CORROSION & PREVENTION 2017

12 – 15 NOVEMBER 2017 | SYDNEY, AUSTRALIA

PROUDLY PRESENTED BY: Australasian Corrosion Association Inc.

MAJOR SPONSOR: JOTUN

SENSOR NETWORKS, INC
Inspection, Testing & Asset-Integrity Solutions

SN Integrity

"Deployment of Smart Ultrasonic Sensors"
For Internal Corrosion Monitoring using Internet of Things (IoT).

Nestor Sequera
SN Integrity
Australia



Smarter Solutions For Your Complex Asset Integrity Challenges

SENSOR NETWORKS, INC
Inspection, Testing & Asset-Integrity Solutions

Agenda

Historical Overview

- Tell Tales
- Intrusive Monitoring: Corrosion Coupons & Probes
- Ultrasonic D Meter
- Evolution of TML's /CML's

Non-Intrusive Smart Ultrasonic Sensors System

- Details: principle, Internet of Things (IoT's)
- Smart Ultrasonic Sensors Attributes

Field Deployment (3 cases)

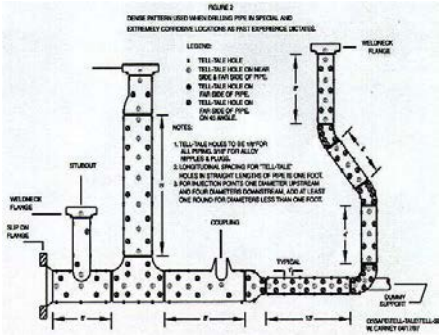
Conclusions

Historical Overview

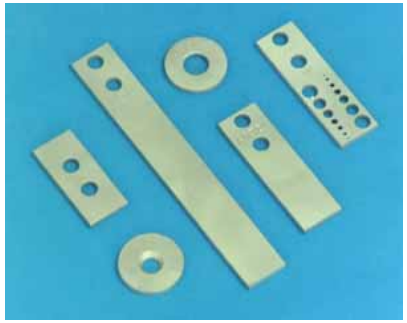
Historic Perspective

- Tell-Tale Drilling
- Corrosion Coupon
- Corrosion Probes
- UT “D” Meter

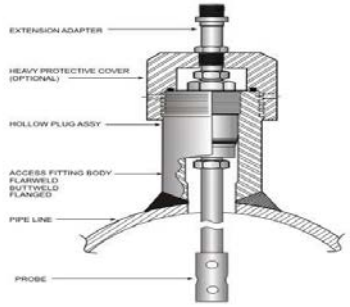
Tell-Tale



Coupons



Probes



Corrosion Probe System

D Meter

UTM TML/CML Proliferation

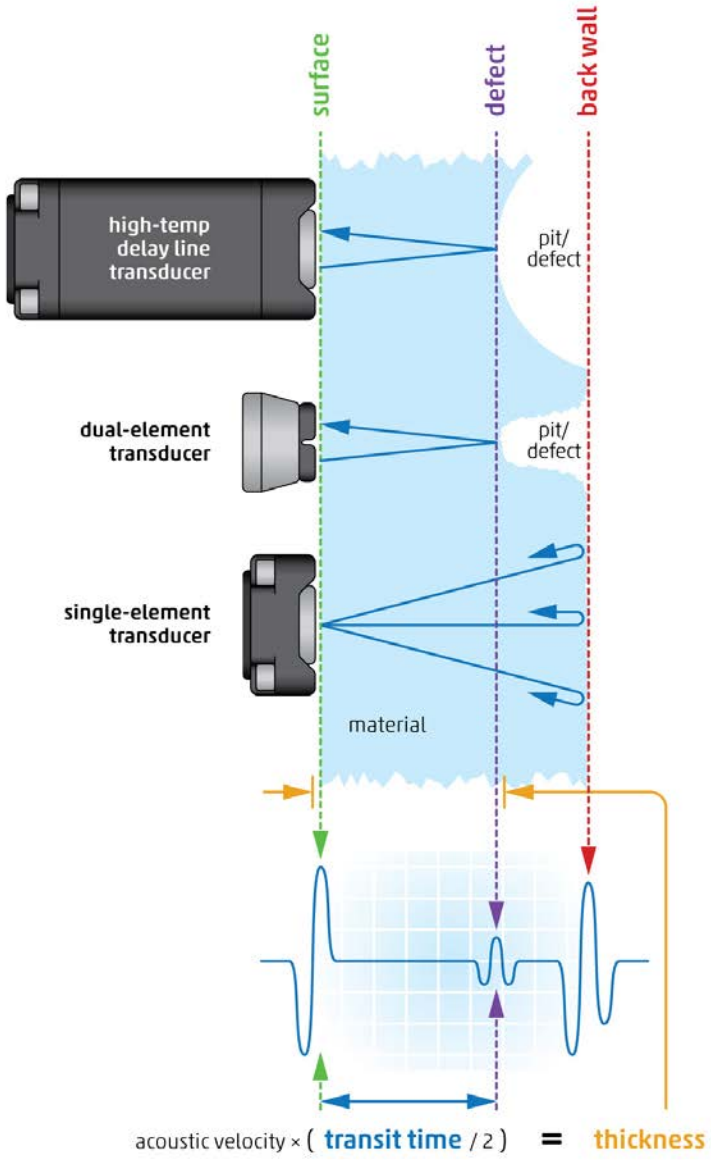
- API 570 and proliferation of TML's
- Good idea taken to extremes
- Some sites have >1,000,000 TML's
- Moderate site estimate of 25,000 TML's over 3 years to be $200 per TML
- Manpower Intensive and more and more difficult

