Mueller Water Products

echologics

A Mueller TECHNOLOGIES COMPANY

Where Intelligence
Meets Infrastructure®

2016 PA AWWA Conference

Acoustic Monitoring Minimizes Water Loss and Risks of Pipeline Failures

Name: John Marciszewski
jmarciszewski@echologics.com
908-420-2369

Presentation Outline

- Water Loss Basics
- Acoustic (Leak) Monitoring Overview
  - Current Approaches
  - Need for Technological Improvements
- EchoShore-DX Monitoring Technology
- Case Studies: American Water
- Transmission Main Monitoring

echologics
A DIVISION OF MUELLER COMPANY

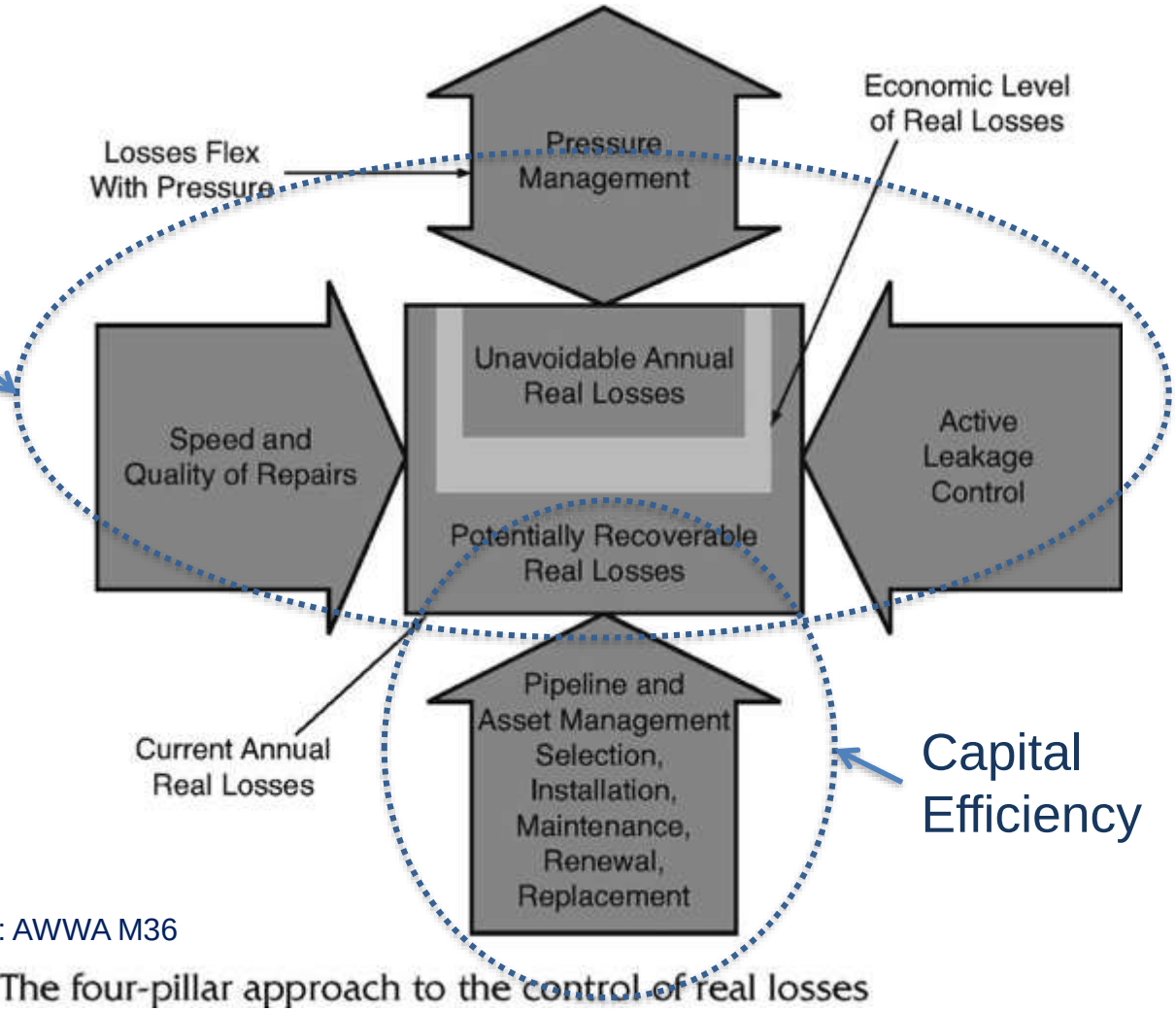
Optimizing Water Systems

NRW, Energy, Pressure, and Pipe

Water Efficiency and System Resiliency

Older pipe networks:

- Leak more (background leakage)
- Leak quieter (more difficult to find)
- Have higher risk of catastrophic failure



Capital Efficiency

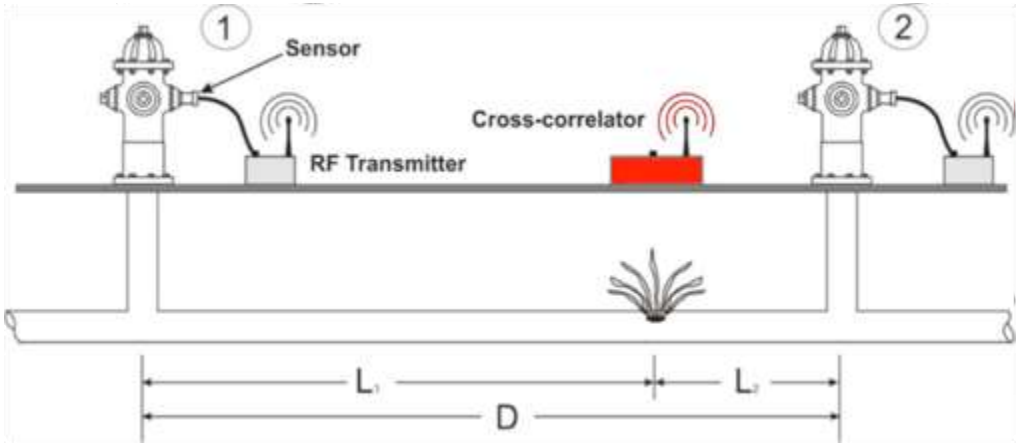
Reference: AWWA M36

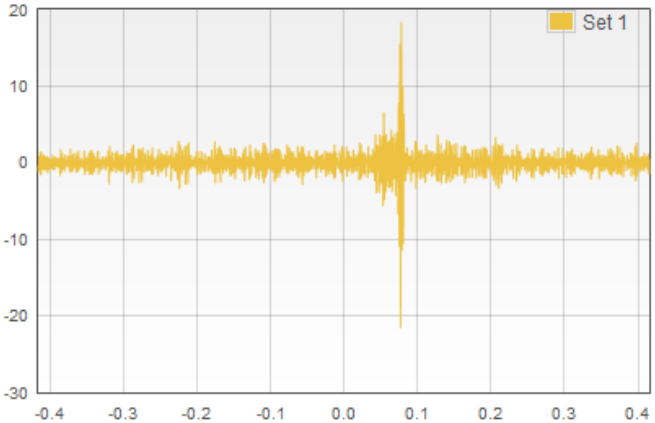
Figure 5-1 The four-pillar approach to the control of real losses

echologics
A DIVISION OF MUELLER COMPANY

Acoustic Leak Correlation Analysis
Principle of Operation

1. Bracket the leak with two sensors
2. The leak sound propagates in both directions
3. Correlator measures the time difference to reach each of the sensors to determine the exact leak location





echologics
A DIVISION OF MUELLER COMPANY

Distribution Mains Monitoring

Current Technologies and Approaches

Type	Description	Pros	Cons
DMAs	Volume of water entering an area is compared against volume of water billed	Quantified NRW in an area	Dead zones; Crews required to locate leak(s)
Sounding Survey	Leak pinpointing using acoustic listening technologies	Location pinpointing	Experience required; Labour intensive.
Noise logging	Single-channel using acoustic loggers. Often 'lift & shift' arrangement	Ability to survey large distances quickly.	Limited performance; Crews required for deployment & data collection

