From: www.fishfinder-store.com

Fish finder illustration of seismic

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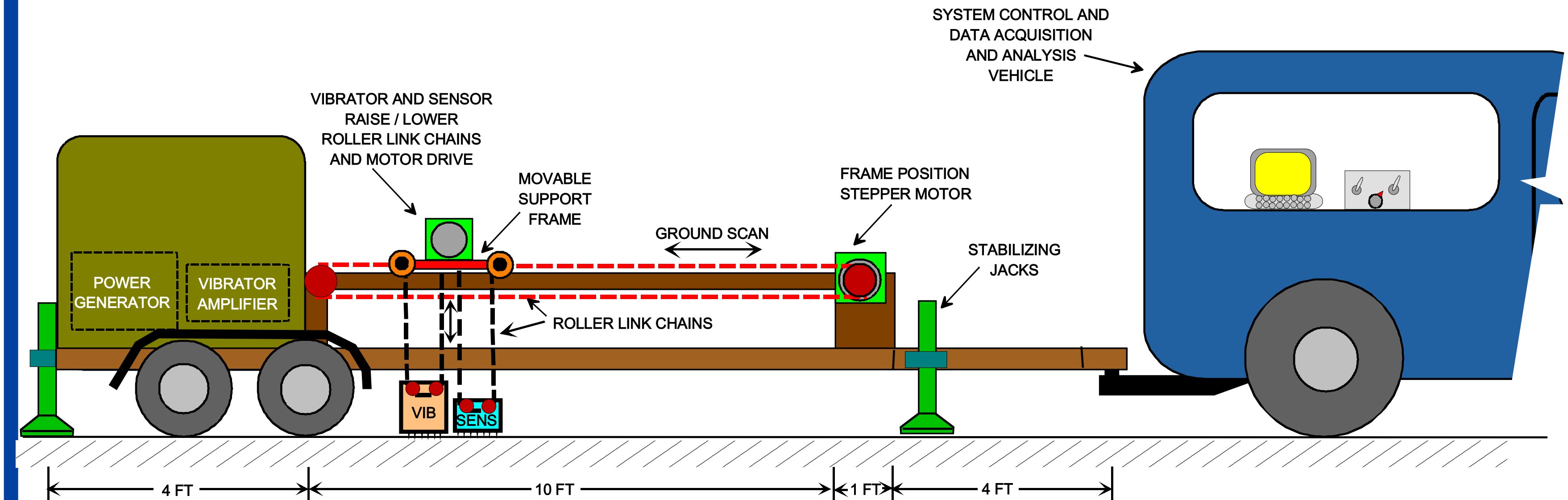
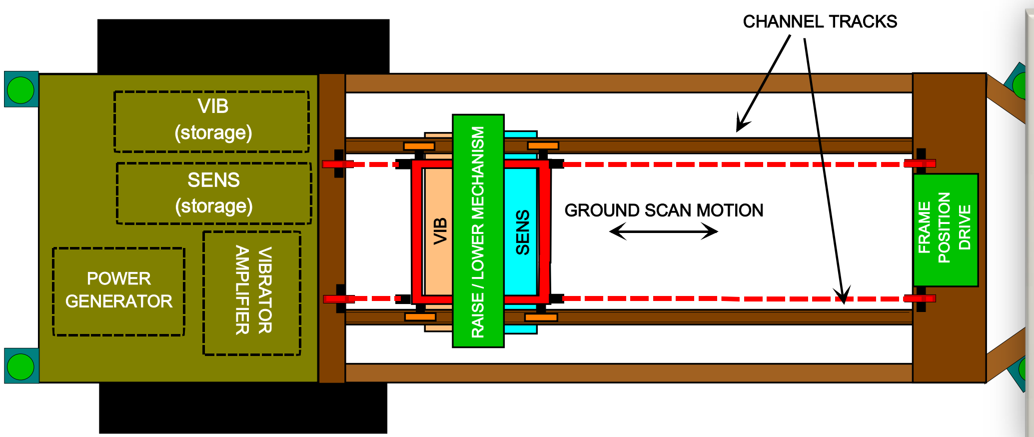
Seismic Platforms





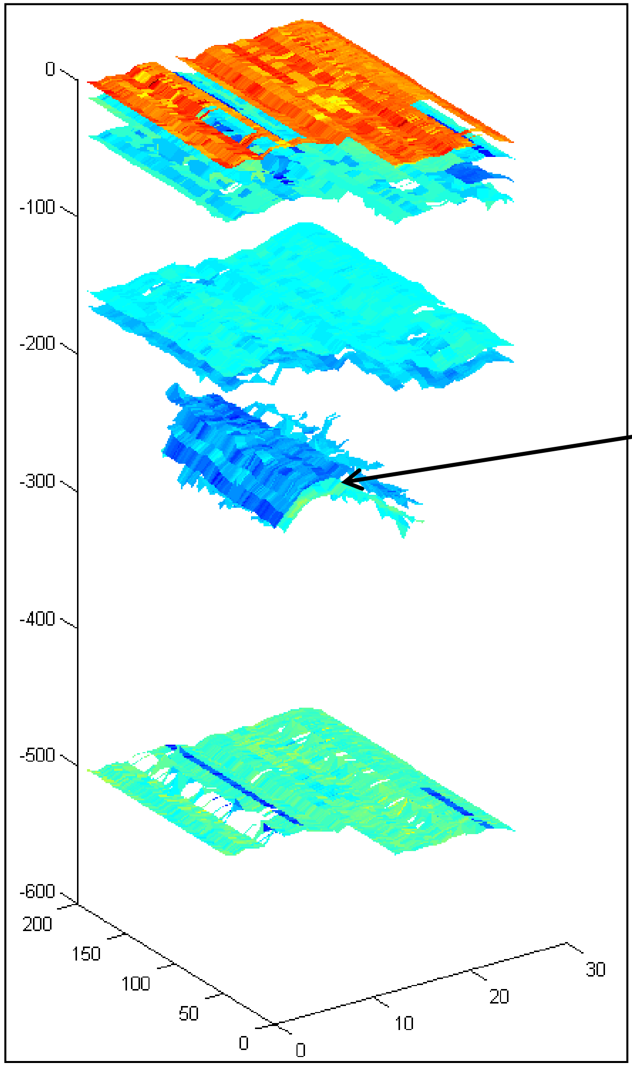
New Technology: Improved Time Domain EM

Naval Research Lab Research System

- Based on UXO detection system used by US military
- Improved target resolution
- Improved depth of penetration

SHRP2 TEM Array

Improved Technology: 3D Interpretation Processing



Hyperbolic signature of a utility in 3D

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Ultimate Application

- Systems will be complex and must be operated by experts
- Will be available to users via consultants/contractors, e.g., SUE consultants
- UIT or licensees

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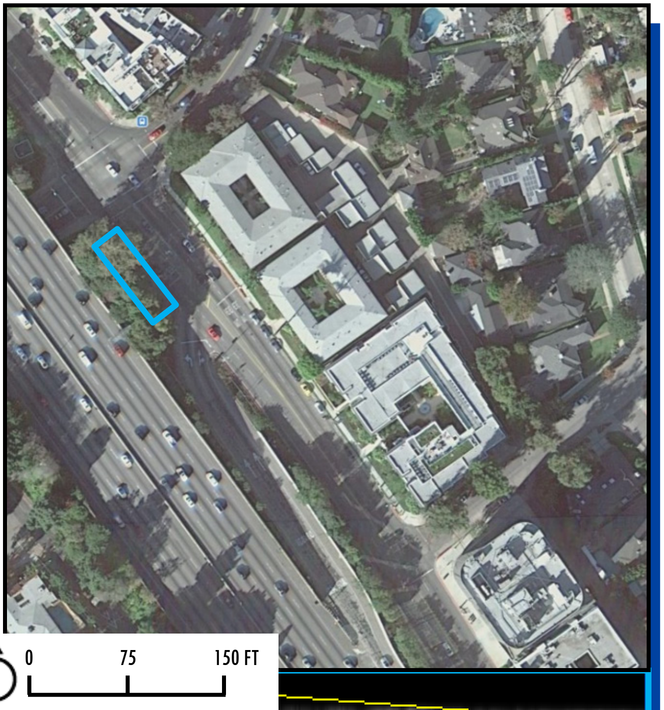
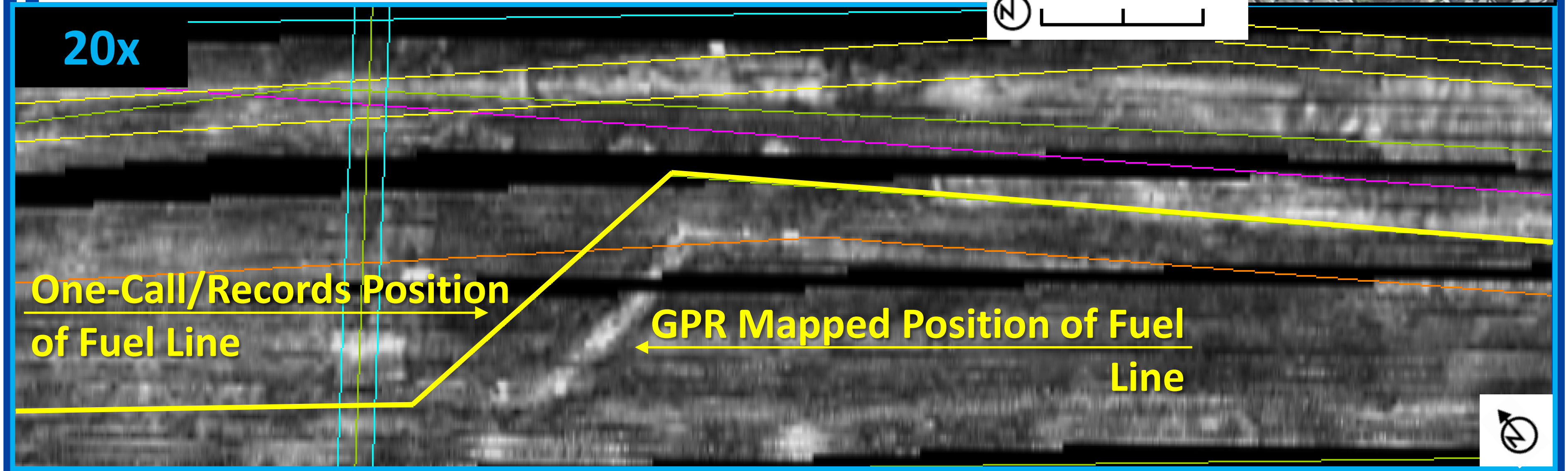
Mapping Example with Currently Available GPR On a Project Where a Range of Techniques and Services Were Applied

Note: Data below is displayed in DEPTH SLICE.





