



# Network-distributed Ultrasound

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ASNT Ultrasonics Conference

June 29 - 30, 2017

Foxwoods, CT

# Agenda:

- ❑ Abstract / Problem Statement
- ❑ Technical issues
- ❑ Digital Networks : Possible Solutions
- ❑ Applications

# Abstract

- High-frequency analog RF ultrasonic signals, typically in the 1 – 10 Mhz range, are transmitted over coaxial cables. In order to maintain signal amplitude, quality and fidelity, the cables should be as short as possible – generally less than 150' (45.7 m). For applications where very long distances are required, it becomes necessary to place the UT instrumentation close to the transducer and digitize the data before sending it the required longer distances. This paper discloses and compares three different network topologies and approaches to remoting the UT system: Modbus over RS-485, Cellular and LORA WLAN. Additionally, the paper will review several practical and cost-effective examples for remote UT monitoring at various Oil & Gas and Power Generation facilities.

# Long UT coax cables are problematic

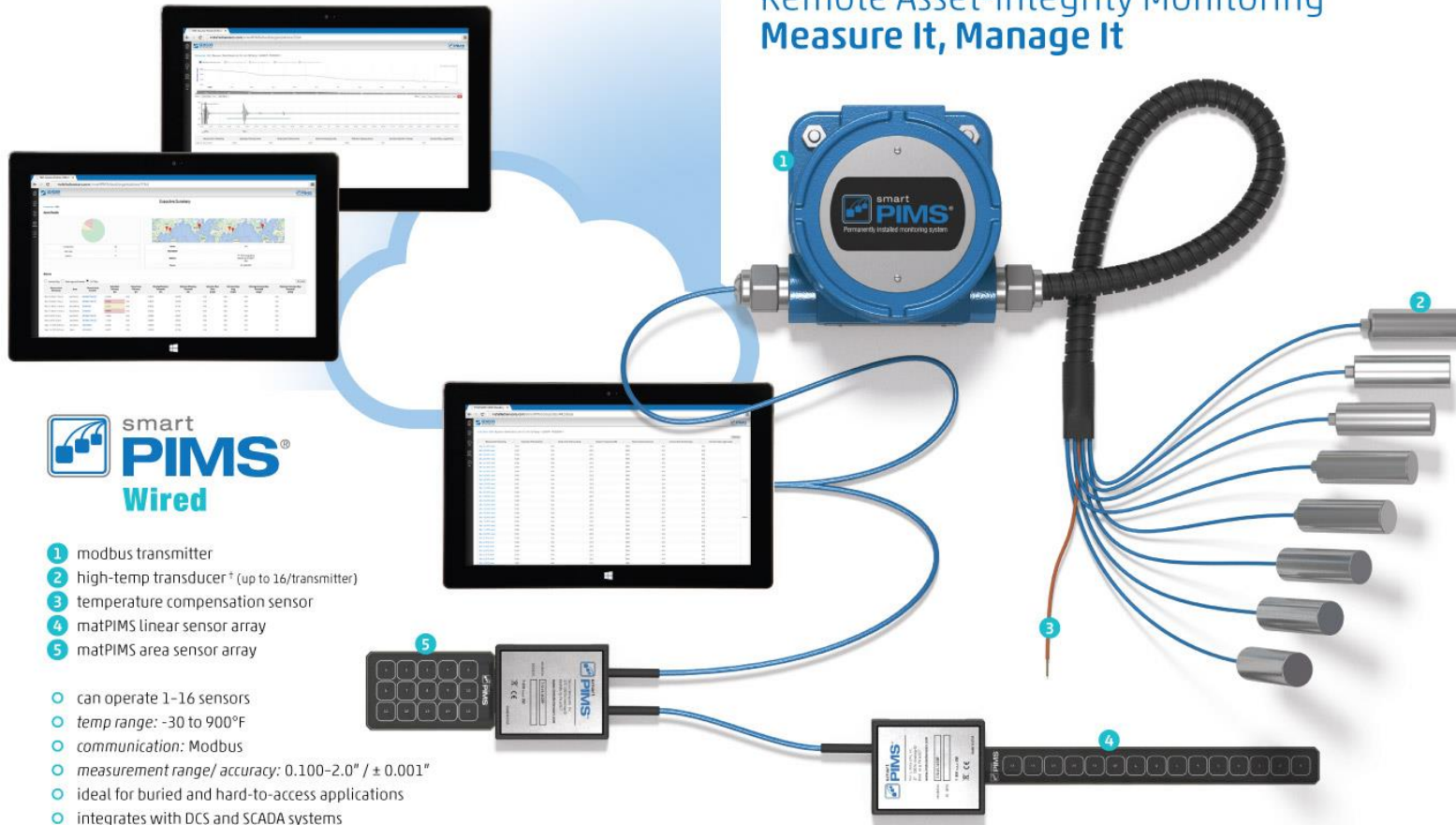
- The longer the cable the more chances for it to act as an antenna and pick up noise from the environment limiting the ability to measure small signals.
- The cable will attenuate the pulser signal as well as attenuate or limit the ability of the UT Transducer to propagate a received signal back to the UT instrument receiver. Attenuation rates can be as high as 3.3 dB at 10 MHz per 100' (30.5 m) of RG-174 cable on both the pulse and receive signals.
- At longer lengths, the cable can look like a transmission line to the Pulser (which contains higher frequency content) potentially resulting in reflections in the cables. The results of which could be multiple excitations of the UT transducer causing reduced resolution.
- Long cable bundles are both expensive and bulky to manage. Cable breakage, wear & tear are also practical issues.