→ High false positive rate
→ Leaks identified, but location is still labour intensive
→ Reliant on specialized labour

Current technologies focus on improving a manual process.
Still an exercise in 'hunting'.

echologics
A DIVISION OF MUELLER COMPANY

Distribution Mains Monitoring
Next Generation Tech and Approaches

Type	Description	Pros	Cons
Multi-Parameter analysis	Multiple parameters, including pressure and flow, from a larger area model the network	Improved leak identification	Secondary indicators only; No direct LD
Permanent correlation	Mesh network of acoustic correlation sensors installed throughout the network	Detects and locates leaks. Tracks leaks over time	Reliant on accurate piping data

New information available allows utilities to:

→ Find leaks before customers *as standard practice*

→ Monitor leaks in the repair queue *as standard practice*

→ Notify customers of repairs/disruptions early *as standard practice*

echologics
A DIVISION OF MUELLER COMPANY

The Need for Permanent Monitoring

Early detection of leaks is vital for water distribution systems, with the ability to identify system failure points:

- Mitigate impact customer levels of service
- Minimize water loss
- Extend asset life
- Schedule and prioritize repairs on an informed, proactive basis
- Minimize the risks of catastrophic failures

echologics
A DIVISION OF MUELLER COMPANY

Consortium Formed 2009

Next-Generation Fixed Monitoring System

Innovation Overview

- In 2009, 4 companies started a collaboration on the development of fixed leak detection technology for water distribution systems: American Water, City of Ottawa, Echologics, and Sustainable Development Technology Canada.
- After a series of successful developmental field trials, the first commercial system, known as EchoShore-DX, was installed in Charleston, West Virginia in 2014. This technology drastically improved the way that water main leaks are identified, prioritized, and repaired.

echologics
A DIVISION OF MUELLER COMPANY

System Components & Layout

Antenna

High Sensitivity Sensor

Integrated processor, radio, and battery

EchoShore DX – Project Parameters

Project Scoping Requirements:

→ GIS Data for the geographic area to be monitored

→ Pipe material, pipe diameter, hydrant locations

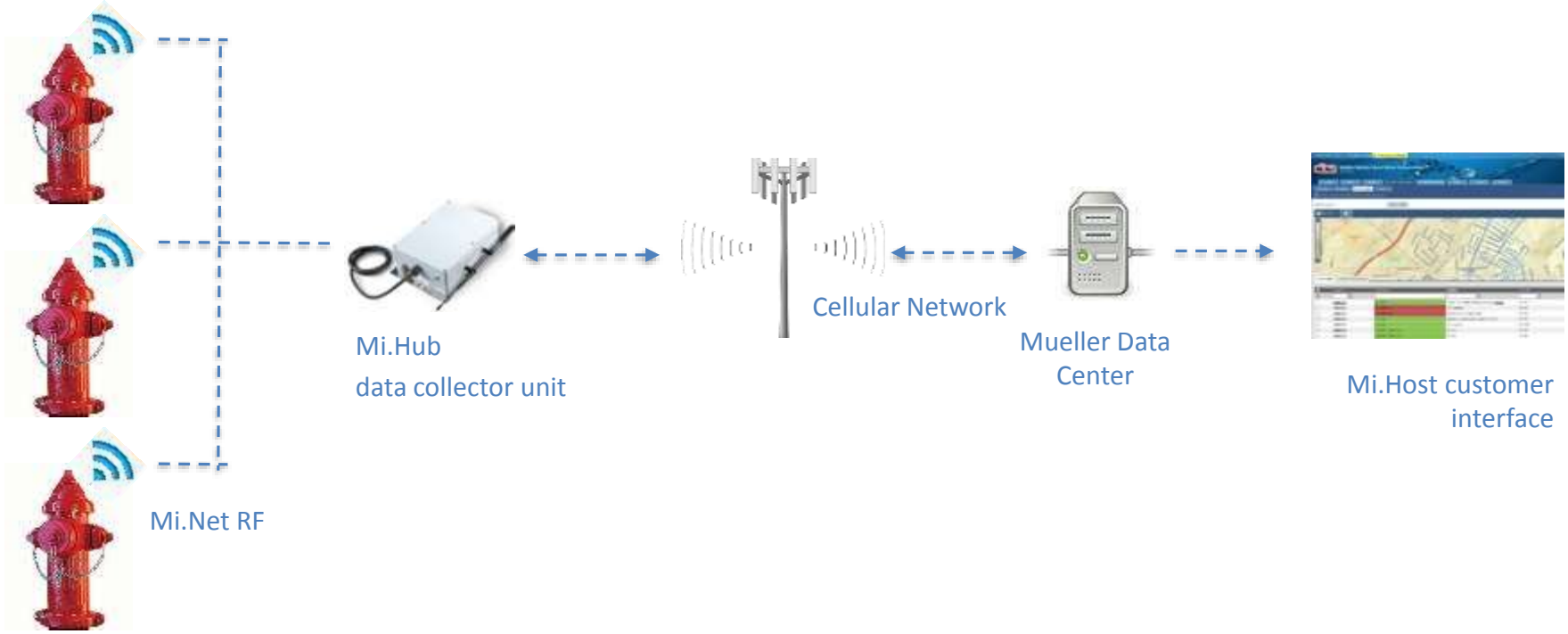
→ Network propagation study to determine network infrastructure reqs

Operating Parameters	
Maximum Mi.Echo Node Spacing	1,500 ft. for non-plastic pipe materials A site specific survey is required for plastic pipe materials
Pipe Diameter	Up to 12" diameter (300 mm)
Pipe Material	Cast Iron, Steel, Ductile Iron, Asbestos Cement, PCCP, PVC, PE, and other plastics
Battery life	5 years
Liquid Temp	33°F to 100°F (0.5°C to 38°C)
Ambient Temp	-27°F to 130°F (-33°C to +55°C)

echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX - System Description

System comprised of a series of nodes and radio infrastructure:

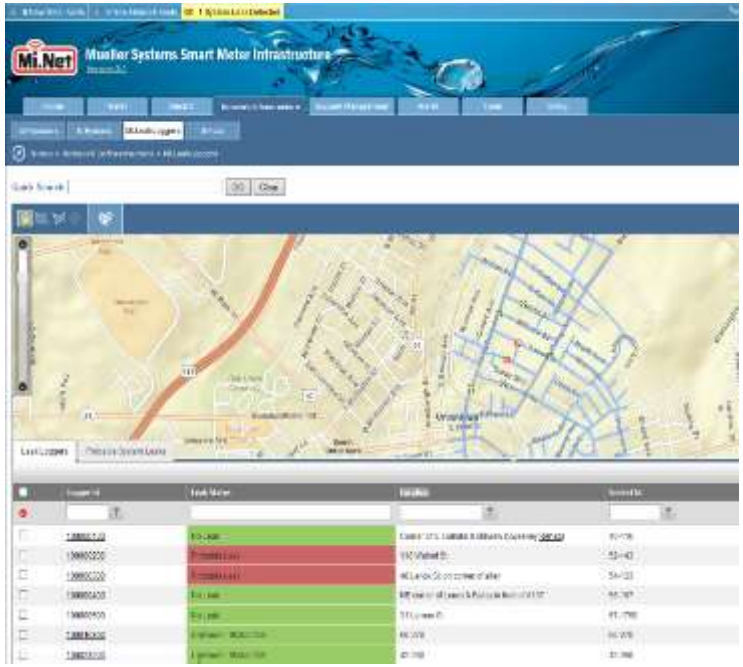


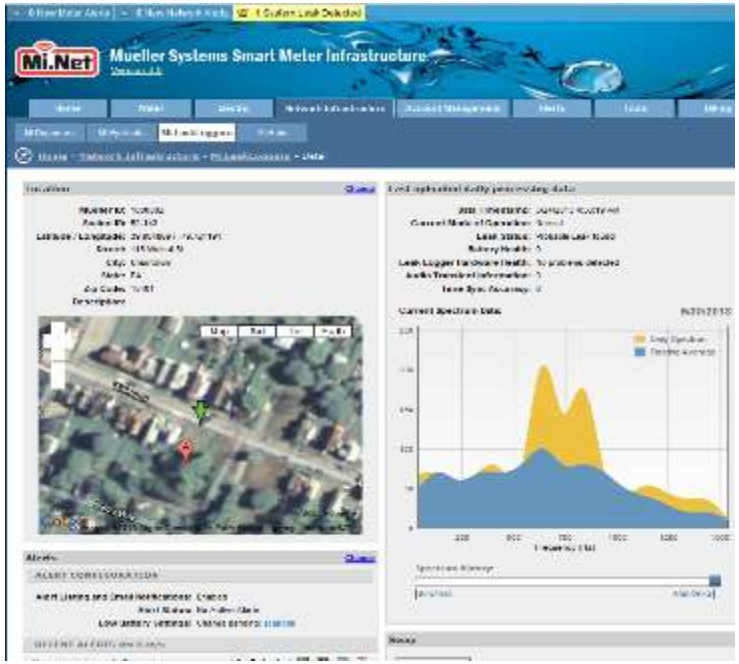
Network of interconnected nodes monitors a service area

echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX - User Interface

- Leverages existing functionality of Mi.Host
- Graphical and visual display of system status
- Leak events geospatially positioned within water infrastructure





Advanced leak detection integrated with Mi.Host interface

echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX – How it Works

Nodes form the leak detection network

System-wide leak detection and correlation on initialization

Baseline background noise level excludes existing leaks

EchoShore-DX will identify and locate existing leaks

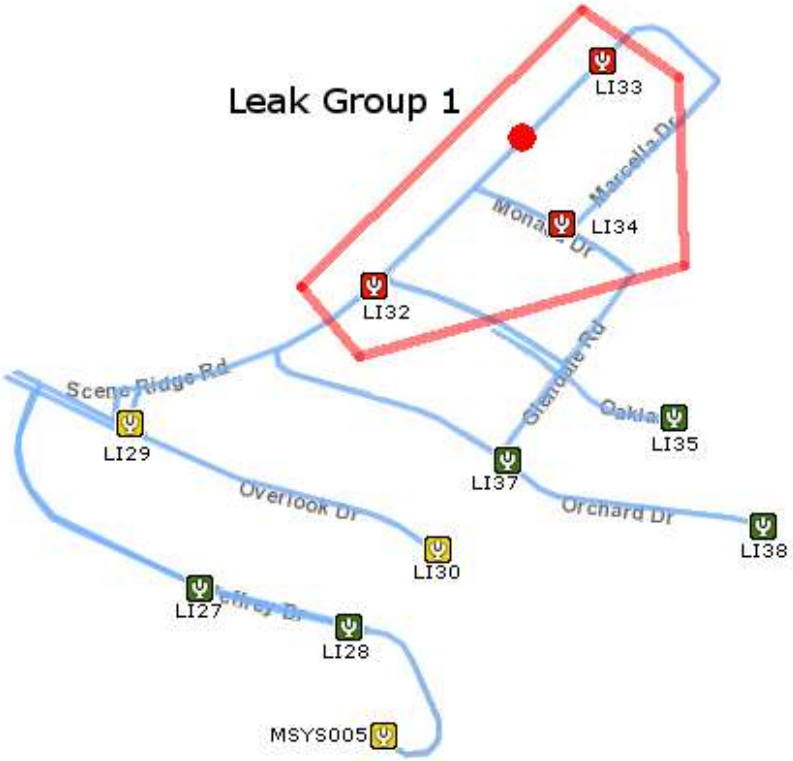
echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX

Secondary Leak Detection at Server Level

Multi-Channel Leak Detection:

1. Leak groups identified
2. Correlation data files from the leak group are obtained
3. Correlations on all node pairs in the leak group are performed



Server-level intelligence increases LD probability and conserves radio bandwidth & battery life

echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX – Operational Experience

AMERICAN WATER
Uniontown, PA

Coverage: 0.5 mi^2 (approx.) [1.3 km^2]
Total Nodes: 18
Pipe: 4" – 12" Mostly DI [mixture of pipe types]
Service Start: June 2013
Experience: First installation site. Field validation, including multiple successful leak simulations. First true leak to be found.

Ottawa, Canada

Coverage: 1 mi^2 [2.5 km^2]
Total nodes: 84
Pipe: 4" – 12" Mostly CI [mixture of pipe types]
Service Start: Sept 2013
Experience: Incrementally larger pilot installation, full DMA. Found 2 leaks to date, none missed, no false positives.

echologics
A DIVISION OF MUELLER COMPANY

EchoShore DX – Operational Experience

AMERICAN WATER
Liberty, PA

Coverage: 0.6 mi^2 [1.4 km^2]
Total Nodes: 43
Pipe: 4" – 12" DI and CI
Service Start: Jan 2014
Experience: Second engagement with American Water. First leak found was monitored over 4 weeks and was fast progressing. Total of 3 leaks found, including an OB.