Challenges of current Pipeline inspections

- Safety
- Accessibility
- Cost
- Data Quality

Non-Intrusive Smart UT System

Operational Principal



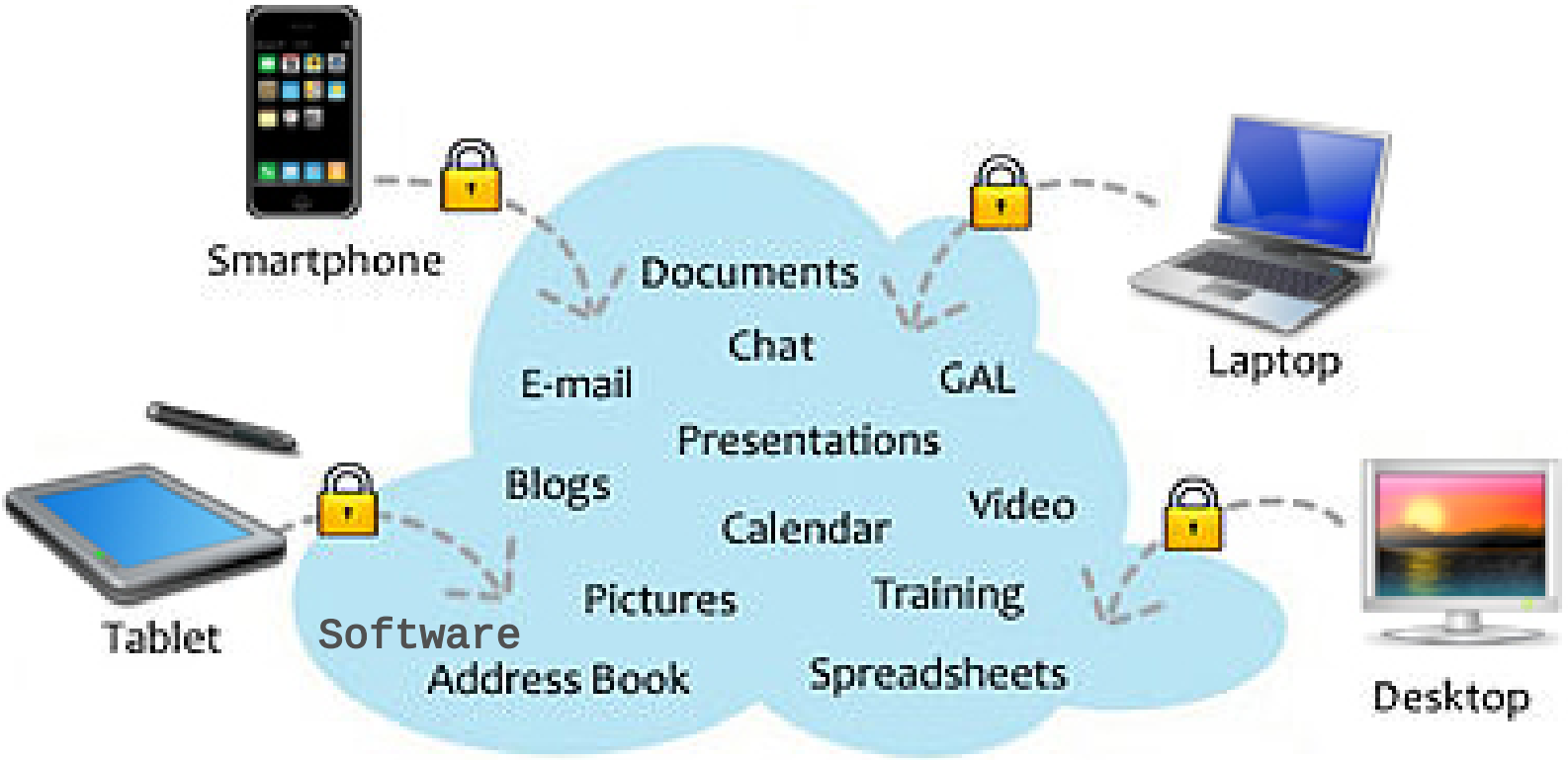
Non-Intrusive Smart UT System Using IoT's

Internet of Things

'A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies'(1)

(1) As defined by International Telecommunication Union

Non-Intrusive Smart UT System Using Cloud



Source:Reprinted from Lanco Global Systems http://www.lancoglobal.com/images/cloud-computing-diagram.jpg, November 2017.

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Non-Intrusive Smart UT System

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asset integrity meets

THE INTERNET OF THINGS

Seamlessly translate ultrasonic thickness measurements and metal-loss rates from an asset to your desktop or mobile device