## Digitize ASAP - Three unique approaches:

- Hard-wired Modbus over RS485
- Cellular over standard commercial networks
- LORA WLAN (Wireless Local Area networks)

# Modbus over RS485

Remote Asset-Integrity Monitoring  
Measure It, Manage It

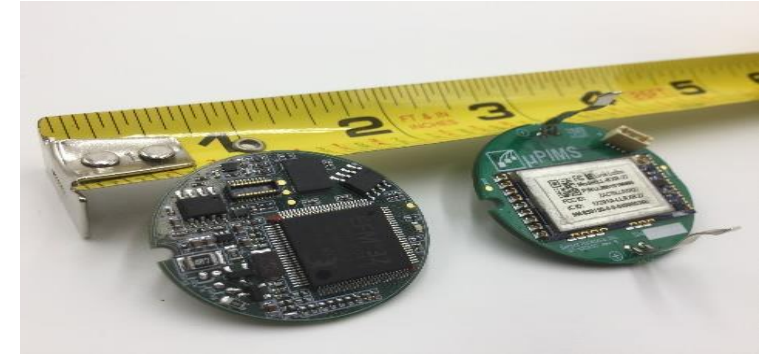


Wired digital network systems are ideal for:

- Closed or “in-the-fence” UT data solutions
- Buried Pipe & Process Control Applications
- “Local only” or push to a web portal

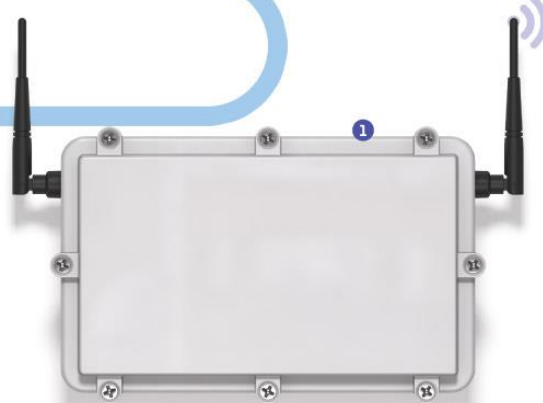
# LORA WLAN

Remote Asset-Integrity Monitoring  
Measure It, Manage It



- 1 LORA WLAN gateway
- 2 mid-temp transducer
- 3 high-temp transducer
- 4 temperature compensation sensor

- scalable to >1,000 nodes/gateway
- measurement range/accuracy: 0.040-4.0" / ± 0.001"
- communication: wireless 900 MHz
- wireless range: >1 mile
- permanent or temporary installation
- temp range: -30 to 900°F continuous (dual MT or single HT)



- LoRa is a **Long-Range**, Industrial IoT wireless protocol ( 900 MHz).  
Low-power, low-cost w' small footprint and a range of > 1 mile.