Deliverables & Schedule

- Prototype seismic and EMI systems
- Seismic modeling software
- Improved version of 3D interpretation software
- Project completion in late 2012
- Commercially ready systems will take another major step
- Likely commercial release in 2013 or 2014, or later depending on funding and unforeseen problems

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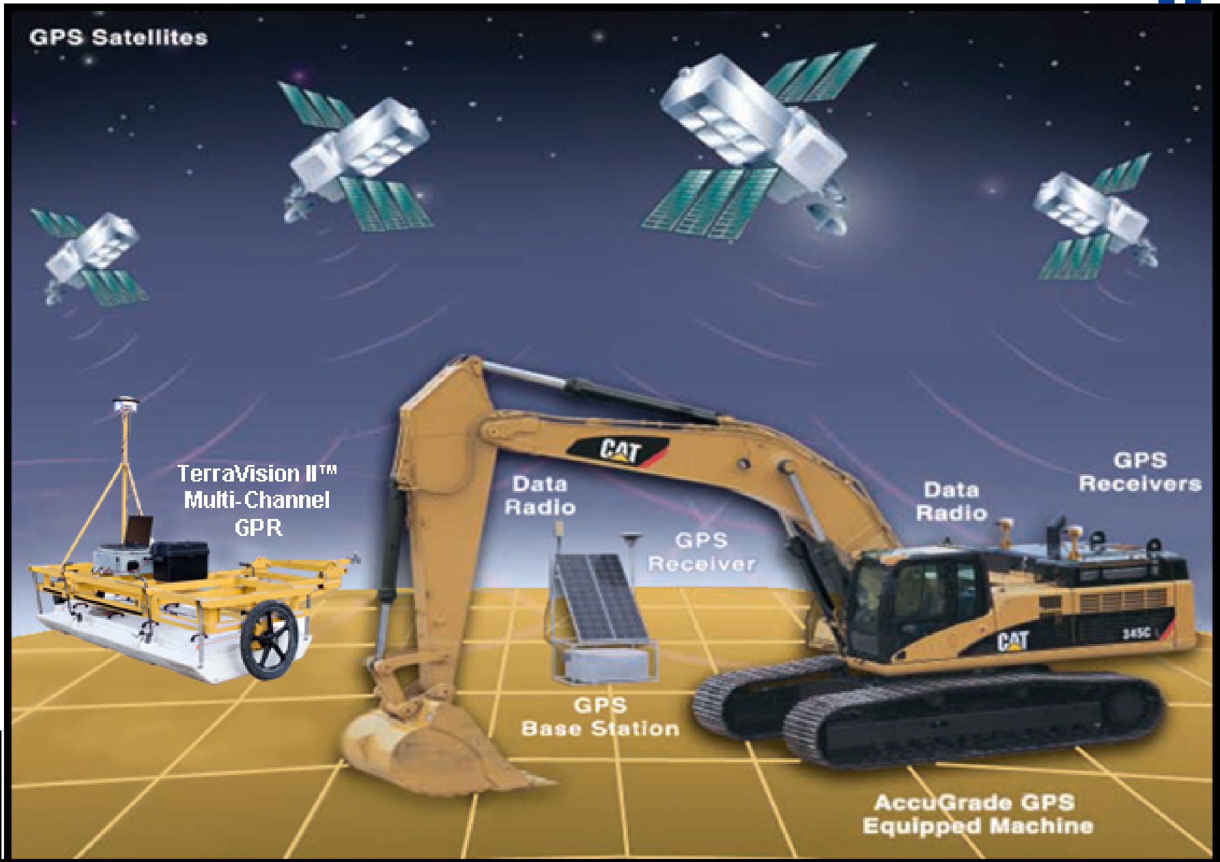
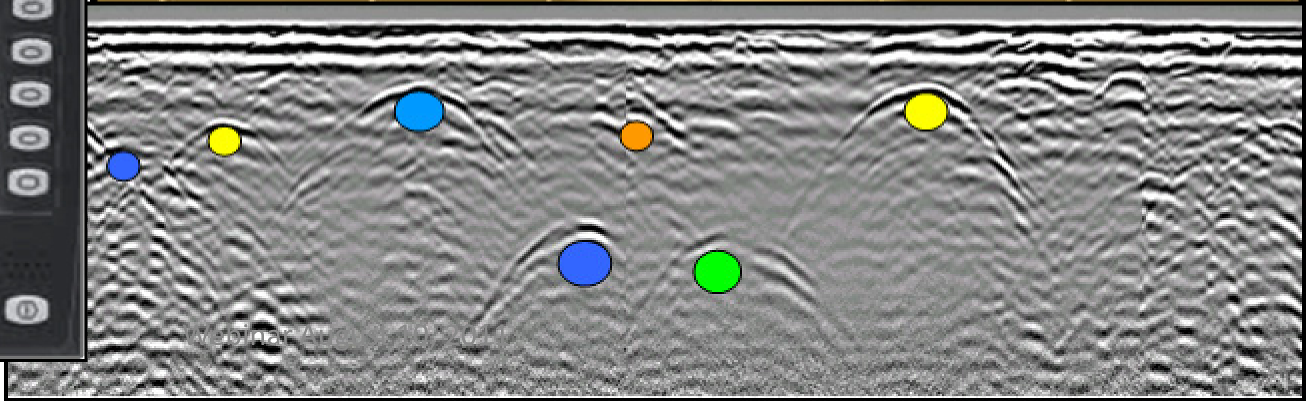
Newly Enabled Application: Machine Control and Guidance





the Energy to Lead

SHRP 2 Project R01-C Encouraging Technology Innovation to Improve the Extent of the Locatable Zone

Chris Ziolkowski
Principle Investigator
Gas Technology Institute

gti

R01-C Presentation

- This presentation will cover the following:
  - The background and motivations for this work
  - The objectives of the current project
  - The technologies being tested
  - The anticipated products of this work
  - Project current status and schedule

R01-C Background

- Infrastructure location records can be "stale"
- Modern installation processes allow greater depth and "stacking" of infrastructure
- Modern materials are less easily detected
- We need to improve both:
  - Our means to locate infrastructure
  - Our means of maintaining this data

R01-C Objective

- To test prototype technologies for <u>locating</u> buried facilities that are:
  - Of diverse composition
  - At depths of up to 20 feet
  - Obstructed or “stacked”
  - In the challenging, road construction environment

Anticipated Technology Products

- UIT: Seismic Reflection Locator
- GTI: Active & Passive Acoustic Locator
- GTI: Scanning Electromagnetic Locator
- VAI: Long-Range RFID Tags

Anticipated Audience

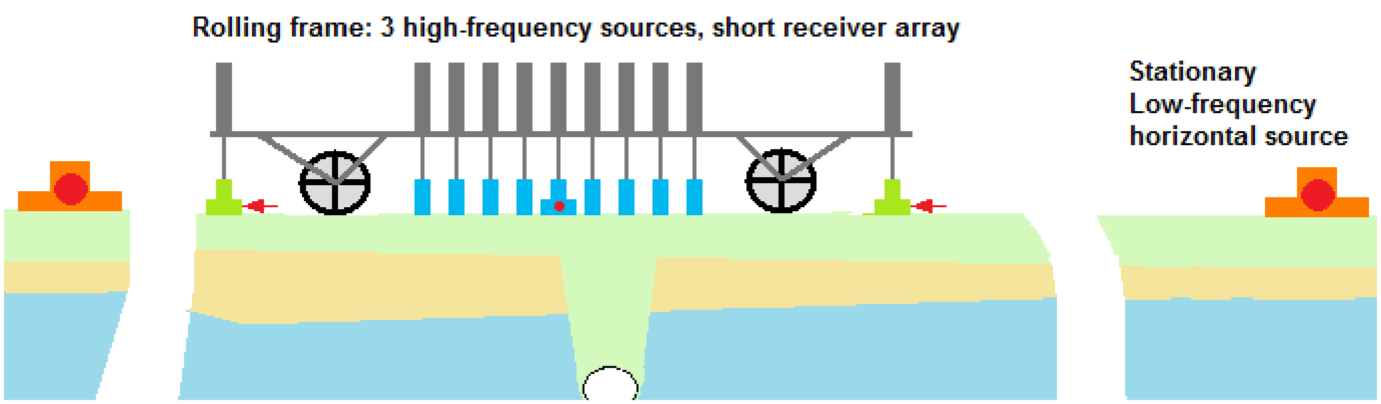
- The anticipated users of these technologies are:
  - Local DOT and highway planning agencies
  - Subsurface Utility Engineering companies
  - Skilled locating technicians who will actually perform the locates

UIT Seismic Reflection Technology

- Targets all pipe materials
- Method staged completely above ground
- Shear waves give superior depth of penetration
- Works in clay soils where GPR does not

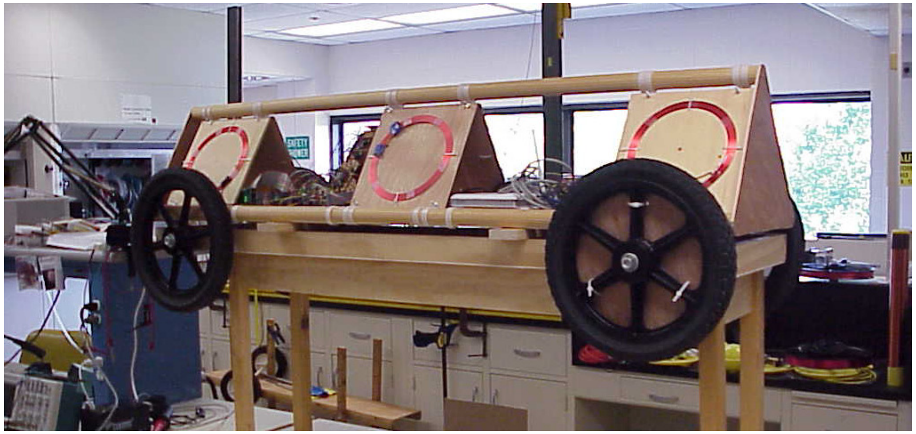
UIT Seismic Reflection Technology

- Profile line is perpendicular to suspected utility
- Fixed location shear wave sources at each end of a profile line for deep reflections
- Cart with sources and receivers travels the profile line
- Shear waves work well with linear targets, i.e. pipe