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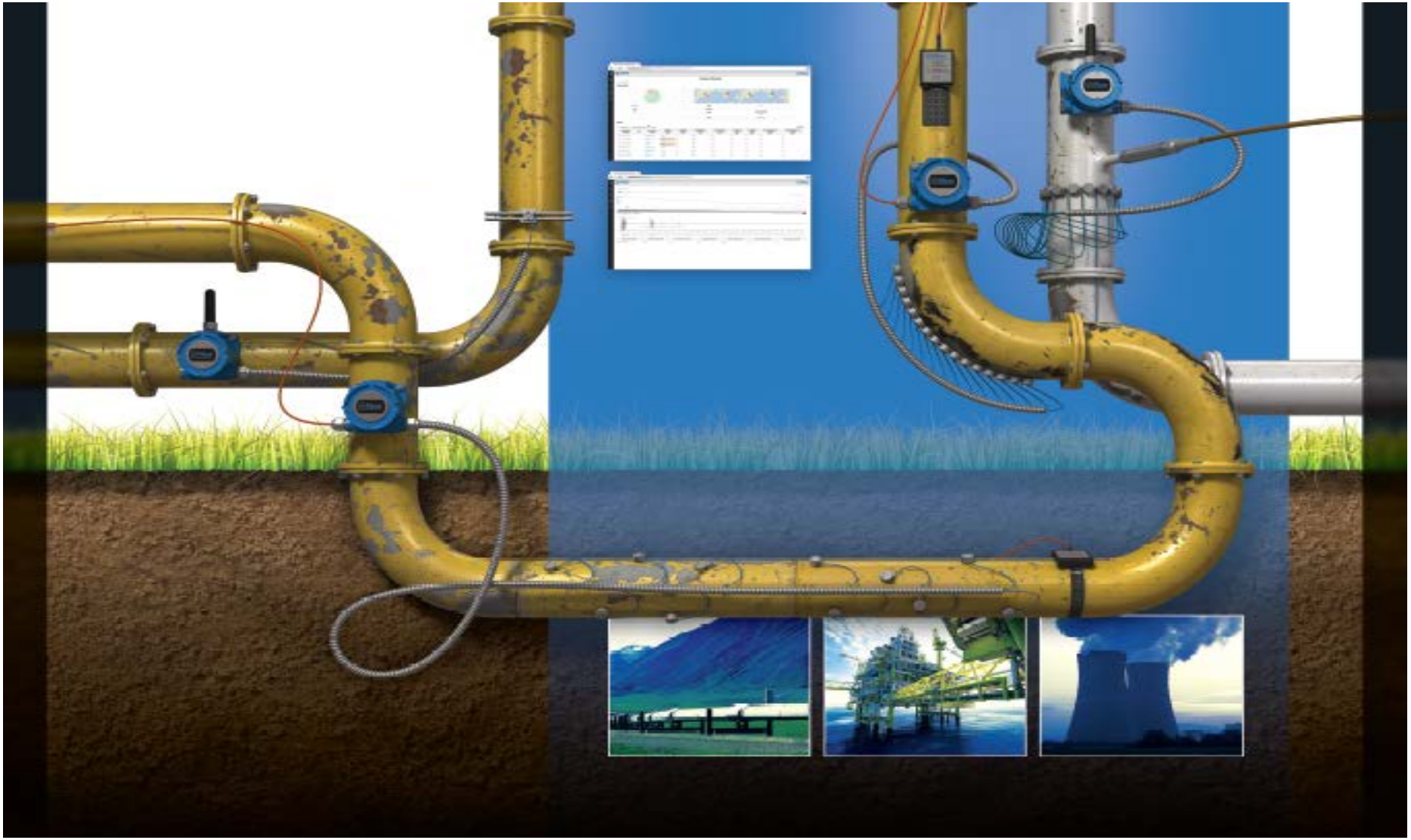
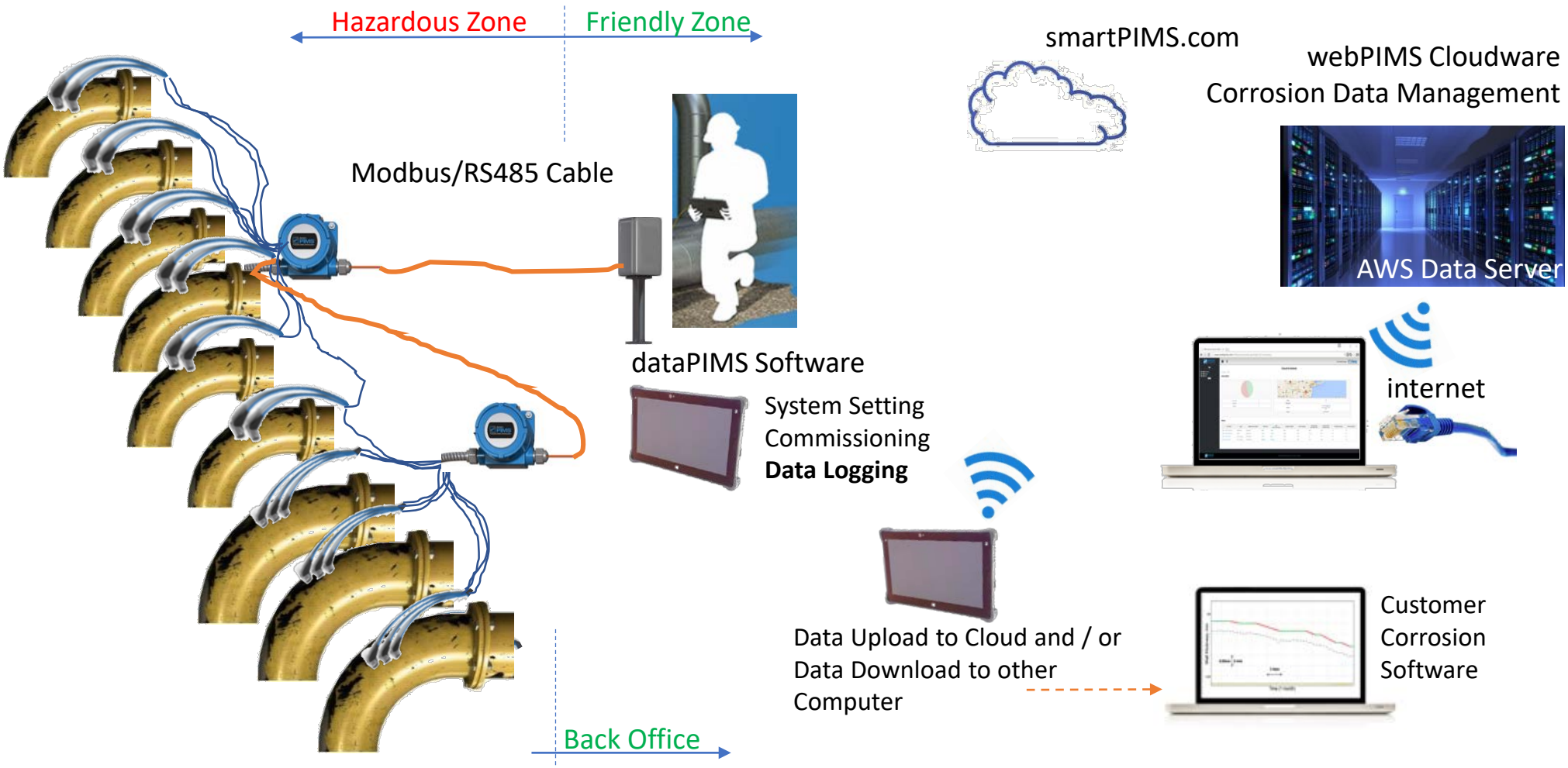
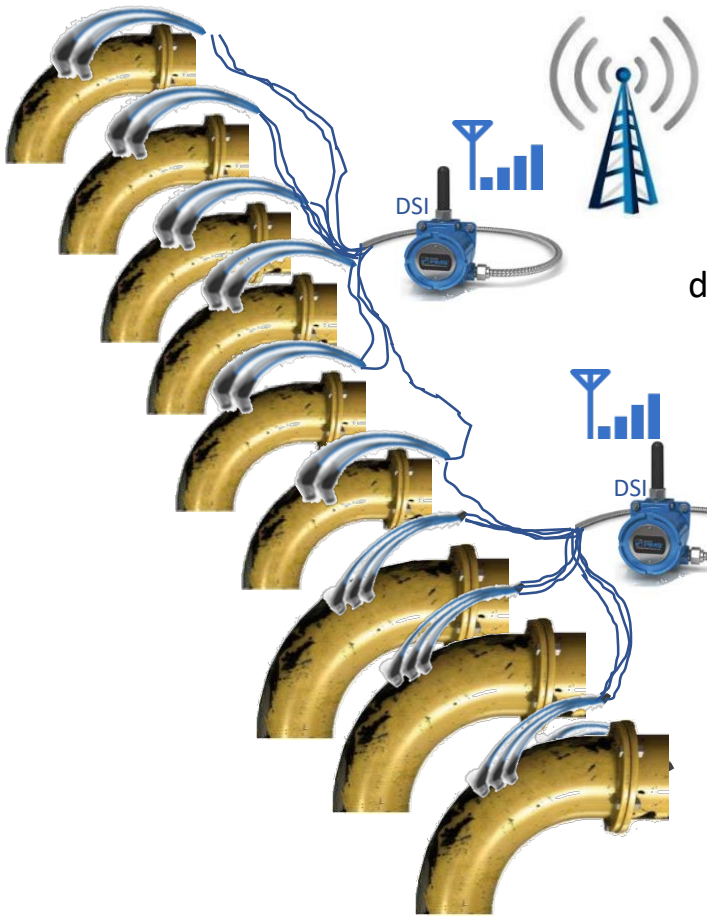