# Cellular

Cellular systems leverage existing and ubiquitous digital networks: 2G, 3G, 4G, LTE and newer M1

Remote Asset-Integrity Monitoring  
Measure It, Manage It



- 1 cellular transmitter
  - 2 dual-element transducer † (up to 8/transmitter)
  - 3 temperature compensation sensor
- 
- 16 channels in single-element mode
  - measurement range: 0.040-4.0"
  - accuracy: ± 0.001"
  - temperature compensation algorithm

Programed to turn on/off at any user interval

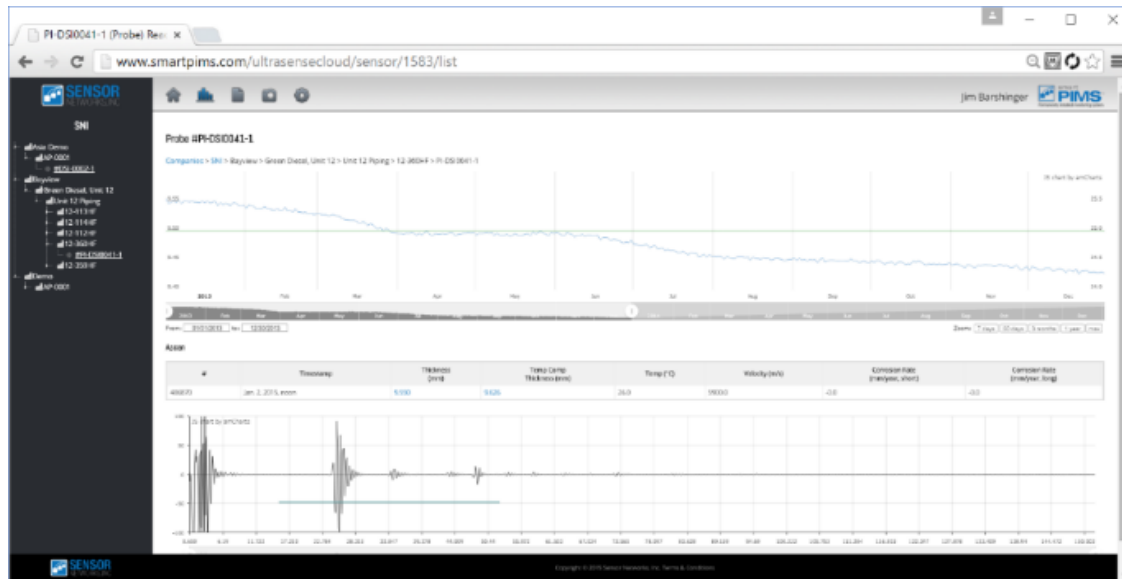
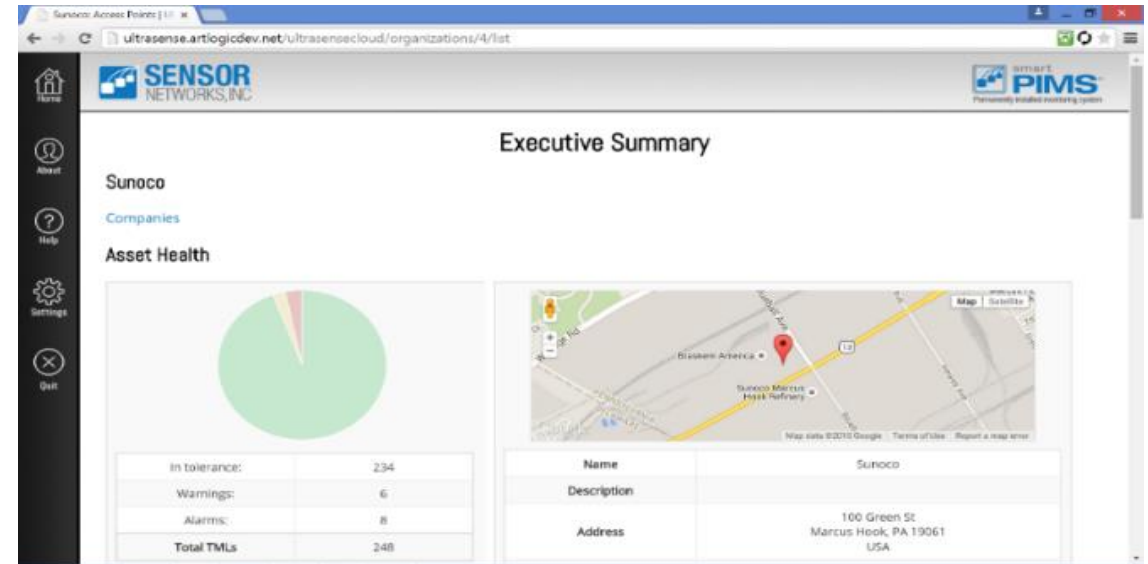
Long-life, lithium batteries can last for >5 yrs.