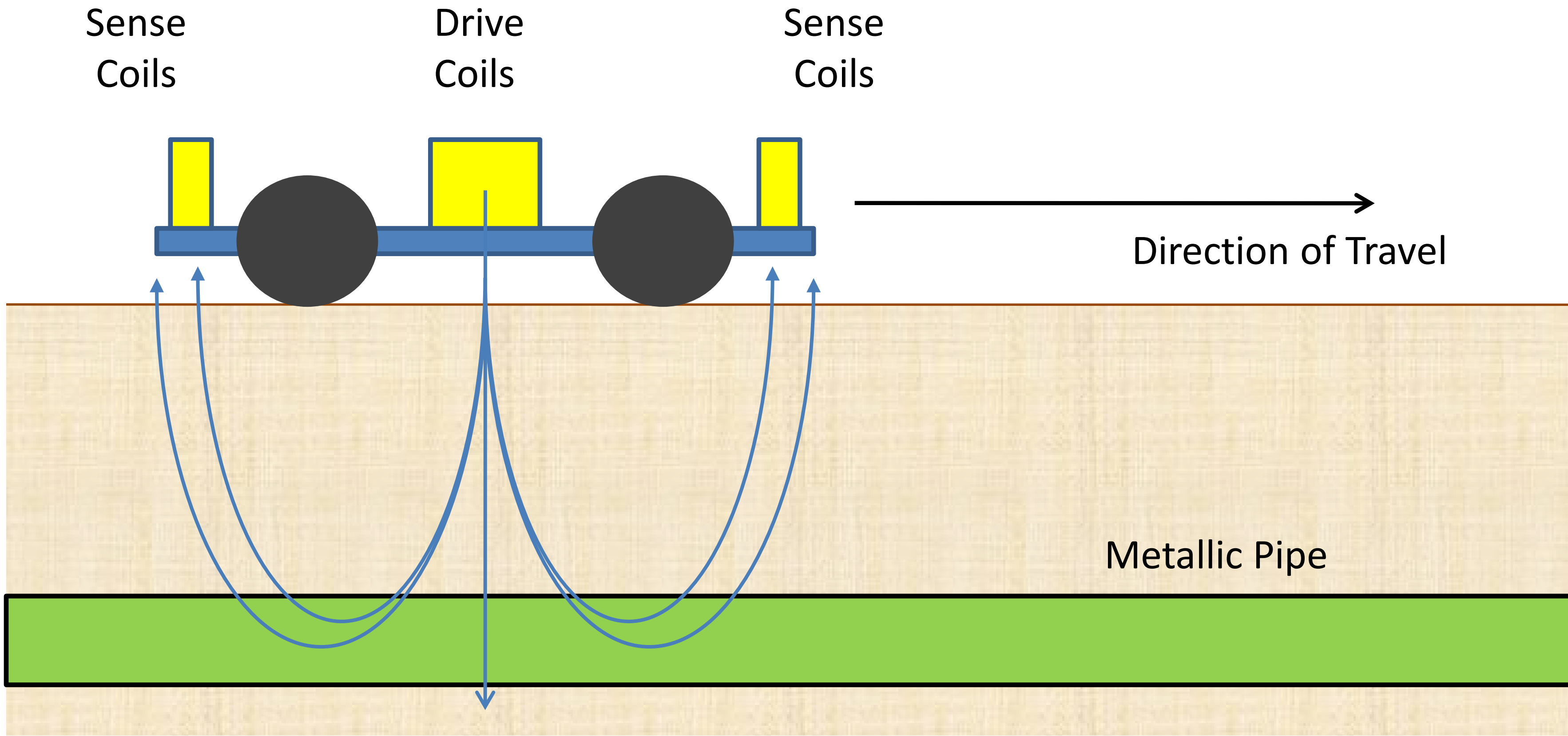


GTI Scanning EM Prototype

- Target is metallic piping
- Low frequency EM for good depth of penetration
- The “inducer” moves with the cart for strong signal
- Differential pickup improves sensitivity
- Scan eliminates the need to be “dead on" target
- Provide angle to target combined with odometry



GTI Electromagnetic Technology



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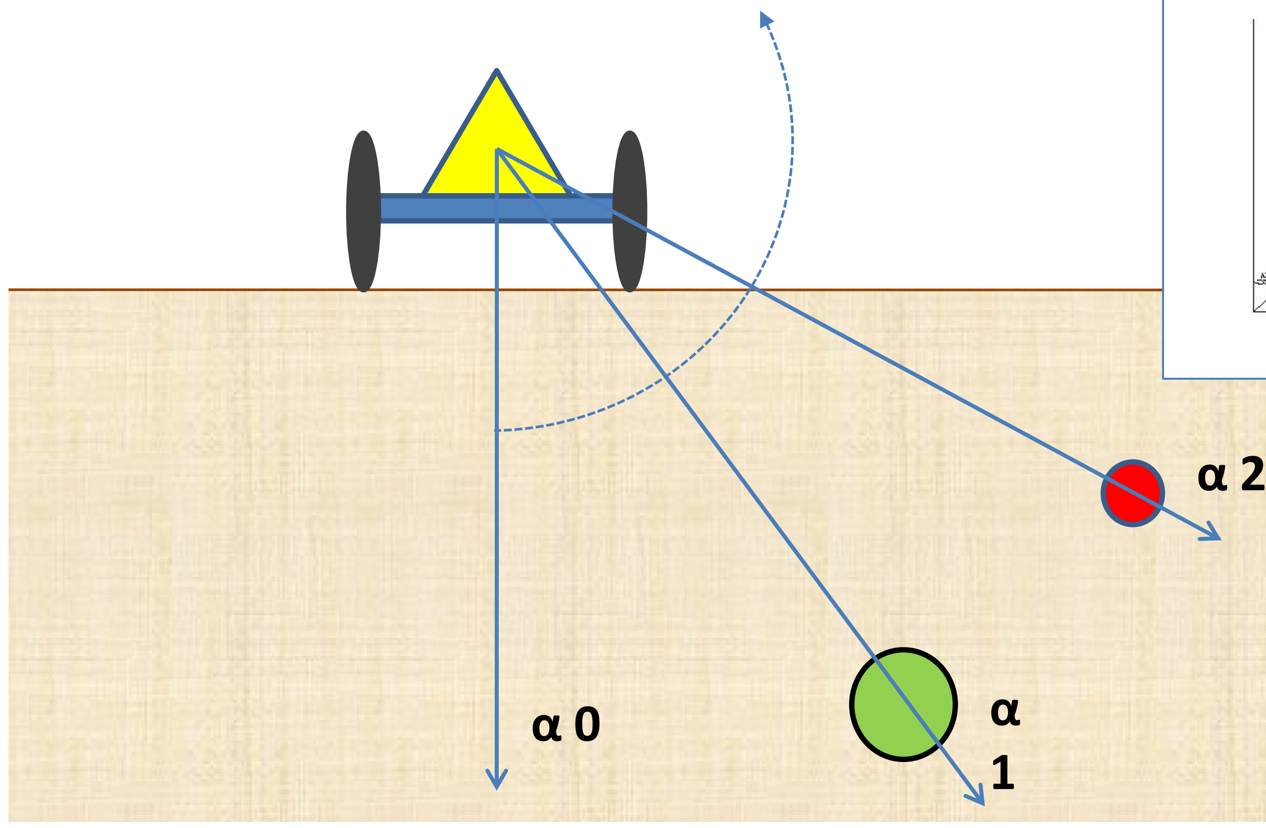
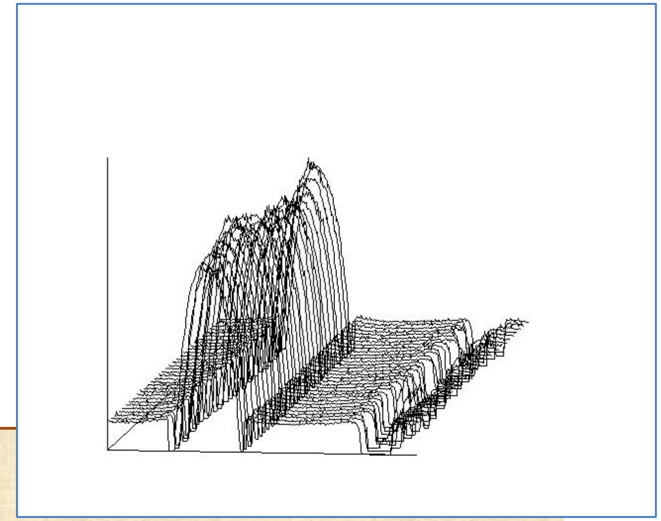
GTI Electromagnetic Technology

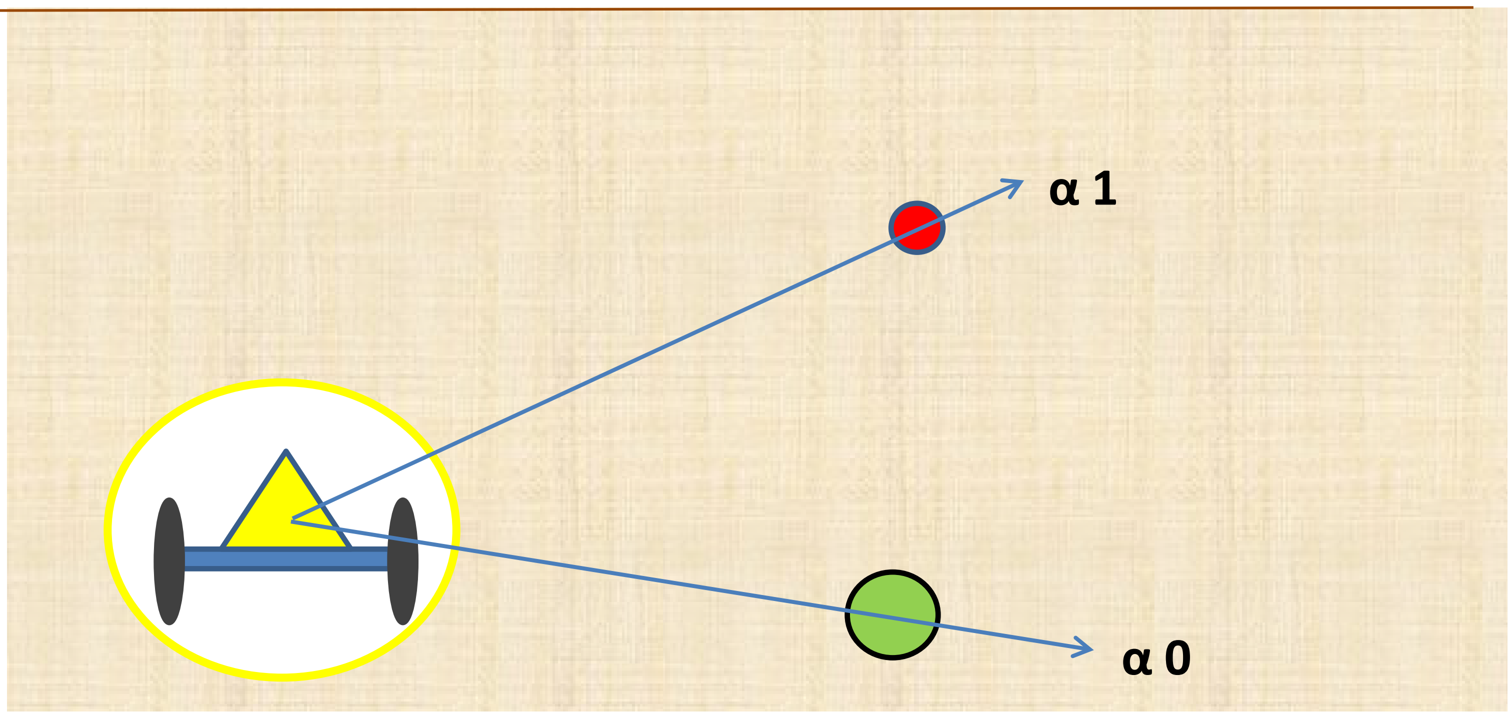
Cart rolls parallel to pipe path (into page)
EM field scans perpendicular to path