Non-Intrusive smart UT System

Modbus Wired Manual UT System



Cellular (Mobile) Wireless UT System



smartPIMS.com

webPIMS Cloudware
Corrosion Data Management

Yearly License fee

dataPIMS Software

System Setting
Commissioning

Installed in Customer Server

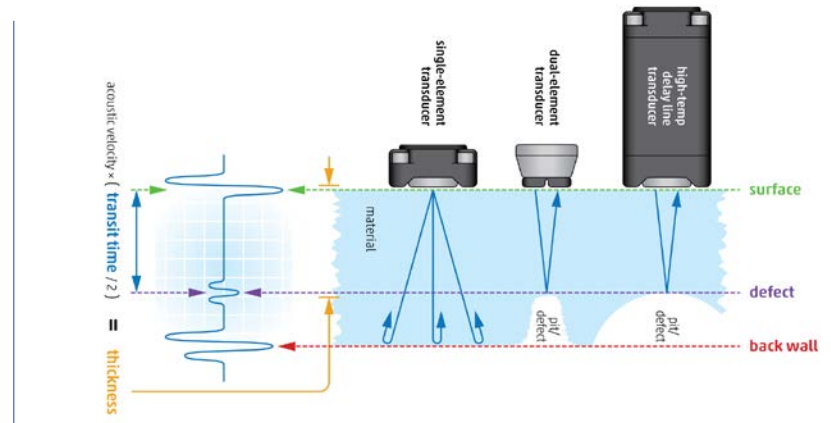
Internet/intranet

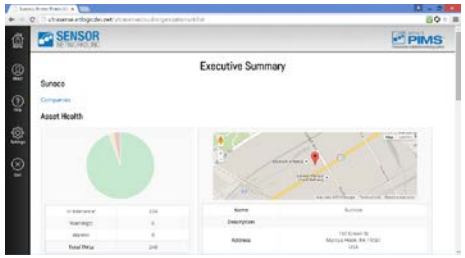
Back Office | Remote Office

Non-Intrusive Smart UT System

Attributes

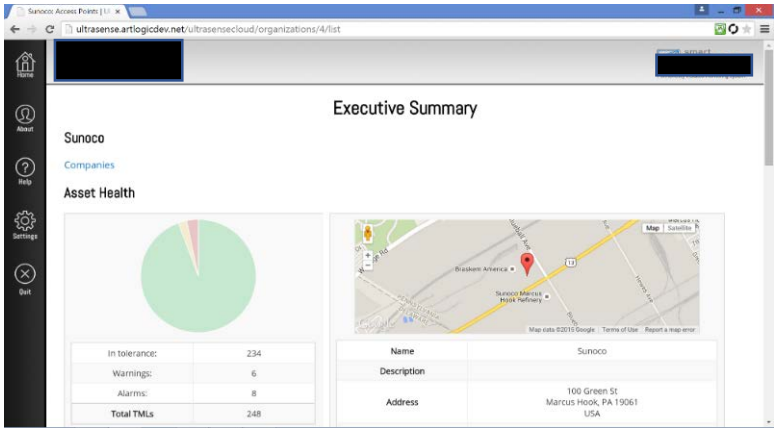
1. Non-invasive to pressure boundary = Safe
2. Direct measurement of the asset condition
3. Modular and versatile
4. Portable / battery operation
5. Non-reliant on IT departments
6. Accurate including Temp Comp.
7. Easy access to the data