AMERICAN WATER
Metro Chicago, IL

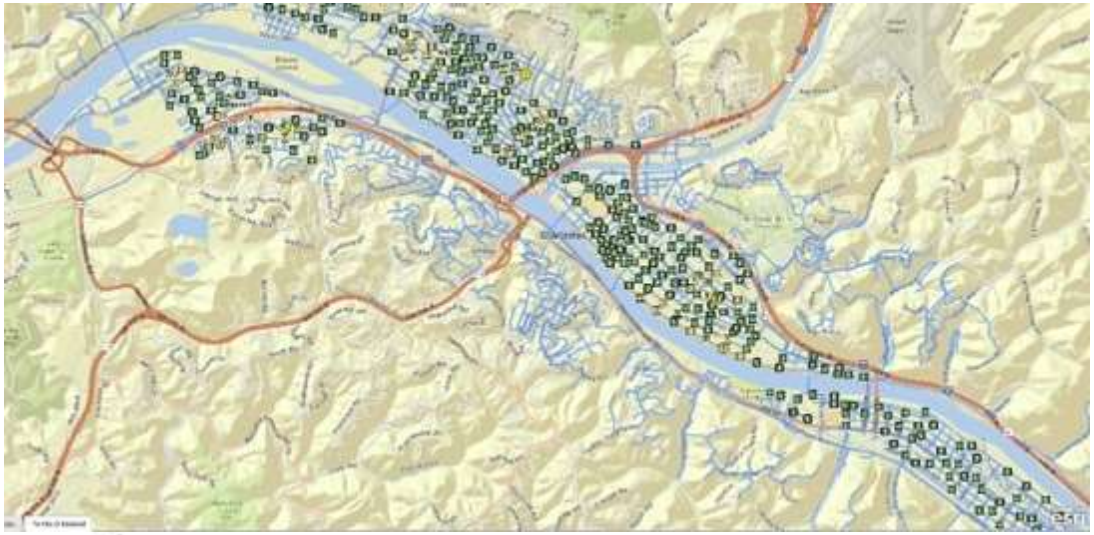
Coverage: 1 mi^2 [2.5 km^2]
Total nodes: 79
Pipe: 4" – 12" Mixed metallic
Service Start: Aug 2014
Experience: Third engagement with American water. Project driven by high cost of wholesale water, elevated leakage rate during change of season. Found 1 leak to date.

echologics
A DIVISION OF MUELLER COMPANY

Permanent Monitoring: Case Study

West Virginia American Water

Service Area: 10 mi^2, Average Production 25 MGD
Total Nodes: 386, approximately 5 mi^2 of network coverage
Pipe: 4” – 12” DI and CI
Service Start: Dec 2014
Experience: 4th installation at American Water. 11 leaks found in the first month and 45 leaks in the first 5 months of operation, 40 of which had not yet surfaced prior to repairs. Credited with 2.3 MGD of water loss reduction. Phase 1 of multiple phased deployments.

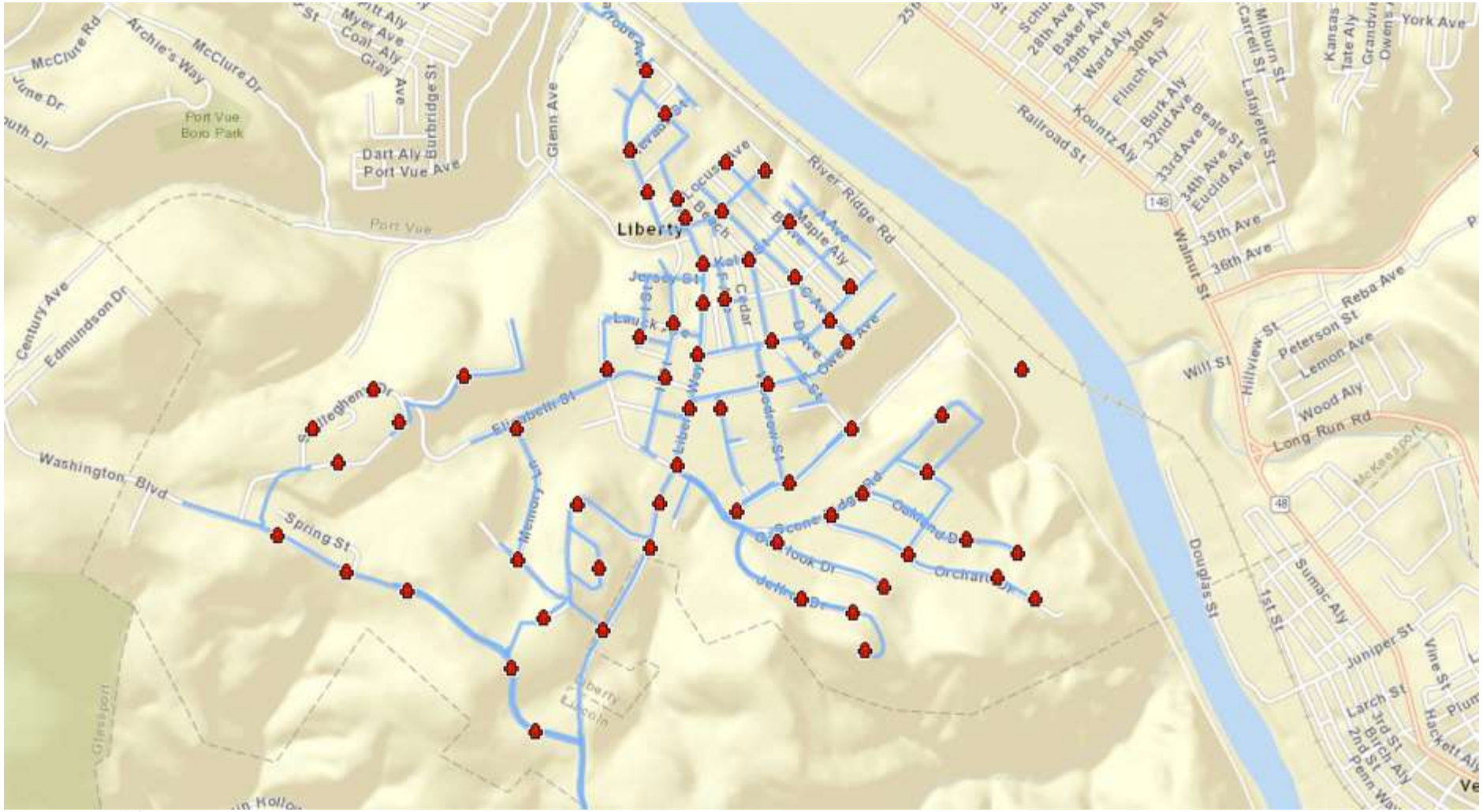


Another 1.5 MGD of water loss was recovered from a 36" PCCP main leak, that was picked-up by the DX system through ground vibration.

echologics
A DIVISION OF MUELLER COMPANY

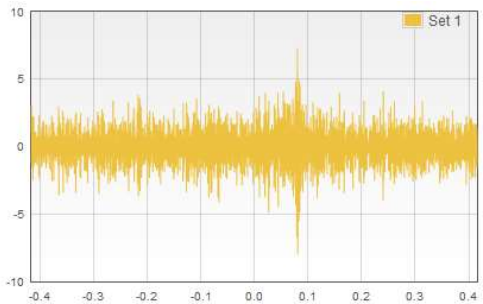
Permanent Leak Detection in Practice

Leak Progression to Failure (almost) – Liberty PA

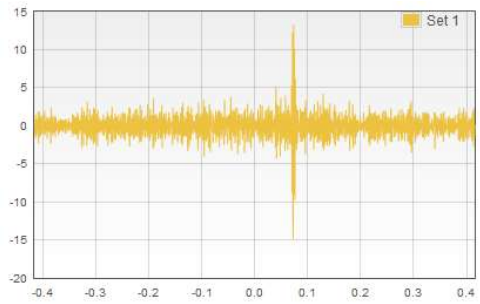


Permanent Leak Detection in Practice

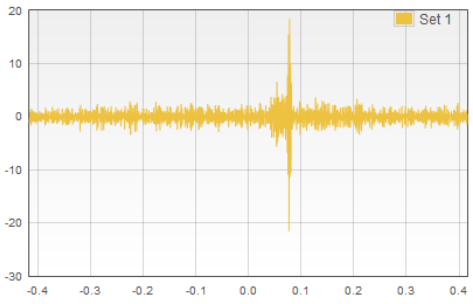
Leak Progression to Failure (almost) – Liberty PA