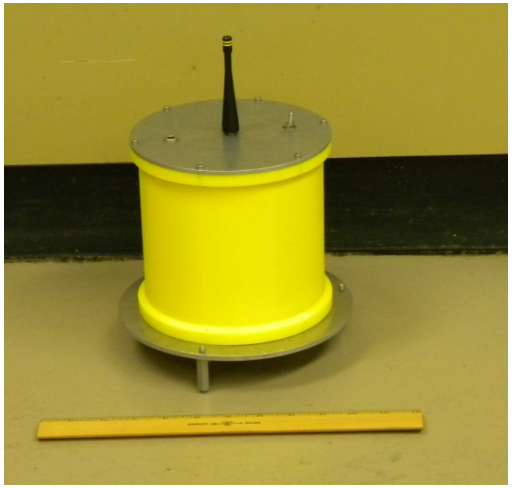
GTI Electromagnetic Technology

Deployment in non-metallic facility should be possible

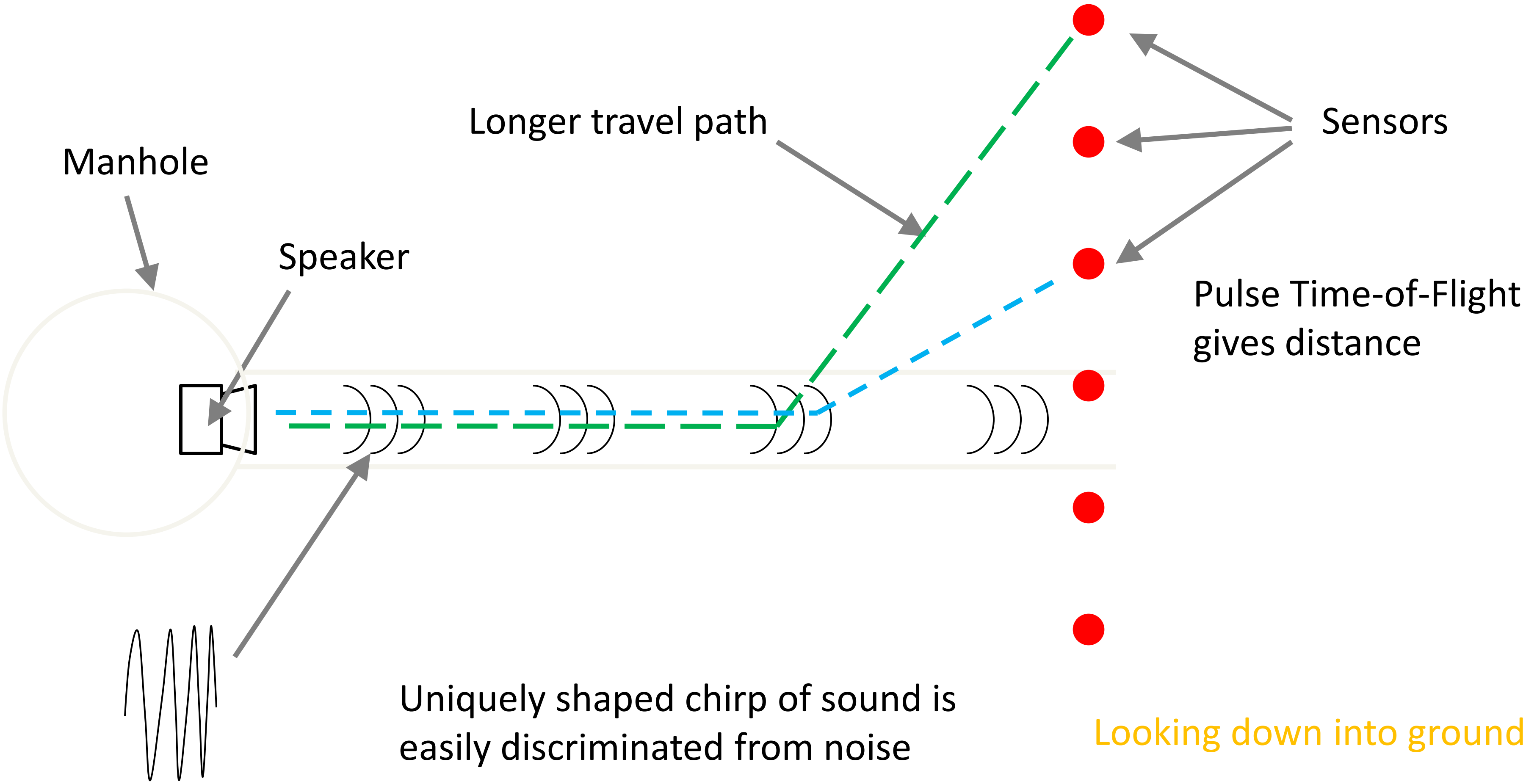


GTI Active Acoustic Method

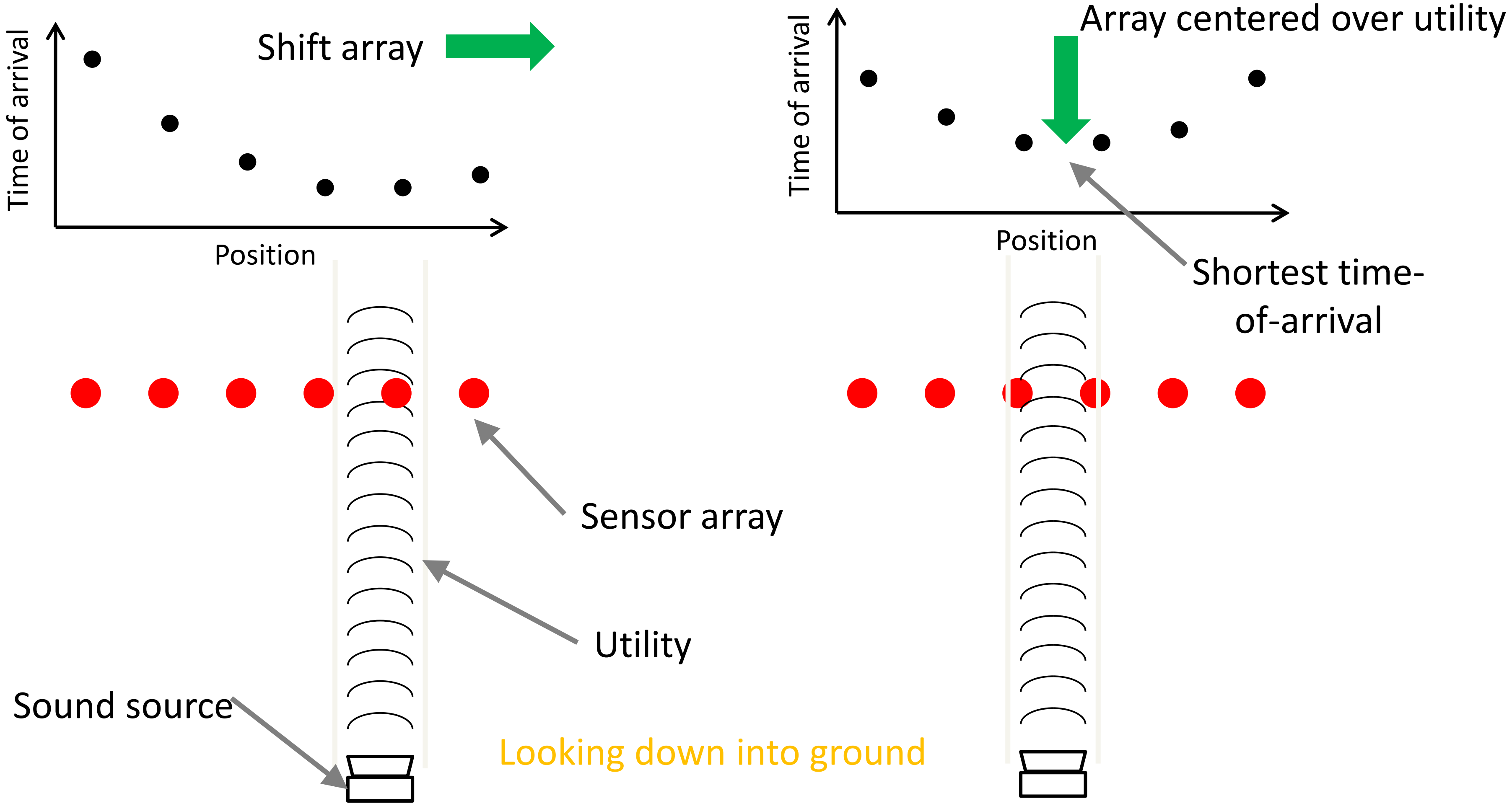
- Target can be any pipe material
- Places a tailored acoustic signal on the pipe itself
- No reflection or “round trip” losses
- Improves discrimination amongst facilities
- Does require a connection to the pipe