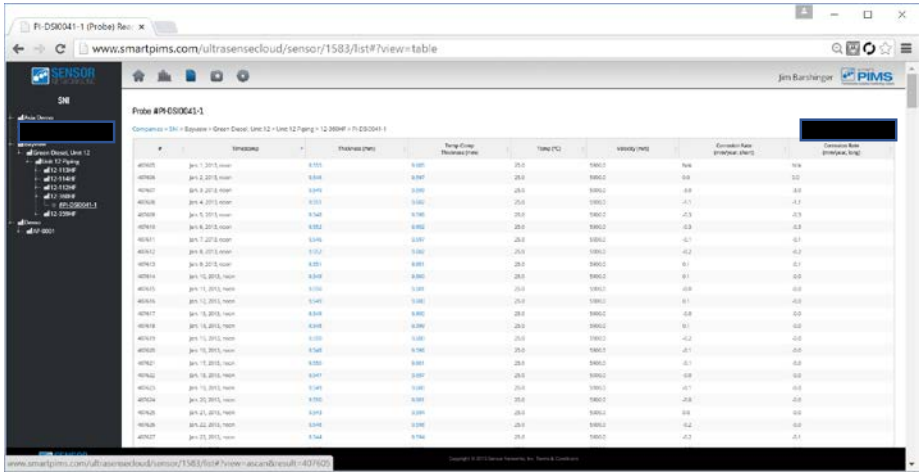


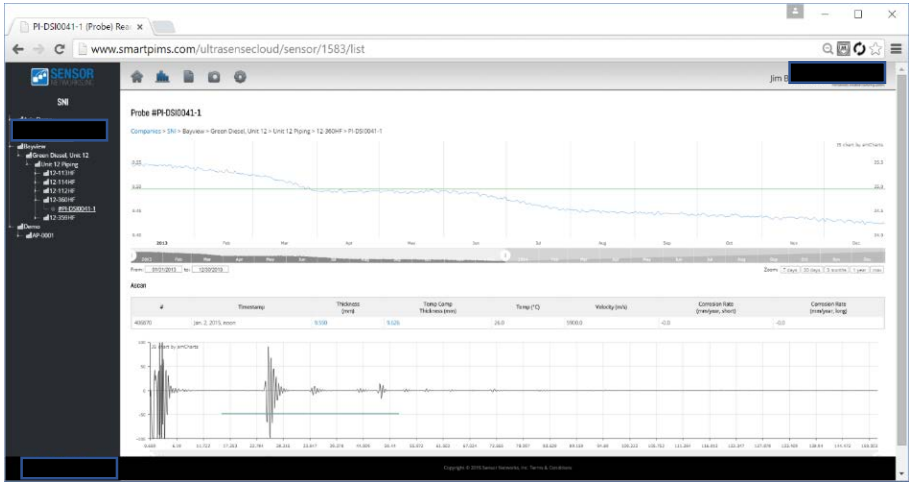


Web-based Data Management

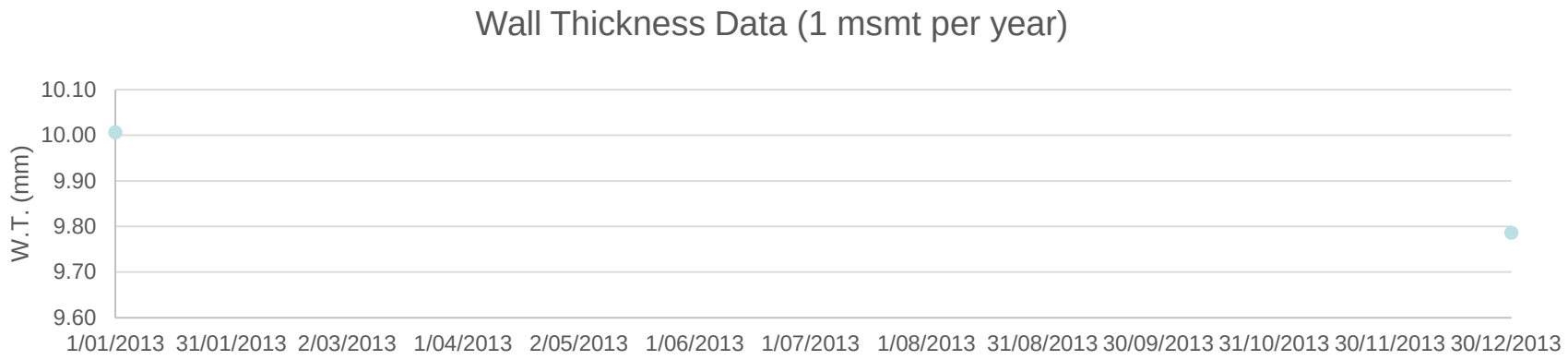
- Auto archiving and record retention simplicity
- Alarms & Warnings via e-mail
  - Min WT and Max CR
  - Ex. < 1.1 mm or > 0.01 mm / week
- CR calculation
- Automated reporting and e-mail alerts
- Google Maps & GPS asset location
- Accessible from any web-browser device