# Web Portal as common back end

A cloud-based web portal can be used to:

- Compile, archive, analyze & trend
- Allow easy access across an organization
- Push software updates to multiple devices



# Network-distributed Ultrasound: 3 into 1

## Remote Asset-Integrity Monitoring: Measure It, Manage It.

Cloud-based management of thickness data from installed UT sensors.

webPIMS™ can automatically or manually receive data from ultrasonic sensors for web-based display, storage, trending and analysis. Users can access this data from anywhere with an internet-enabled device such as a PC, tablet or smart phone.



(814) 466-7207  
www.sensornetworksinc.com



- 1 cellular transmitter
- 2 dual-element transducer\* (up to 8/transmitter)
- 3 temperature compensation sensor

- 16 channels in single-element mode
- measurement range: 0.040-4.0"
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- temperature compensation algorithm

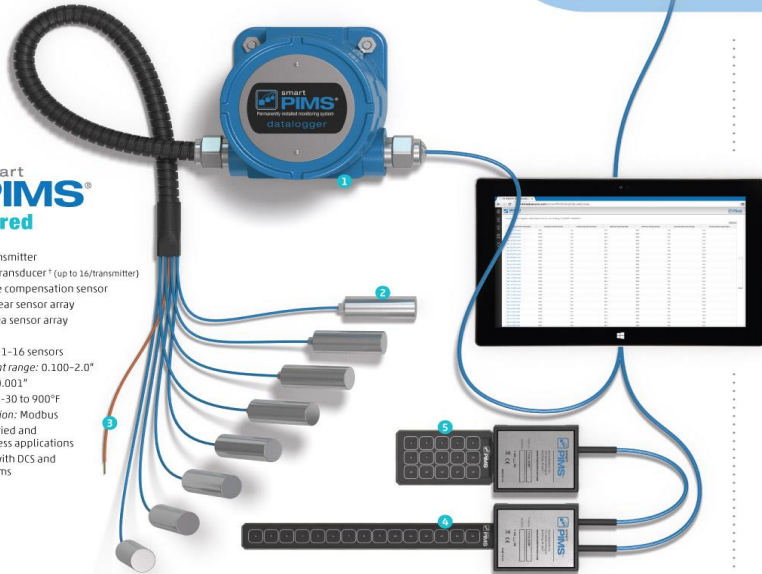
Single-element, dual-element, high-temp and shear-wave transducers are available. Only one type of transducer per transmitter.

Multiple network connectivity schemes, including manually-collected data can all be stored and accessed in one common secure portal.



- 1 modbus transmitter
- 2 high-temp transducer\* (up to 16/transmitter)
- 3 temperature compensation sensor
- 4 matPIMS linear sensor array
- 5 matPIMS area sensor array

- can operate 1-16 sensors
- measurement range: 0.100-2.0"
- accuracy: ± 0.001"
- temp range: -30 to 900°F
- communication: Modbus
- ideal for buried and hard-to-access applications
- integrates with DCS and SCADA systems



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- wireless range: >1 mile
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# Applications:



## Upstream:

Sand erosion monitoring  
Offshore NDT  
Injection Point



## Midstream:

Buried Pipelines  
Unpiggable lines  
49 CFR 192

## Downstream:

Difficult access – high  
temp, insulated, elevated  
Injection point  
Crude overhead  
Corrosion rate, process  
control





# Crude Overhead Line

**Overview:** Customer installed new overhead lines connecting units. Lines located in un-accessible areas and wanted data on corrosion rates and inspection needs. Customer installed permanently installed UT sensors to monitor pipe intrados, extrados, top & bottom locations

**Application:** Crude Overhead Line 100F - 300F

- 12" Sch. 40 ... all nominal wall thickness .4" +/- 12%

**Product Used:** smartPIMS Cellular

- smartPIMS LT Cellular w/ 8 dual element probes permanently attached
- Monitoring interval: 1 reading every 2 days, transmission every 6 days. Estimated battery life ~4 yrs.
- DSI bolted to hand rail and unistrut, cables run to TMLs

**Outcome:**

- Inspection costs – JLG lift, scaffolding, or rope access required to reach locations 40' off the ground
- Process control – access to more ... accurate and quality data to trend corrosion rates



# Hydro-Fluoric (HF) Alky Unit Monitoring

**Overview:** Customer was sending NDT technicians to inspect the top of the HF Alky unit daily to monitor specific low spots to ensure wall loss did not exceed minimum required rate before outage planned in 6 mo.