GTI Active Acoustic Depth



GTI Active Acoustic Location



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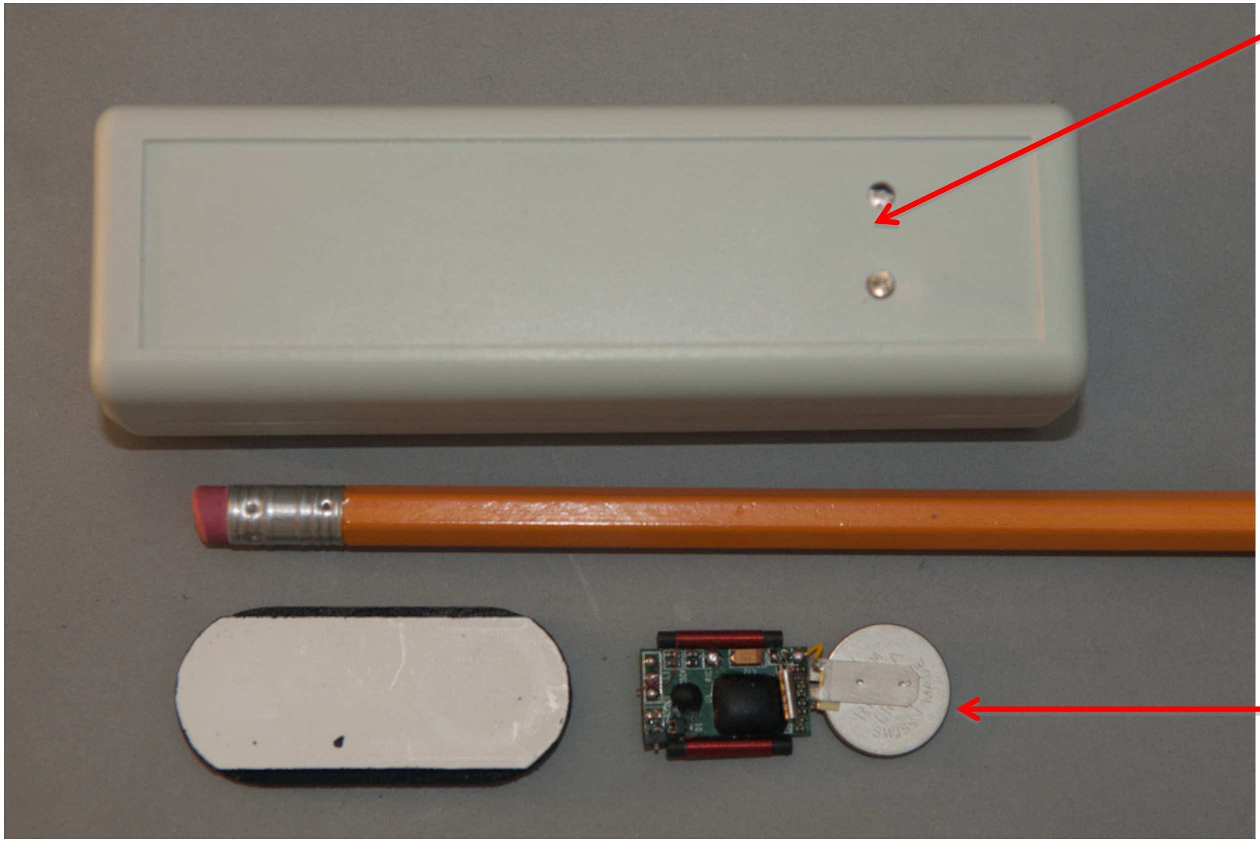
GTI Passive Acoustic Method

- Uses the same hardware to detect “passive” characteristic signals (such as 60 Hz vibrations from electrical lines)
- Software for passive signatures runs on the same platform
- Does not require any attachment to the facility being sought
- Passive signal still originates from facility rather than being a round trip reflection

VAI Long Range RFID Tags

- Visible Assets Inc. active RFID tags have these features:
  - Range of up to 50 feet in soil
  - Battery life of 20+ years
  - IEEE 1902.1 public protocol communication
- In addition to tags, VAI is producing readers and locators

VAI Current State of Prototypes

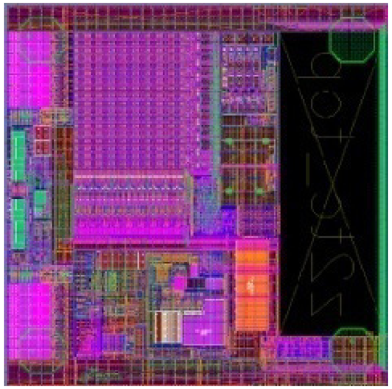


Current Pipe Tag Prototype

Current RuBee Production Tags

VAI Single Chip Implementation

- VAI is working on a single chip implementation that will have advantages for buried service
  - Reduced size enables Mil Spec package
  - Reduced power consumption – increase lifetime
  - Reduce total cost to realistic range $3-$5/Tag
  - Enable tags with built in sensors



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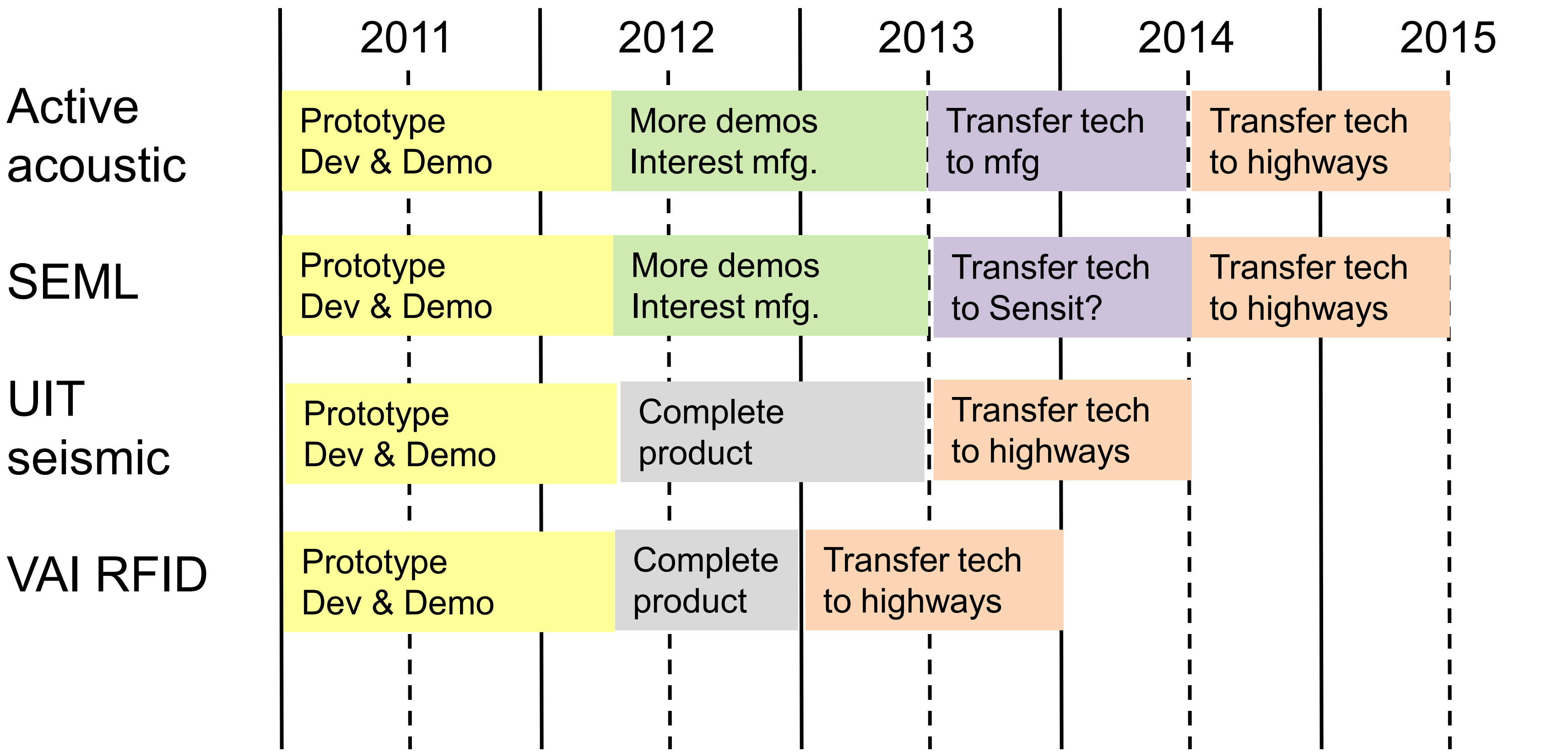
Suggested Implementation Roadmaps



Continuous industry publications, webinars, etc.

Summary

- Existing tools (GPR and EM locators) work well in some soils, but fail at modest pipe depths in others
- New tools are needed for clay soils, stacked utilities, deep utilities, and looking under pavement from the side
- No one tool can be used for all soils and utility materials
- R01-C identified promising, near-term technologies worthy of development

SHRP2 PROJECT R01-A: TECHNOLOGIES FOR THE STORAGE, RETRIEVAL, AND UTILIZATION OF 3-DIMENSIONAL UTILITY LOCATION DATA

Gas Technology Institute

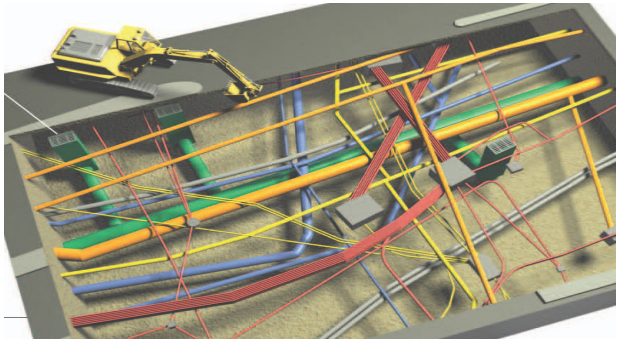
Alicia Farag

Agenda

- Background
- Project Objective
- Expected Outcome
- Research Approach
- Research Products
- Schedule and Status

Background

- DOTs need accurate and up-to-date utility information during project development in order to consider the impact on utilities.
- Designers are usually provided with this information at the beginning of a project, but do not have a mechanism to ensure it is kept up-to-date.
- There is currently no system in place to track utility changes during a project and notify designers of the changes.
- DOTs need to completely re-map utilities for every new project.



Project Objective

- Create a system that provides a single, up-to-date repository for 3-D utility location data within a project boundary
- Leverage existing permitting and one-call processes to create a change notification system
- Develop supporting administrative procedures
- Utilize existing DOT mapping software

Expected Outcome

- Reduce re-design work resulting from utility changes unknown to the DOT designers
- Reduce project delays in the design and construction phase
- Reduce excavation damage to utility lines

Research Approach

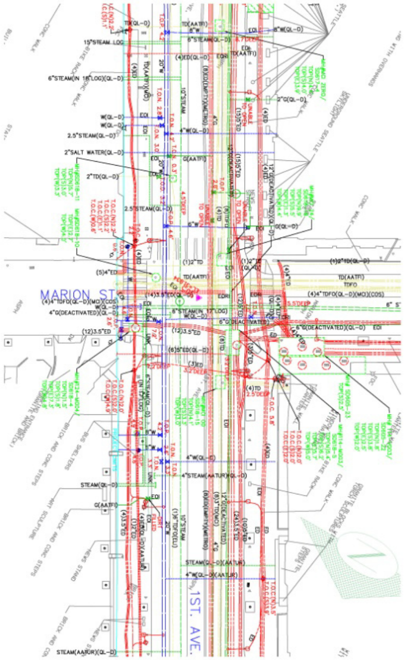
- Build a 3-D utility data model
- Utilize a spatial document management system
- Utilize 3-D visualization and notification tools
- Create administrative procedures
- Incorporate supporting best practices

3-D Utility Data Model

- Sufficient detail to allow designers to model:
  - Location (x, y, z)
  - Attributes (size, material, owner, etc.)
  - Quality and accuracy (ASCE Quality Level)
  - Administrative controls (security, access, etc.)