Data collection frequency is key to enhanced trending



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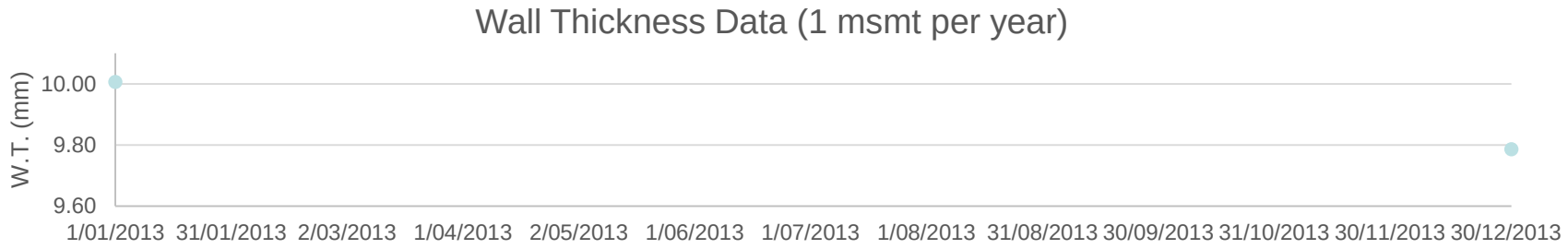

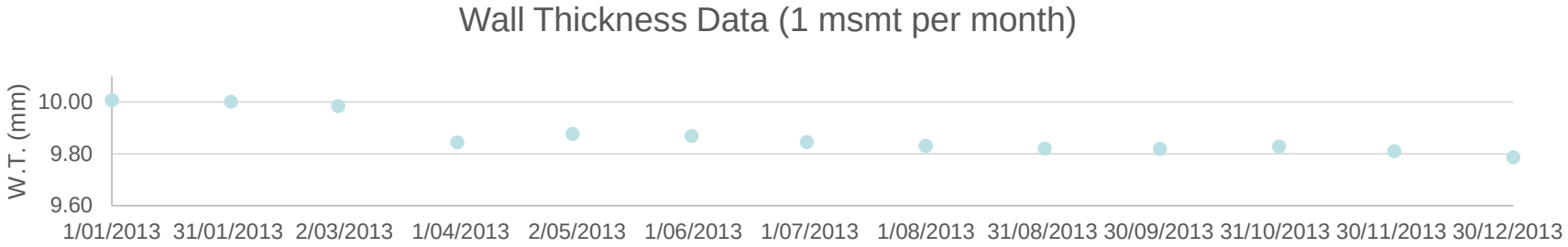

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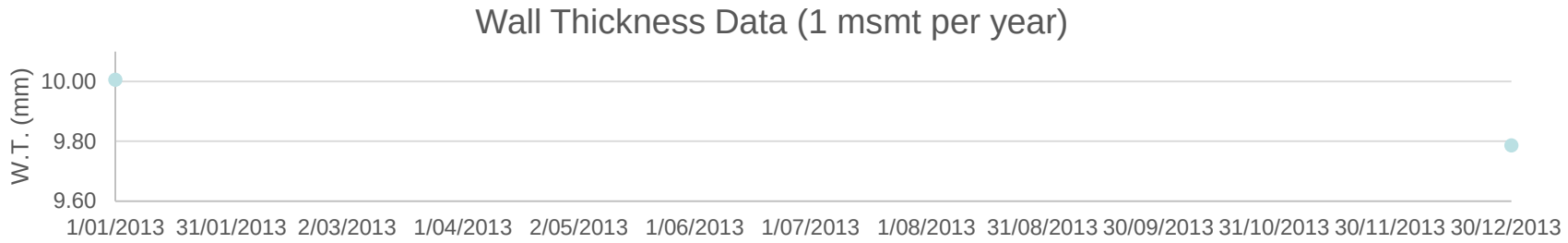