Origin



+2 weeks



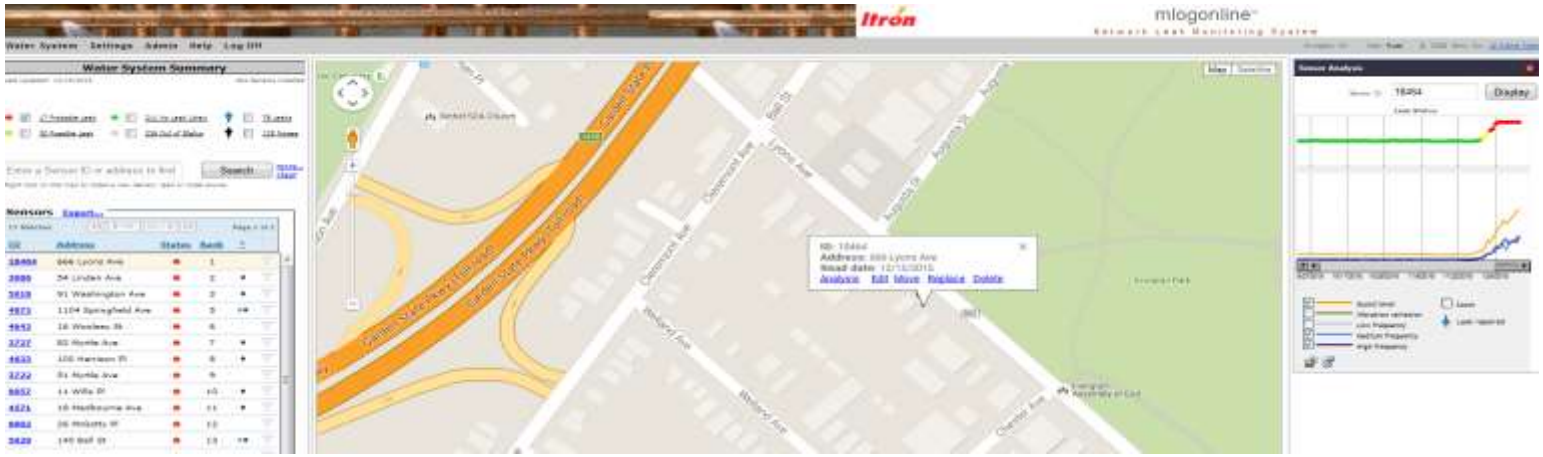
+4 weeks

Dave Hughes: *"…a time bomb defused"*;
5 gpm leak paid for the system

The Need for Permanent Monitoring

Case Study: New Jersey American Water

In 2007, New Jersey American Water deployed its first automated leak reporting system in Irvington, Maplewood and West Orange. Approximately 3,500 sensors have been placed on service pipelines with some connected to AMI. All return acoustic information to the vendor's software that interpreted the leak noise and, through a computer cloud, the data is available to our staff.



echologics
A DIVISION OF MUELLER COMPANY

New Jersey American Water

Automated Leak Reporting Experience

The daily return of data found many leaks and provided advantages over traditional leak detection approaches, e.g., listening surveys, but this technology still has many limitations, including:

- Too many false positives that resulted in time consuming investigations without finding leaks;
- Difficulties detecting leaks through multiple materials, commonly found with old repair sites where plastic pipe was inserted to replace deteriorated iron or steel pipe;
- Inability to characterize a leakage noise to determine leak size; and
- Despite a historic profile of acoustic sound, resources were required to interpret the data.

echologics
A DIVISION OF MUELLER COMPANY

New Jersey American Water

Largest, Multi-System Deployment

- New Jersey American Water deployed 1,000 leak logger nodes
- Target water systems
  - Regulatory driven, e.g., Delaware River Basin Commission
  - High water loss combined with high cost of water
- Six systems in New Jersey
  - Belvidere
  - Frenchtown
  - Irvington
  - New Egypt
  - Pemberton
  - Washington

Site	# Nodes
New Egypt	43
Pemberton	17
Frenchtown	27
Belvidere	76
Washington	300
Irvington	528

- Business cases showed net savings in Year 1

echologics
A DIVISION OF MUELLER COMPANY

New Jersey American Water

Major Leak – Washington Township

- Leak was located 1,900' from logger on a 16" DIP transmission main
- Leak was on a disintegrated plastic Tap-to-Curb (TTC)
- NJAW estimated the leak at 80-100 gpm
- Leak was not surfacing anywhere, but the water was only 18" below ground when excavated

echologics
A DIVISION OF MUELLER COMPANY

EchoShore TX

The Need for Permanent Monitoring

Transmission Networks

Top Risks Identified by Water Utilities

1. Emergency Repairs & Damage From Bursts
2. Water Loss Management
3. Pressure Management

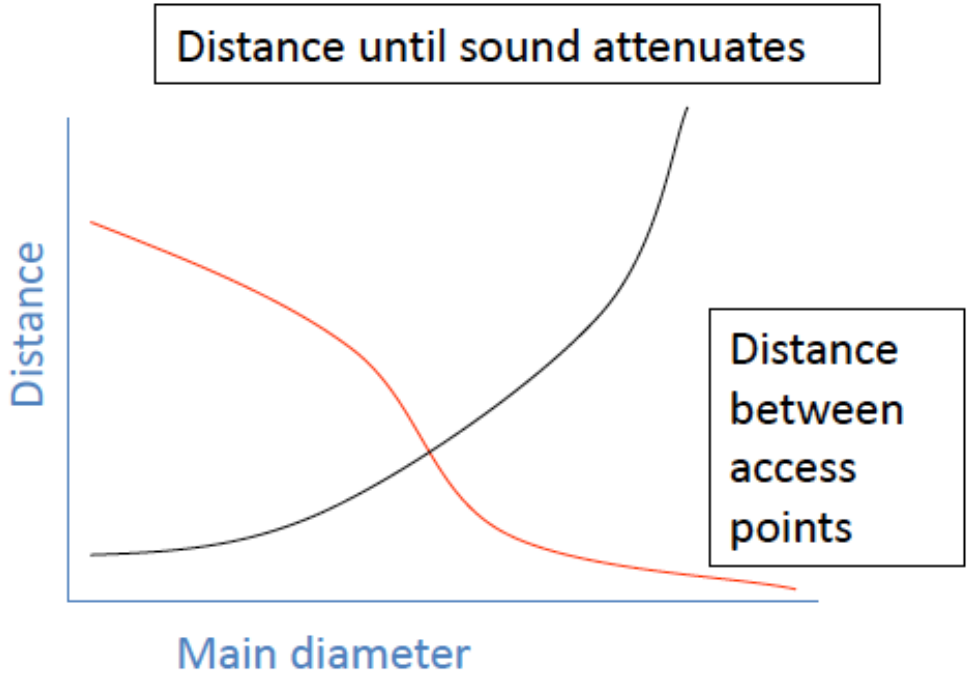
Not all transmission main segments carry the same level of risk