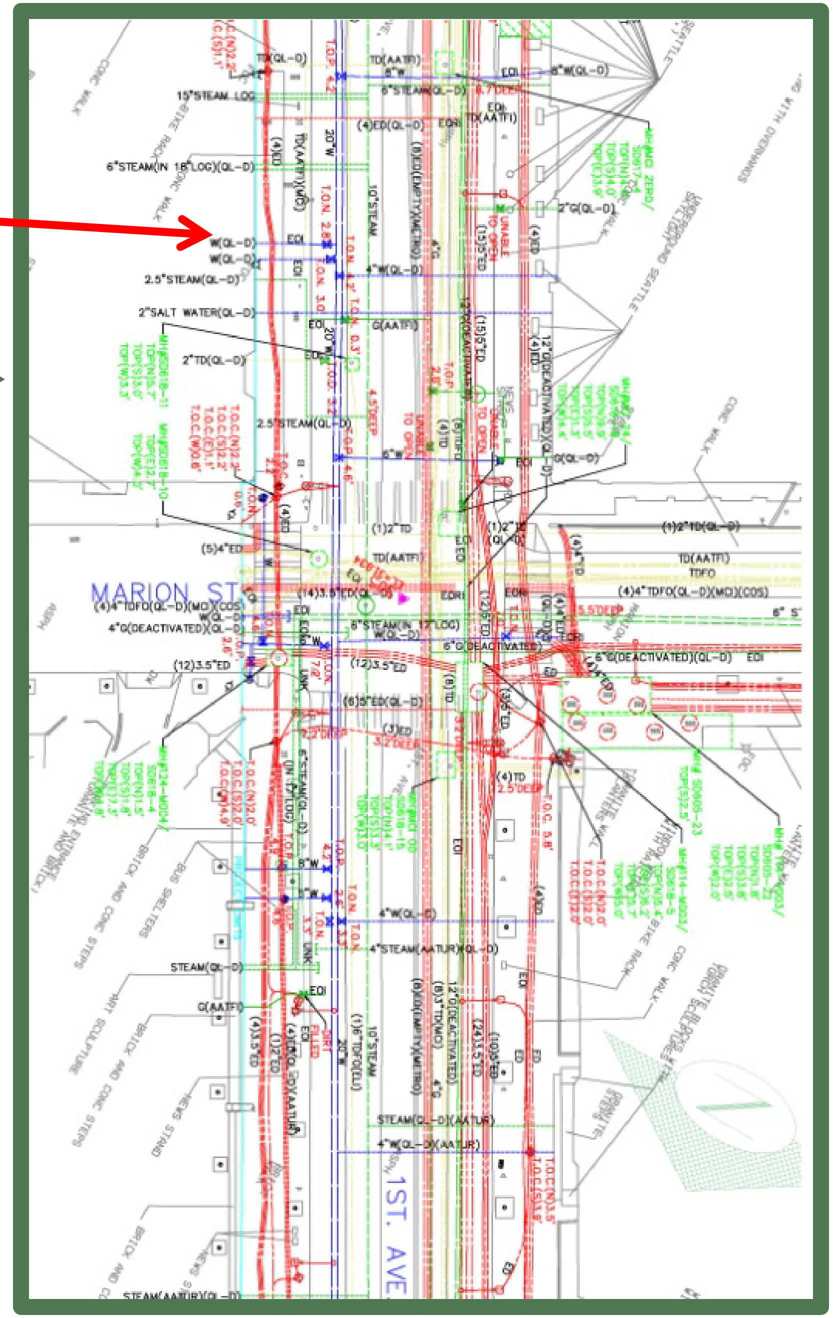
Spatial Document Management System

- Stores all project documents, raster and vector drawings, spreadsheets, survey data, etc.
- Spatial features allow administrative controls
  - Project Boundary Polygon
  - Permit Boundary Polygon
  - One-call Ticket Boundary Polygon



Initial Project Utility Mapping

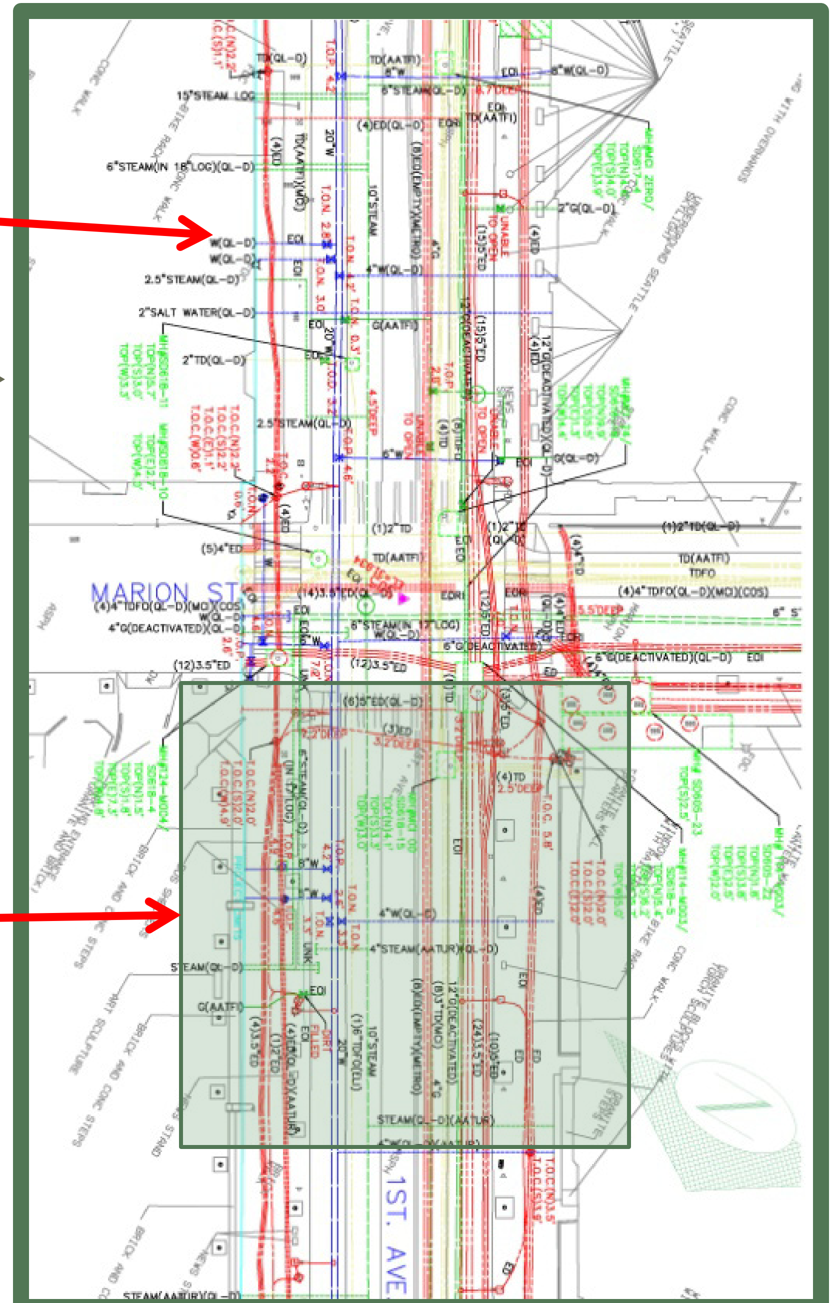
The DOT Project Limits
(Project Boundary Polygon)



Initial Project Utility Mapping

DOT Project Limits
(Project Boundary Polygon)

New DOT Permit for
Utility Relocation
(Permit Boundary
Polygon)



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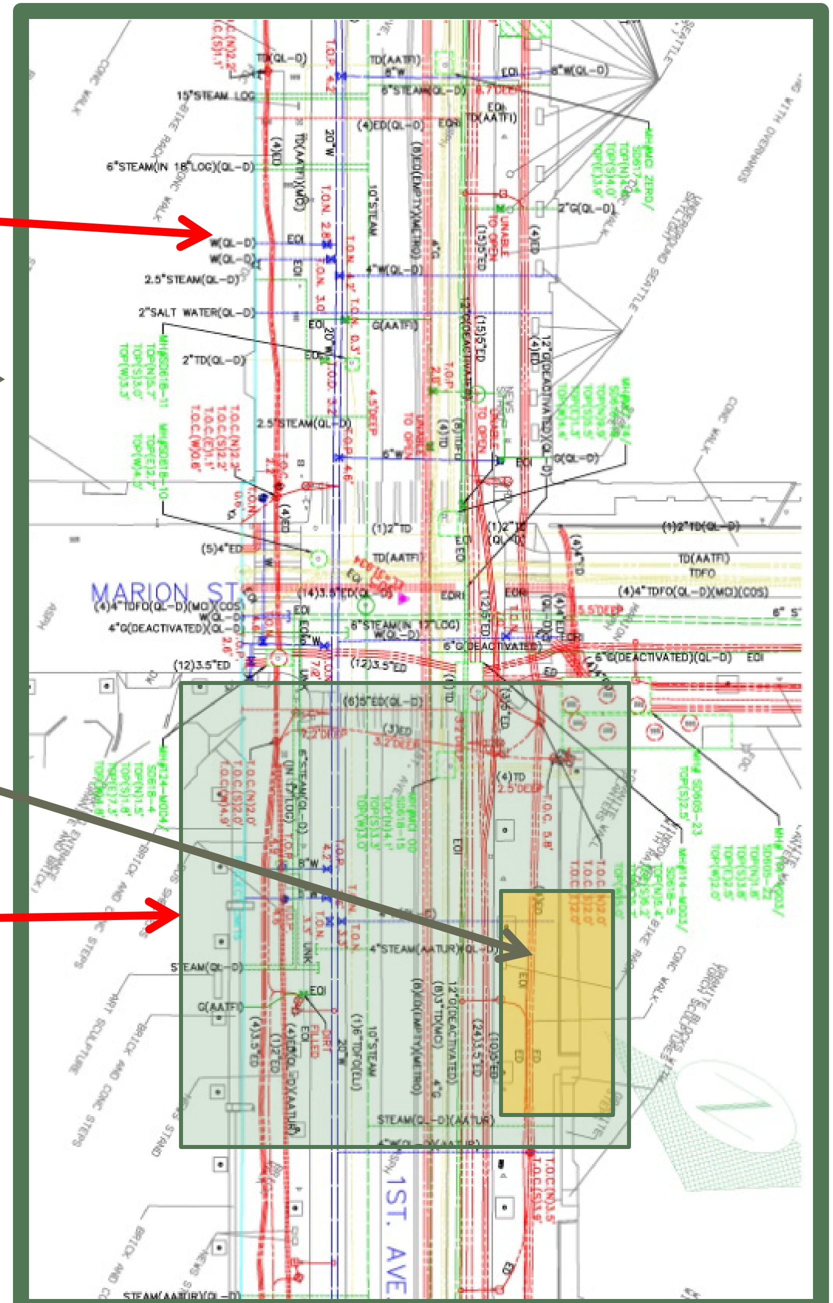
Initial Project Utility Mapping

The DOT Project Limits
(Project Boundary Polygon)

One-Call Ticket (One-Call
Ticket Boundary Polygon)

Boundary of New DOT
Permit for Utility
Relocation (Permit
Boundary Polygon)



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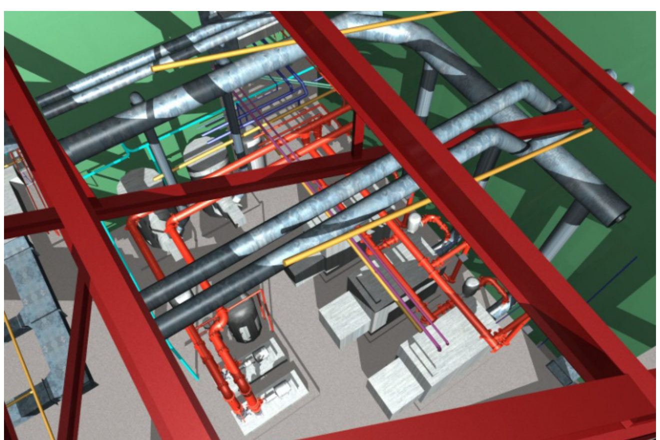
Administrative Procedures

- Integration with permit and one-call process
- Quality and accuracy management
  - Gatekeeper function
  - Certified Record Drawing
- Balancing security with access

Visualization and Notification

- Utilize existing 3-D visualization tools
- Change and notification system



EMAIL

Date: September 10, 2012
To: All Project T-31 Task Designers
From: Utility Gatekeeper

There is a change to the existing utilities on the referenced project.