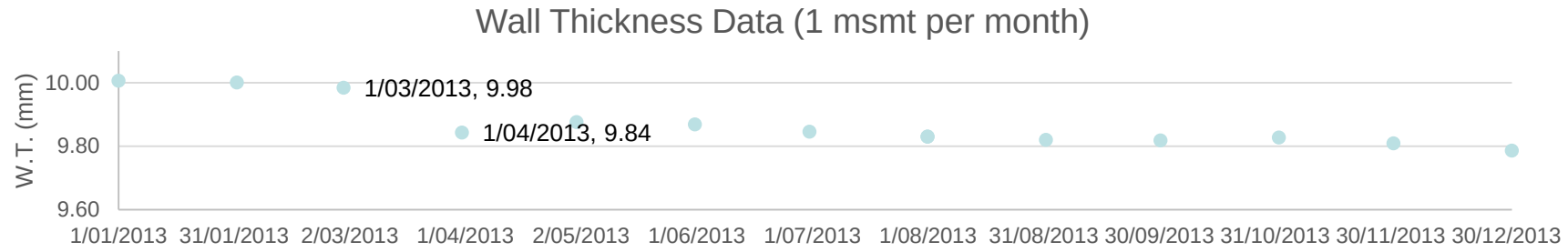

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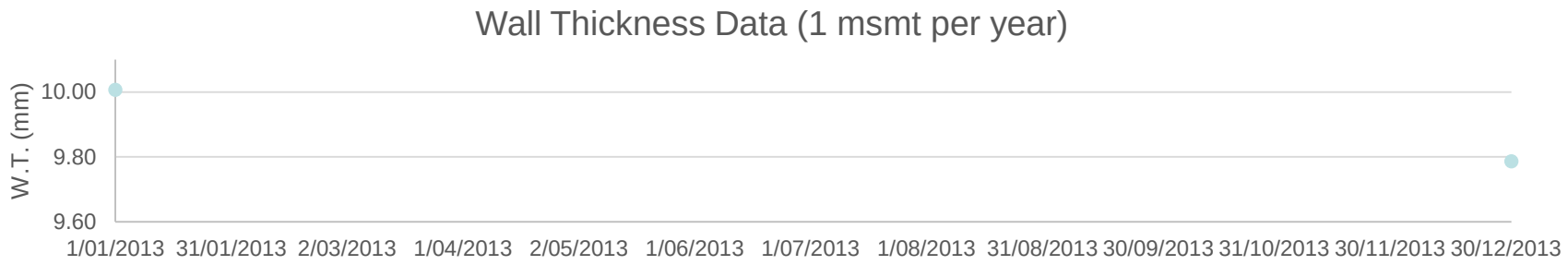

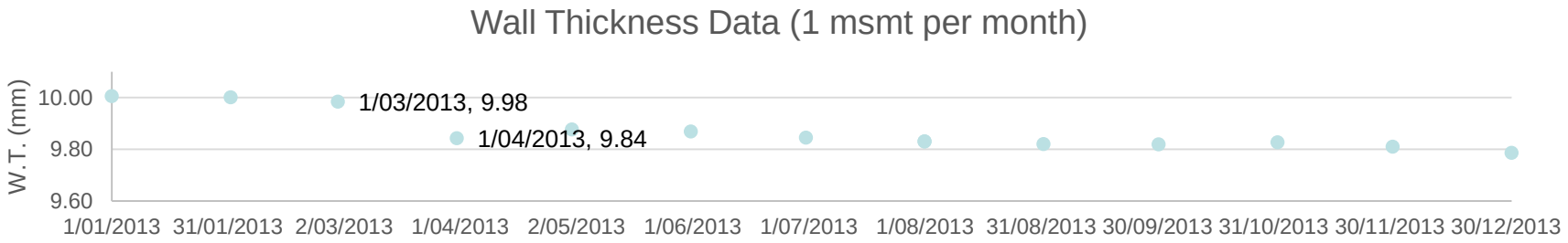

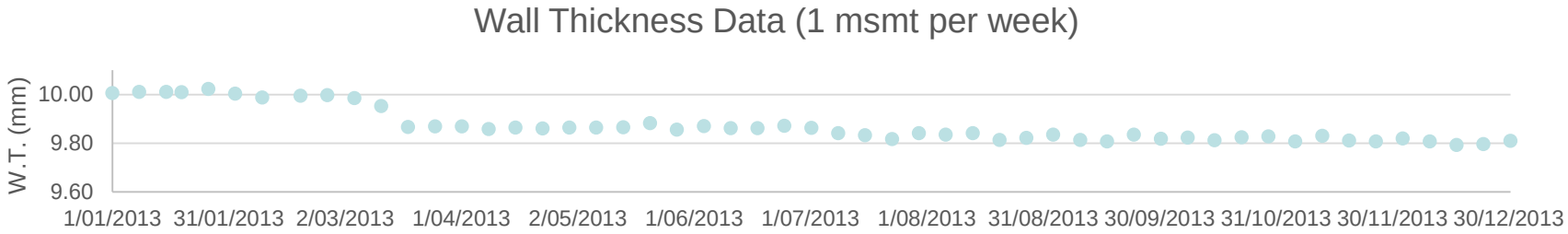

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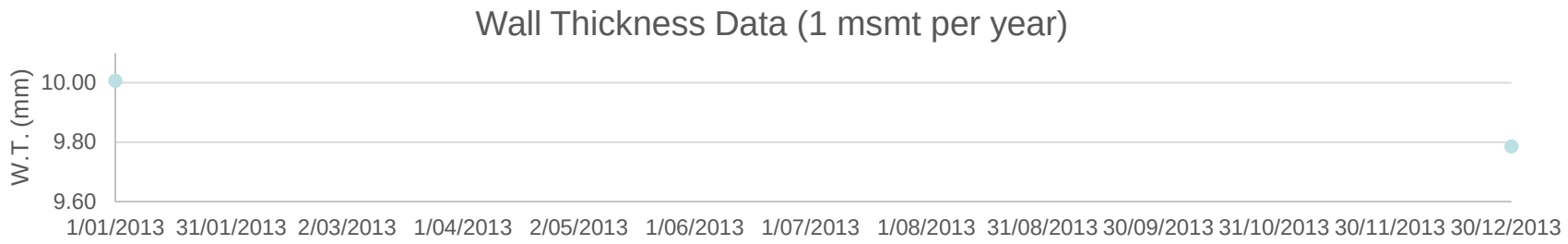