echologics
A DIVISION OF MUELLER COMPANY

Acoustic Behavior of Trunk Mains

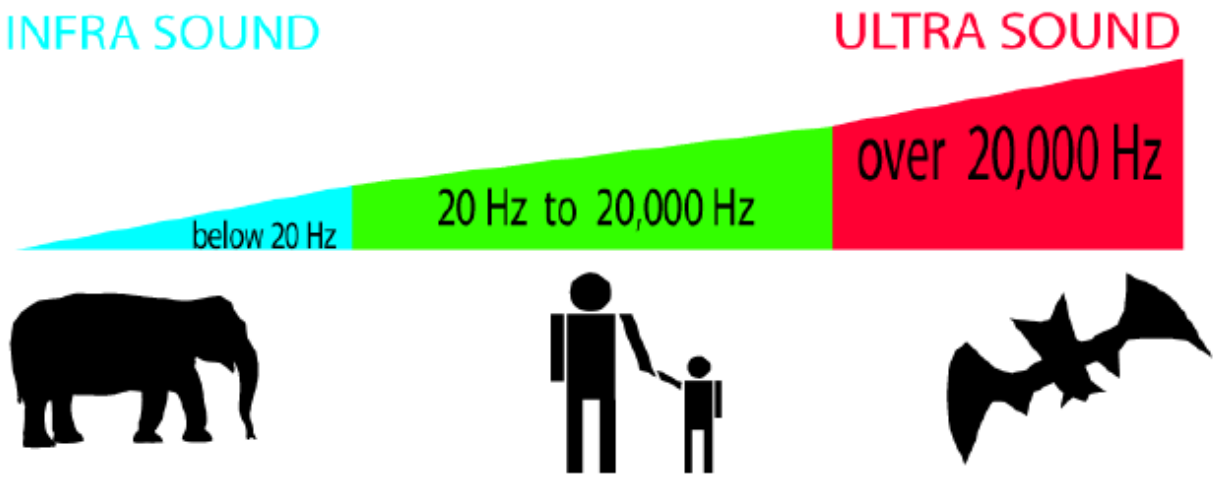
What Makes Transmission Main Leak Detection Difficult

- Most leak detection equipment is designed for distribution mains, and fails on large mains
- Large mains transmit different frequencies
- Large mains have more ambient noise (traffic, water flow)
- Sound attenuates faster in large mains
- Fewer appurtenances available



echologics
A DIVISION OF MUELLER COMPANY

The Acoustics of Leak Noise

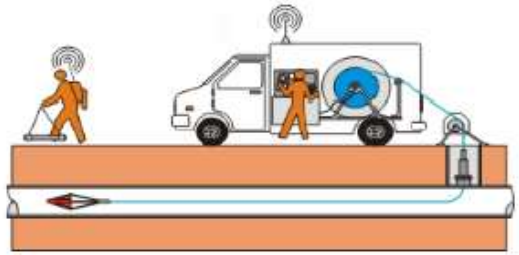


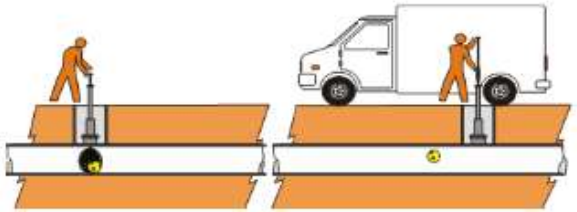
Human Optimum	200 - 4000 Hz
150mm Cast Iron Pipe	200 - 1000 Hz
150mm PVC Pipe	10 - 50 Hz
1200mm Cast Iron Pipe	10 - 80 Hz

echologics
A DIVISION OF MUELLER COMPANY

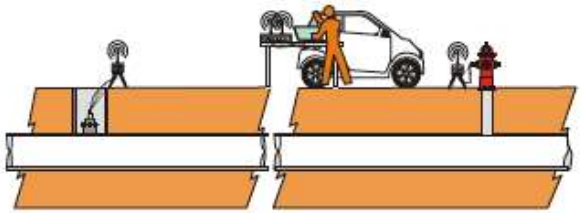
Commercially Available Technologies

- **Invasive technologies** have proven successful at finding leaks, but
  - Operational Challenges (flow, velocity, off-takes)
  - Extensive civil works required
  - Require highly trained operators in the field
  - Expensive





- **Standard Correlators** are less effective with increasing main size
  - Unable to detect and isolate low frequency leak noise
  - Closer access points needed, but fewer points available
  - Require highly trained operators in the field

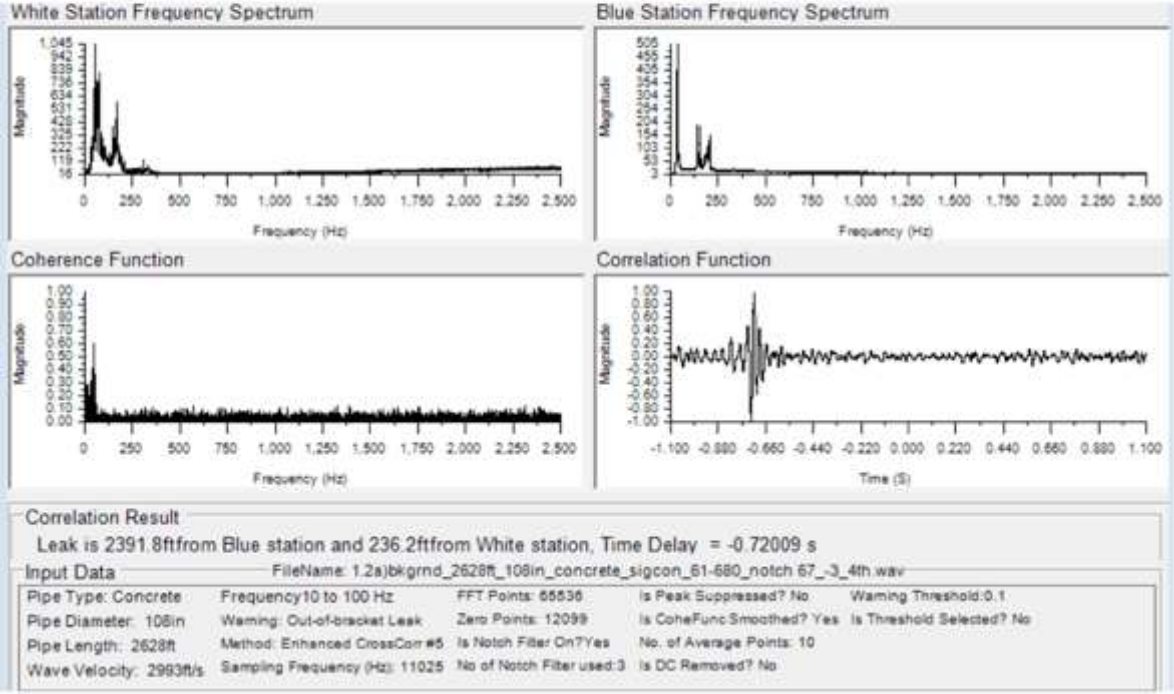


echologics
A DIVISION OF MUELLER COMPANY

Transmission Main Leak Detection:
108” Concrete 2,627’ Between Sensors

Utility: East Bay Municipal Utilities District
Project Location: California, USA
Project Timeframe: September 2010