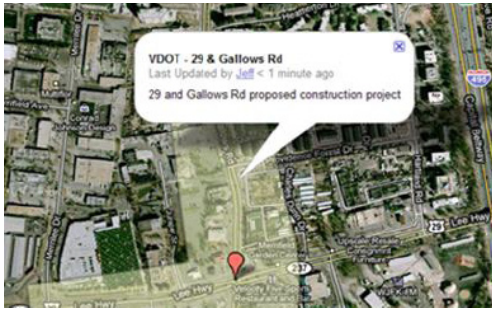
Location: At Project GPS Coordinates 38.54.47.13N ; 77.13.35.98W
What: Washington Gas has relocated their 10” HP gas line

Please view document UM 21.6 for details of the change.

The Master Utility Map has been updated as of 9/10/12, 10:42AM EST.

Supporting Best Practices

- RFID marker ball and smart tag technology
- Certified Record Drawings for new installations
- Electronic one-call boundary “white-lining”
- ASCE 38 Utility Quality Levels and/or similar metadata
- GPS-enabled cameras and utility locators



Research Products

- 3-D Utility Data Model
- Implementation Strategy
- Pilot Project
  - Virginia DOT, VUPS, participating utility companies
  - Implementation with existing tools
  - Inclusive of RFID marker ball program
  - Evaluation of administrative controls

Research Products

- Final Report
  - Recommendations for further implementation
  - Technology and administrative best practices

- DOTs, one-call centers, vendors, and service providers can use the data model and best practices to support further implementation

Schedule and Status

- Completing Phase 1 Report
- Starting Proof of Concept
- Pilot Project in late 2011

SHRP 2 Project R15-B: Identification of Utility Conflicts and Solutions

Cesar Quiroga

Texas Transportation Institute

Advancing Technologies for Working with Underground Utilities: Current SHRP 2 Research

SHRP 2/FHWA/AASHTO Webinar, August 10, 2011

Presentation Outline

- Background and research objectives
- Research products
- Implementation plan and current status

Utility Conflict Scenarios

- Utility facility vs. transportation design feature (existing or proposed)
- Utility facility vs. transportation construction activity or phasing
- Planned utility facility vs. existing utility facility
- Noncompliance with:
  - Utility accommodation laws, regulations, and policies
  - Safety or accessibility regulations

Solution Strategies

- Remove, abandon, or relocate utilities in conflict
  - Relocating utilities NOT NECESSARILY OR ALWAYS the best or most cost-effective solution
- Modify transportation facility
- Protect-in-place utility installation
- Accept an exception to policy

Research Objectives

- Utility conflict matrix (UCM): Important tool for managing utility conflicts
- Objectives:
  - Review trends and identify best UCM practices
  - Develop a recommended UCM approach and document related processes
  - Develop training materials
  - Develop implementation guidelines

SHRP 2 R15(B) Research Products

- Prototype 1: Compact, standalone UCM
- Prototype 2: Utility conflict data model and database
- One-day UCM training course
- Implementation guidelines

Products are ready for implementation

Prototype UCM Development

- Many states use tables or spreadsheets to manage utility conflicts
- Different categories of data tracked
- Wide range of styles and content
  - 26 sample tables received
  - 144 different data items in total
  - Range of data items per table: 4 – 39 (average: 14)
  - One size does not fit all
  - Different ideas about “consensus” tables

Recommendations from State DOTs

- Utility conflict matrix:
  - Track utility conflicts at facility level
  - Maintain and update UCM regularly
  - Develop UCM reports for utility companies
  - Keep UCMs simple
  - Use 11x17-inch page size for UCM
  - Start UCM during preliminary design phase
  - Include data from UCM in PS&E assembly

Prototype 1: Utility Conflict Matrix

- MS Excel format, includes drop-down lists

Utility Owner and/or Contact Name	Conflict ID	Drawing or Sheet No.	Utility Type	Size and/or Material	Utility Conflict Description	Start Station
AT&T	1	U-1	Telephone	Fiber Optic	Conflict with construction of frontage road widening.	21+00

End Station	Start Offset	End Offset	Utility Investigation Level Needed	Test Hole	Recommended Action or Resolution	Estimated Resolution Date	Resolution Status
22+00	45' Lt	45' LT	QLC		Relocation before construction.	3/8/2010	Utility conflict identified.

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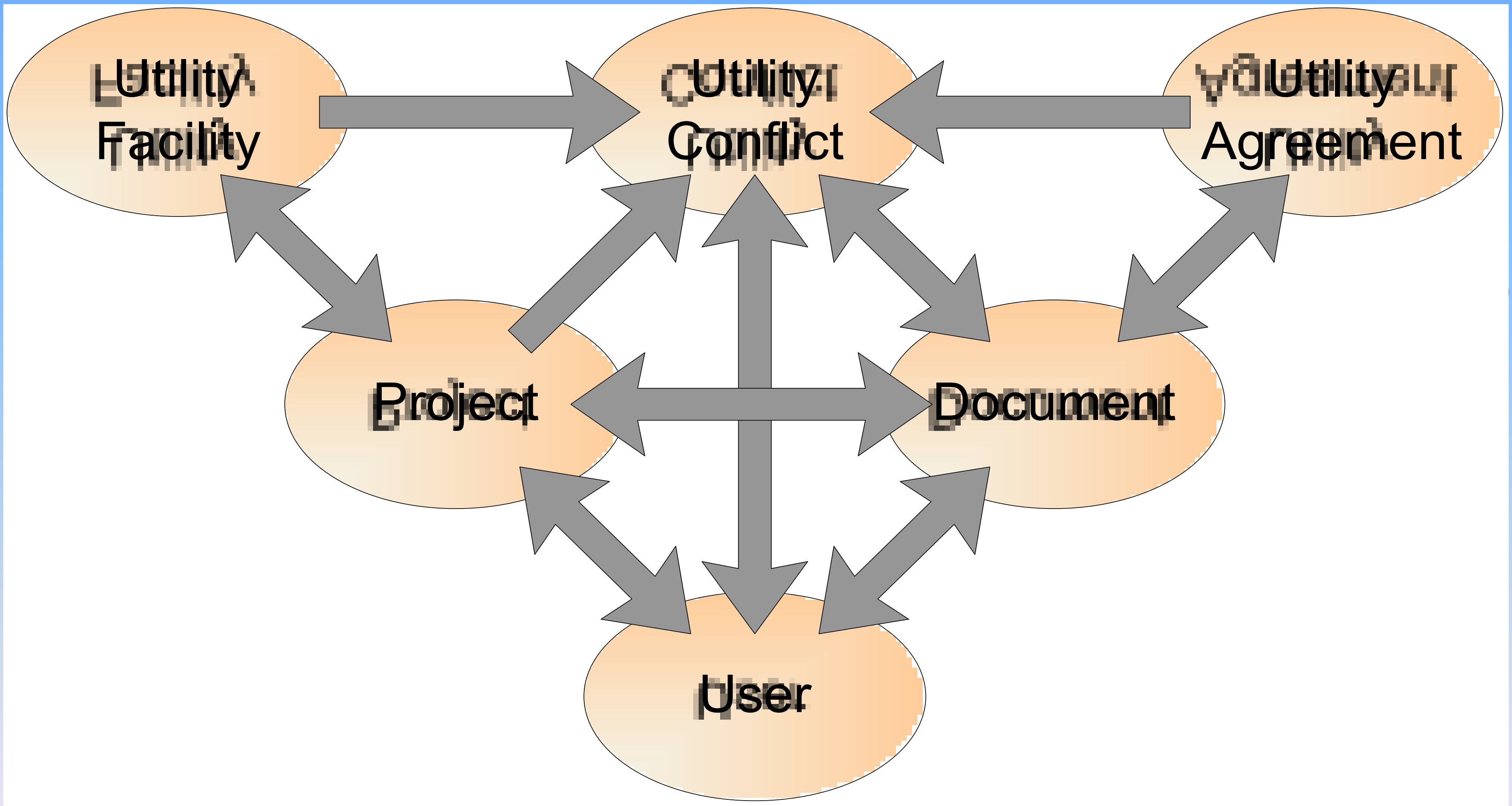
Prototype 1: Cost Estimate Analysis

Alternative Number	Engineering Cost (Utility)	Direct Cost (Utility)	Engineering Cost (DOT)	Direct Cost (DOT)	Total Cost	Feasibility	Decision
0	$ 10,375.00	$ 63,875.00	$ -	$ -	$ 74,250.00	Yes	Selected
1	$ 7,875.00	$ 32,375.00	$ -	$ -	$ 40,250.00	No	Rejected
2	$ -	$ -	$ 95,375.00	$ -	$ 95,375.00	No	Rejected
3	$ -	$ -	$ -	$ -	$ -	No	Rejected
4	$ 10,375.00	$ 63,875.00	$ -	$ -	$ 74,250.00	No	Rejected

Prototype 2: Data Model and Database



Prototype 2: Example (Prototype 1)

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Utility Conflict Matrix Developed/Revised By: ____________________ **Date:** __________