**Application:** HF Alky Unit, ~150F

- 24" Sch. 40 ... most piping is <math>< \frac{1}{2}</math>" nominal wall but measured at ~0.300" with pitting and general "low spots"

**Product Used:** smartPIMS Cellular

- smartPIMS LT Cellular w/ 8 dual element probes temporarily attached, managed by refinery maintenance team
- Monitoring interval: 12 hours
- Data is monitored & trended daily using webPIMS
- Installation time: 4 hours

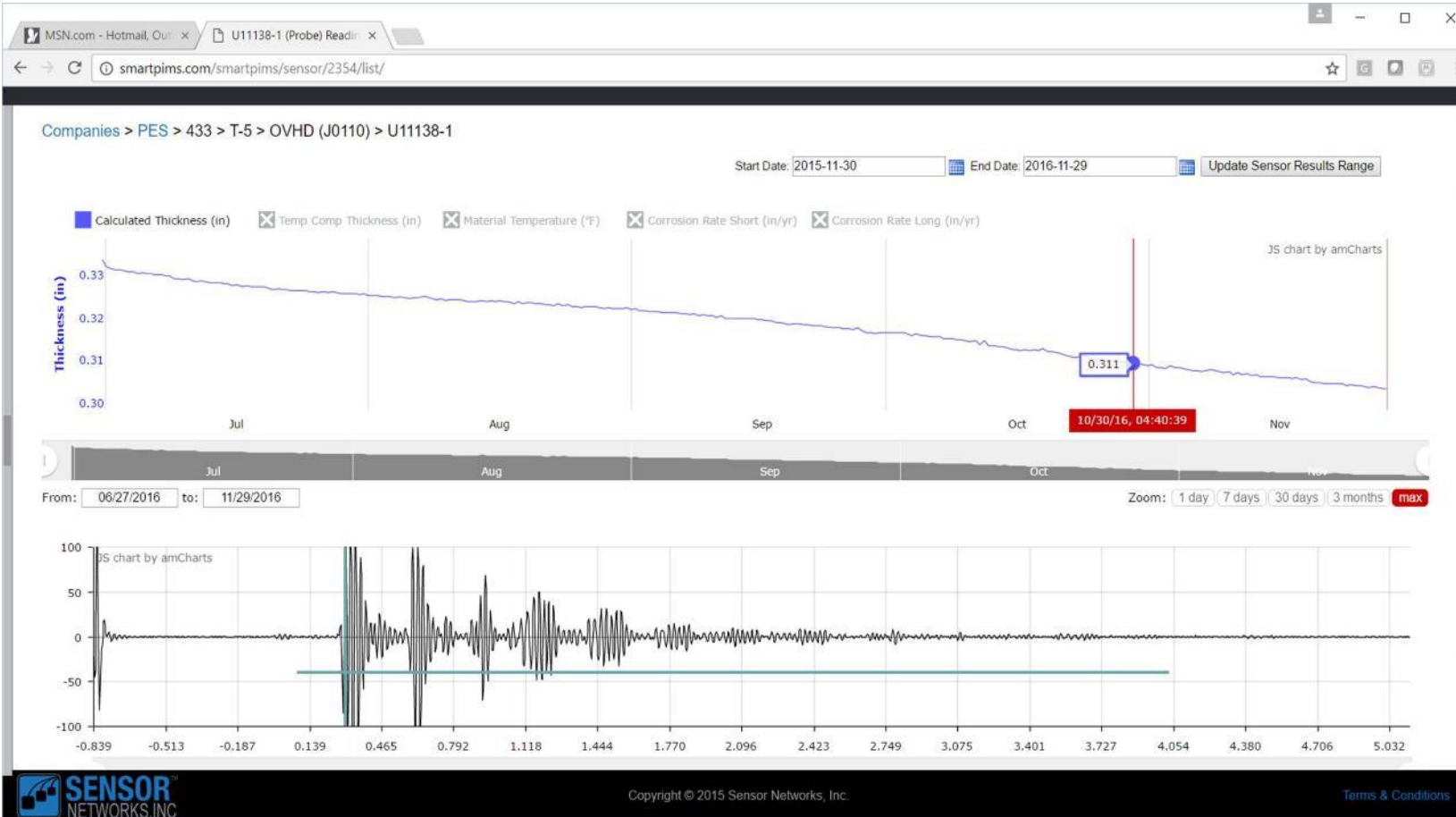
**Outcome:** Objectives achieved:

- Safety – kept personnel from climbing & cumbersome inspection positions on tower
- Economic – saved >\$365K in inspection cost
- Easy to install/monitor, accurate & semi-permanent solution





# Recent data from Philadelphia Refinery: 65 MPY metal loss



# Atmospheric Gas-Oil Line Monitoring

**Overview:** Customer wants to extend life to next turn-around and make sure that line is no longer corroding. **Application:** Atmospheric gas-oil, ~270C

- 3" Sch 40, subject to severe but uniform corrosion, most piping is <math>\frac{1}{2}</math>" nominal wall

## Product Used:

- smartPIMS HT Cellular w/ 4 HT probes temporarily attached, managed by on-site service provider
- Monitoring interval: 4 hours
- Data is monitored & trended daily using webPIMS
- Installation time: 6 hours

**Outcome:** Refinery able to safely monitor process piping which was not scheduled to be repaired during outage and trend for future metal loss conditions

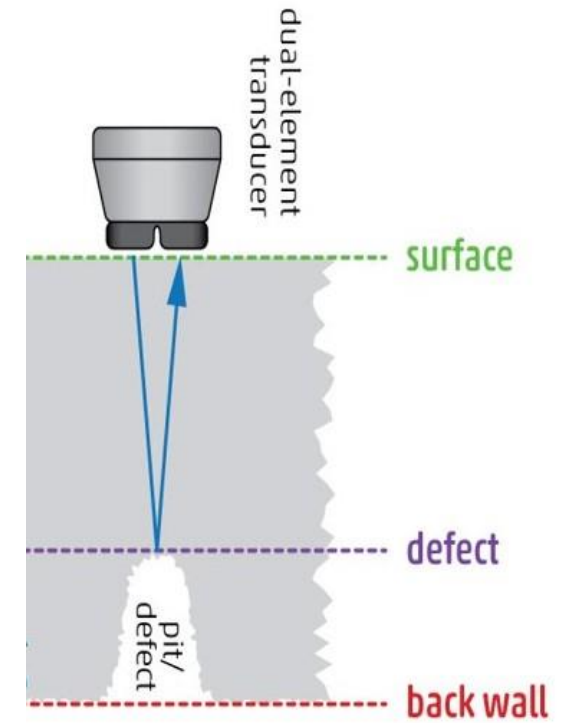
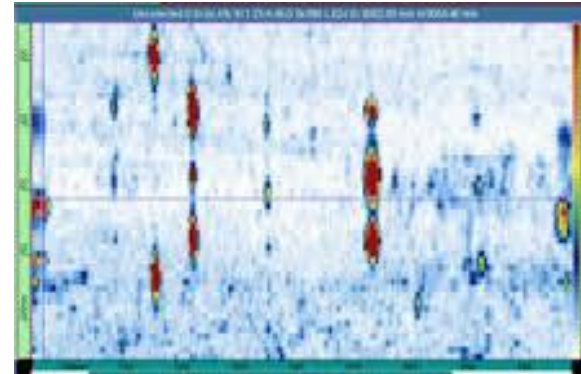




# Pit-track™

Pit-track is a unique ultrasonic hardware & software solution that allows asset owners to precisely monitor critical individual pits for growth.

- Dual-element transducer
- Measure down to 0.040" (1 mm)
- Resolution to 0.0001" (2.5 micron)
- Temp range: -5° to 300 ° F (-20 ° to 150 ° C)



When combined with SNI's smartPIMS electronics and cloud software, multiple pits can be tracked with auto-alarm capability via e-mail. Used post ILI and /or in conjunction with conventional UT scan data Pit-track can monitor multiple individual pits with high precision.



# Process Control of offshore oil & gas production



- Sand erosion monitoring
- Eight – sixteen UT thickness monitoring sensors per pipe elbow extrados
- Monitor from 10 mm down to 1 mm with 25  $\mu$  resolution
- 1 – 32 transmitters per single cable network tied directly to control room's DCS



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