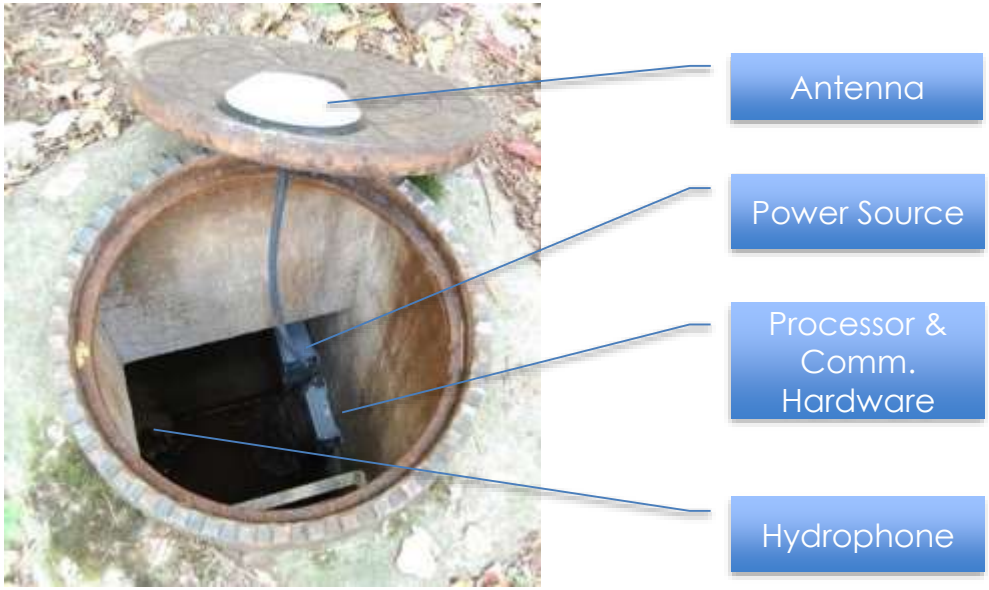
Pipeline Diameter: 108”
Correlation Plot Number: 3
Material: Concrete

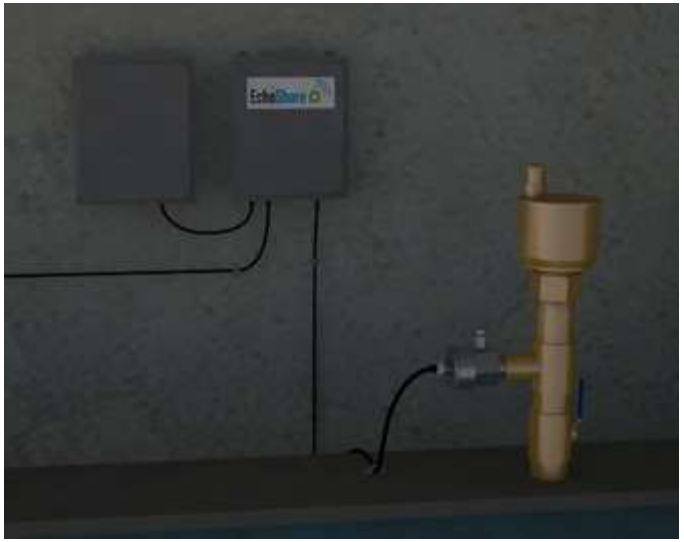


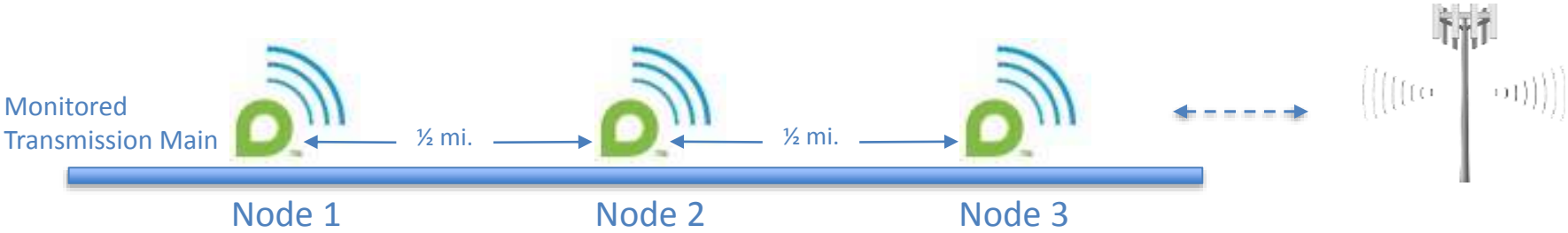
echologics
A DIVISION OF MUELLER COMPANY