Reviewed By: ____________________ **Date:** __________

End Offset	Utility Investigation Level Needed	Test Hole No.	Recommended Action or Resolution	Responsible Party	Estimated Resolution Date	Resolution Status	Cost Analysis
45' Lt	QLC		Relocation before construction.	U	3/8/2010	Utility conflict identified	Detail
37' Rt	QLC		Relocation before construction.	U	3/8/2010	Utility conflict identified	Detail
48' Rt	QLC		Relocation before construction.	U	3/8/2010	Utility conflict identified	Detail
48' Rt	QLC		Relocation before construction.	U	3/8/2010	Utility conflict identified	Detail
49' Lt	QLB		Design change.	D	3/8/2010	Utility owner informed of utility conflict	Detail

Prototype 2: Example (Prototype 1)

lution Alternatives

e Analysis

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Date: 11/24/2010

Project Owner: Texas Department o

Project No.: 1234-56-789

Project Description: Road construction pr

Highway or Route: I-10 Katy Freeway

Conflict ID:	1
Utility Owner:	AT&T
Utility Type:	Telephone
Size and/or Material:	Fiber Optic
Project Phase:	60% Design

Alternative Number	Alternative Description		arty	Engineering Cost (Utility)	Direct Cost (Utility)	Engineering Cost (DOT)	Direct Cost (DOT)	Total Cost	Feasibility	Decision
0	Relocation before construction.	No c no a		$10,375.00	$63,875.00	$0.00	$0.00	$74,250.00	Yes	Selected
1	Protect in-place.			$7,875.00	$32,375.00	$0.00	$0.00	$40,250.00	No	Rejected
2	Design change.			$0.00	$0.00	$95,375.00	$0.00	$95,375.00	No	Rejected
3	Exception to policy.			$0.00	$0.00	$0.00	$0.00	$0.00	No	Rejected

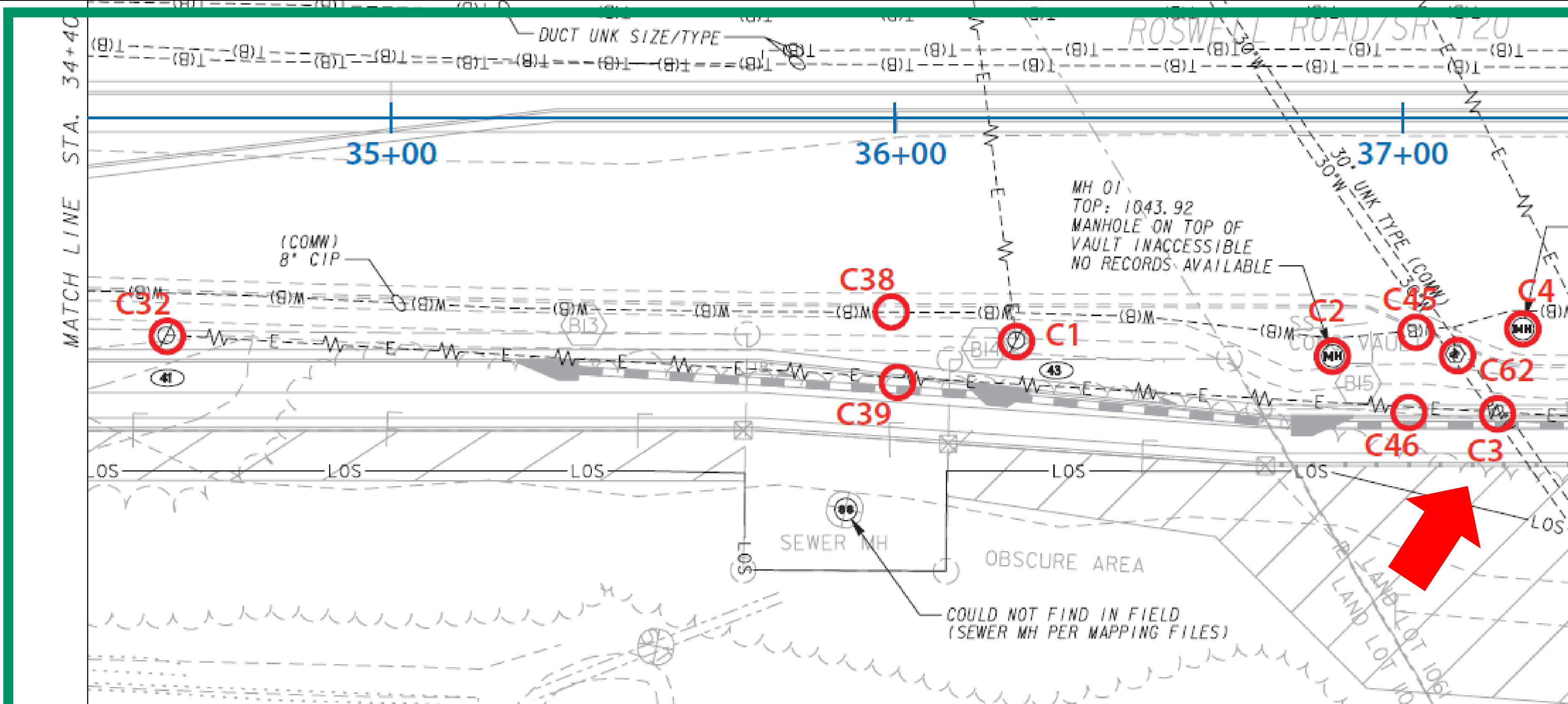
Prototype 2: Other Potential Reports

- All utility conflicts associated with company X (project, corridor, or timeframe)
- Average conflict resolution time for electric utilities
- All utility conflicts with resolution time >100 days
- Customized UCMs for individual utility companies
- Utility certification for inclusion in PS&E package
- …

One-Day UCM Training Course

- Lesson plan (6 lessons)
- Presentation materials (PowerPoint)
- Presenter notes
- Participant handouts
  - Handouts, sample project plans, UCM templates
- Companion CD
  - All training materials, including UCM
  - Prototype utility conflict database

Hands-on Utility Conflict Analysis



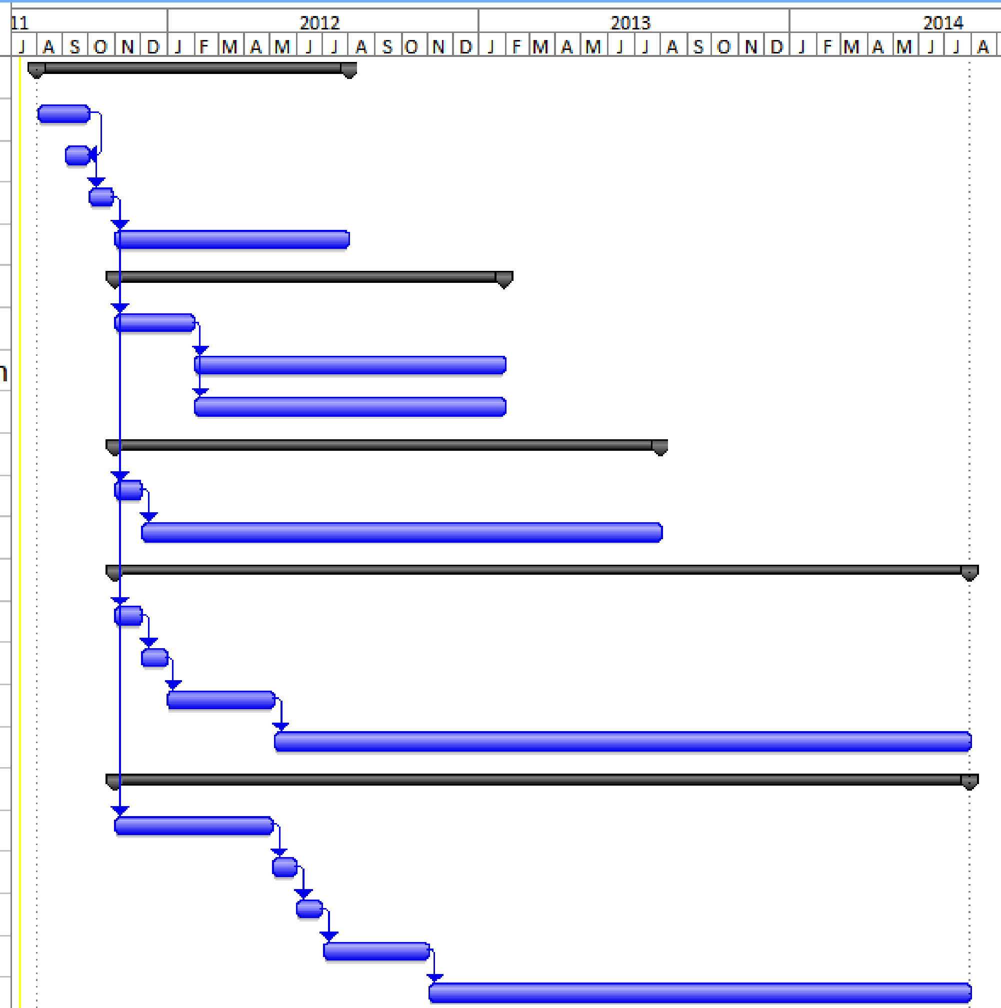
Utility Owner	ID	Sheet No.	Utility Type	Size/ Material	Utility Conflict Description	Start Sta.	End Sta.	Start Offset	End Offset	Inv. Need	Test Hole	Recommended Action	Rsp. Party	Est. Res. Date	Res. Status	Cost Analysis
	C3	1	WM	30”	Proposed 18” drainage pipe would cross WM.	37+20		60’ Rt		QLA	3	Review possibility of adjusting drainage pipes up to avoid conflict, lowest structure (B13) is at 5.6‘.	D	n/a	Utility conflict identified.	

Implementation Plan

- Implementation team
- UCM training courses
- Prototype 1 implementation
- Prototype 2 implementation
- Alternative Prototype 2 implementation

Implementation Schedule

WBS	Task Name
1	**Implementation Team**
1.a	Assemble implementation team
1.b	Conduct training session with implementation team
1.c	Establish progress milestones, targets, and funding
1.d	Promote research products
2	**UCM Training Courses**
2.a	Conduct UCM training courses at designated state DOTs
2.b	Transition UCM training course to long-term training mechanism
2.c	Conduct UCM training course at additional state DOTs
3	**Prototype 1 Implementation (typical state DOT)**
3.a	Assemble agency-wide task force
3.b	Monitor implementation at district level
4	**Prototype 2 Implementation (typical state DOT)**
4.a	Assemble agency-wide task force
4.b	Identify user and system needs
4.c	Develop and test user interfaces
4.d	Monitor implementation
5	**Alternative Prototype 2 Implementation (pooled fund)**
5.a	Identify participating state DOTs
5.b	Assemble multiagency task force
5.c	Identify user and system needs
5.d	Develop and test user interfaces
5.e	Monitor implementation



SHRP 2 R15(B) Research Team

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- Cardno TBE
  - Paul Scott, Nick Zembillas
- Utility Mapping Services
  - Phil Meis, Tom Swafford
- Ash Engineering
  - Janice Sands Ash, Gary Monday

Thank you for attending the webinar!

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