EchoShore TX

System Components & Layout



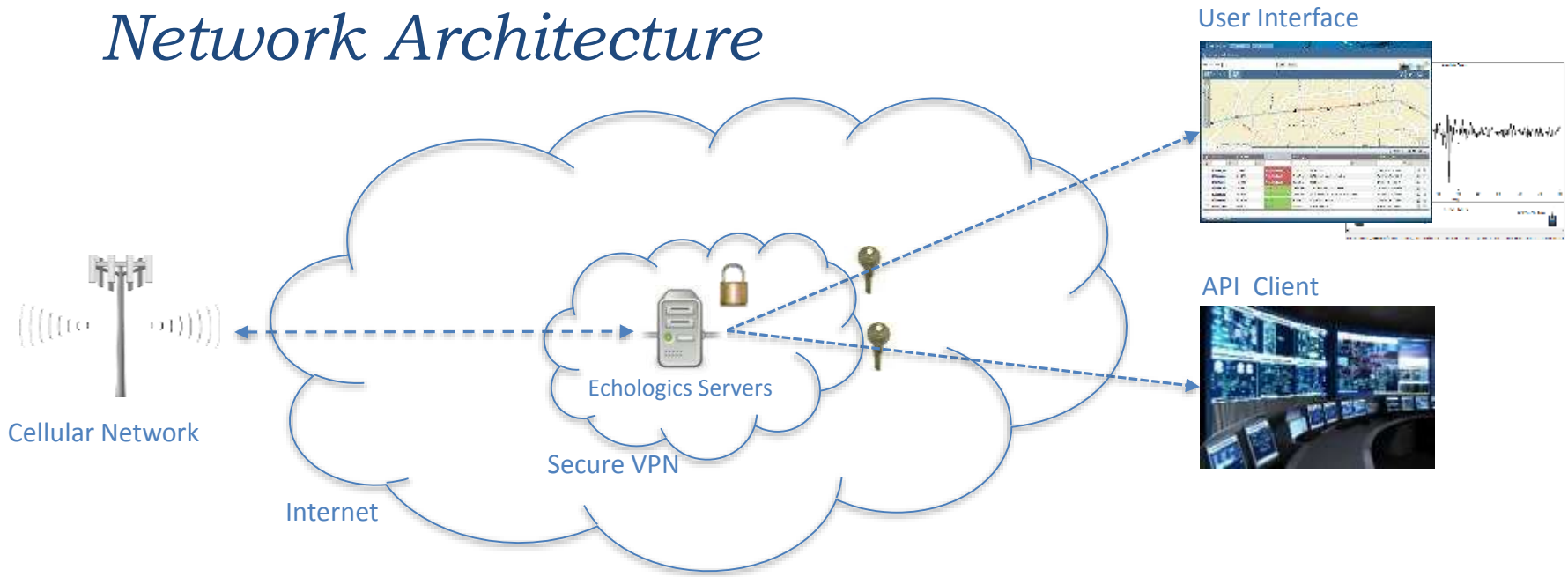




echologics
A DIVISION OF MUELLER COMPANY

EchoShore TX

Network Architecture



Network of interconnected nodes monitors a service area

echologics
A DIVISION OF MUELLER COMPANY

EchoShore TX

Installation: In-Chamber Arrangements

Permanent monitoring in Singapore
DN700 (28") steel pipe

Permanent monitoring in Canada
DN1500 (60") concrete lined steel pipe

Permanent monitoring in USA
DN600 (24") concrete pipe

Permanent monitoring in USA, DN900 (36") AC pipe

echologics
A DIVISION OF MUELLER COMPANY

EchoShore D™

TX System Operation

24 hour leak detection cycle

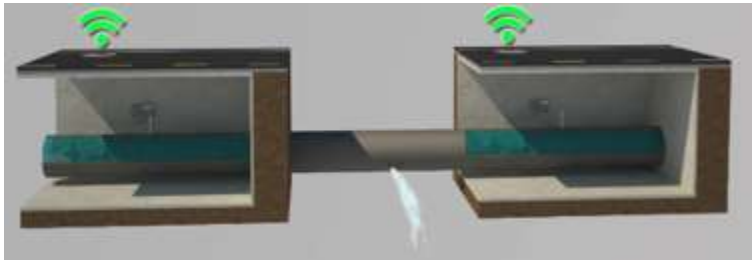
- Time-synced acoustic data capture
- Upload to central server and processed
- Results passed to UI or SCADA

Autonomous

- Automated correlation peak selection
- Reporting

On-Demand Functionality

- User can force unscheduled data capture
- Manual correlation



Time between leak detection surveys reduced from years to hours

echologics
A DIVISION OF MUELLER COMPANY

EchoShore TX

Expandable Functionality

Core functionality is acoustic leak detection

Upgrades include:

Water hammer detection

Tamper detection, and other acoustic anomalies

Pressure/Flow

Temperature

Chlorine

Other Customer Requirement

4-20 mA Signal

Opportunity to expand from advanced leak detection to customized pipeline monitoring

echologics
A DIVISION OF MUELLER COMPANY

NIST Smart Cities Global Challenge

- White House initiative to showcase Smart City Technologies
  - Mueller, AT&T and IBM are participating vendors for water sector
  - Las Vegas, Los Angeles and Atlanta are participating cities
- June 1st/ 2nd Presentations at NIST in Washington D.C.
- Technology engagements consist of EchoShoreTX in conjunction with AT&T wireless communications and IBM Visual Dashboard
- Vendor/ Client Benefits
  - Echologics secures EchoShoreTX contracts, national media exposure, senior client contact
  - Participating cities gain national exposure as Smart City

echologics
A DIVISION OF MUELLER COMPANY

Smart Cities Challenge
Operational Experience

Project: Las Vegas, NV
Pipeline: 36” Asbestos Cement
Objective: Leak monitoring
Monitoring Start: April 2015

Project: Atlanta, GA
Pipeline: 20” Ductile Iron
Objective: Leak, pressure monitoring
Monitoring Start: April 2015

Project: LADWP, CA
Pipeline: 36” Concrete Lined Welded Steel
Objective: Leak monitoring
Monitoring Start: May 2015

echologics
A DIVISION OF MUELLER COMPANY

Nevada Center of Excellence

- Purpose: State initiative to foster job growth
- Mission
  - Showcase adoption of water technology at Las Vegas Valley Water District
  - Attract water technology company investment and jobs
  - Jointly develop leading water technologies
- Echologics/Mueller participation benefits
  - Office space and conference room facilities
  - Joint marketing for hosting visiting utilities and political delegations
  - Test site for any "bleeding edge" technologies
    - Example: EchoShore TX on Las Vegas Strip
      - https://www.youtube.com/watch?v=dr =youtu.be
  - State funding for hiring of required personnel
  - Formal promotion of LVVWD as leading case study/ reference

NEVADA CENTER of EXCELLENCE
INNOVATIONS & SOLUTIONS IN WATER RESOURCES

echologics
A DIVISION OF MUELLER COMPANY

EchoShore – Mobile

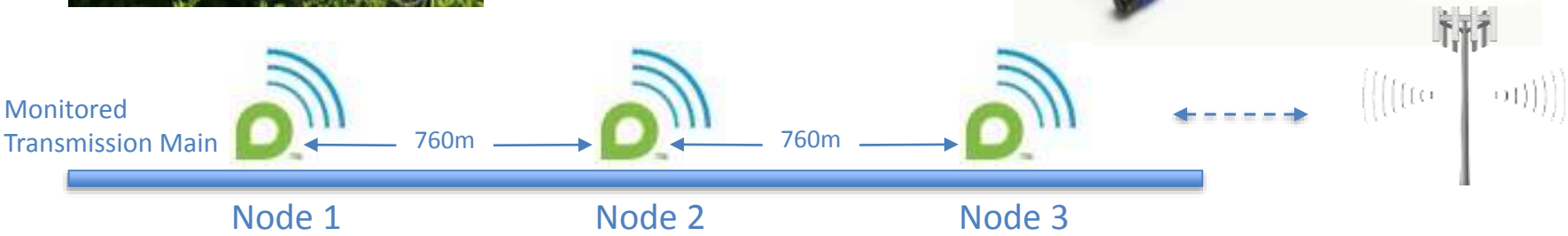
Utility performs the field work

Antenna

Power Source

Processor & Comm. Hardware

Hydrophone

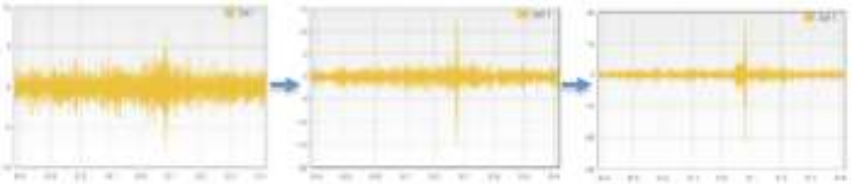


echologics
A DIVISION OF MUELLER COMPANY

Permanent Monitoring Solutions

- **Reduces *Non-Revenue Water*** with early leak detection
  - Average leak goes undetected for up to 9 months
  - Many leaks never surface

- **Monitor leak progression** to determine urgency



- **Minimize risks of catastrophic bursts** by fixing leaks early
  - Liabilities $1M+ considering collateral damages
  - Avoid bad publicity and customer dissatisfaction
- **Saves repair costs**
  - Lessen the extent of pipeline (asset) damage
  - Reduce the number of emergency (overtime) repairs
  - Minimize wasted capital associated with *false positives*
- Improve the **safety of field personnel** by eliminating the need for traffic controls during leak investigations

echologics
A DIVISION OF MUELLER COMPANY