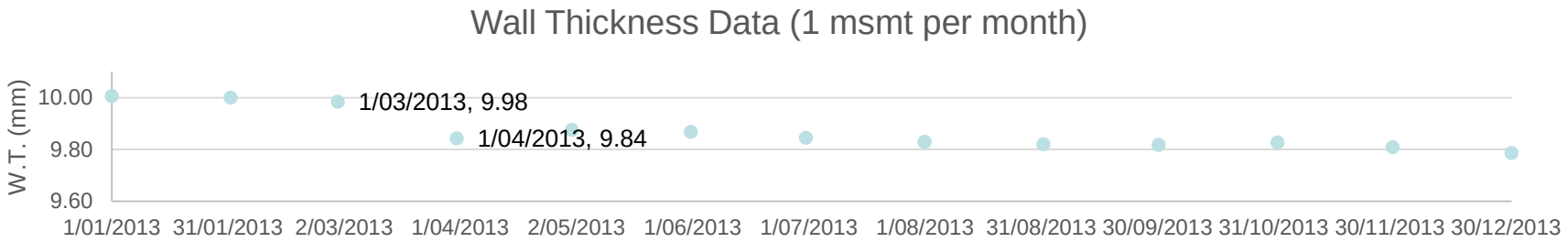

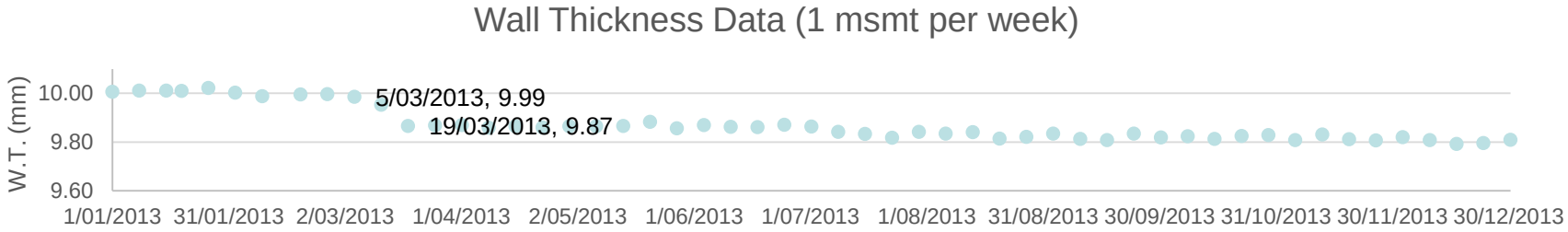

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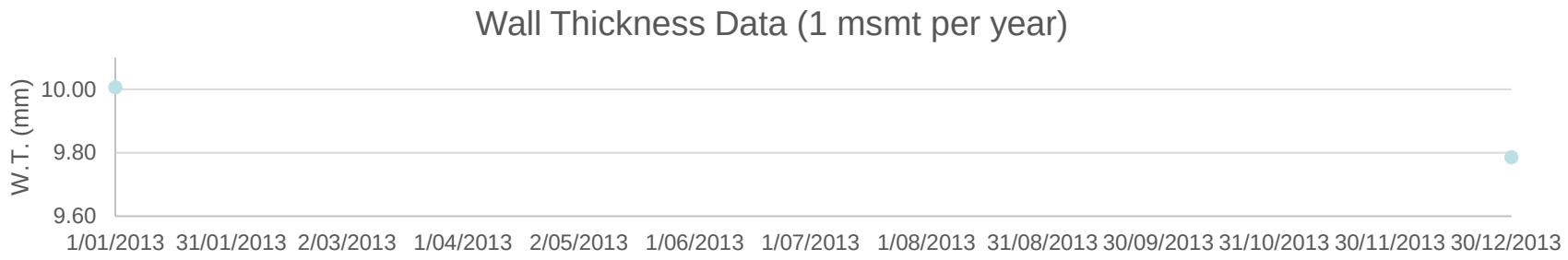

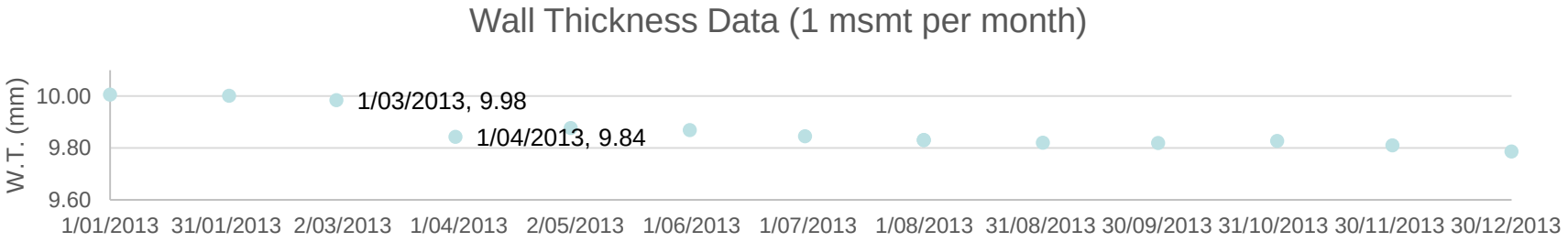

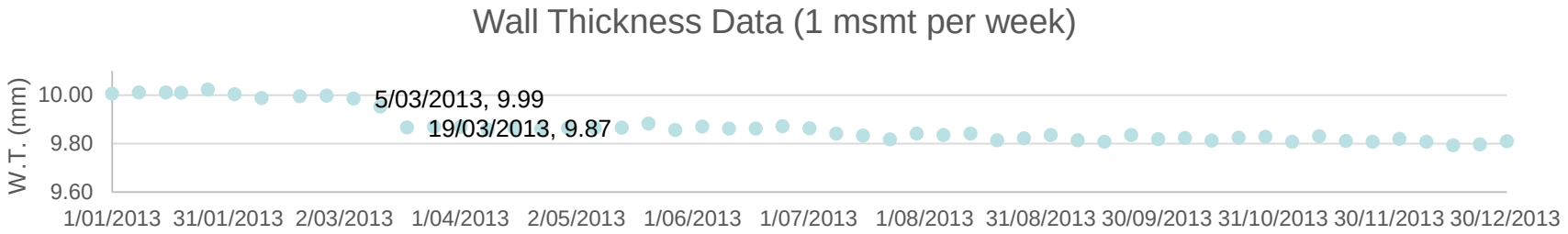

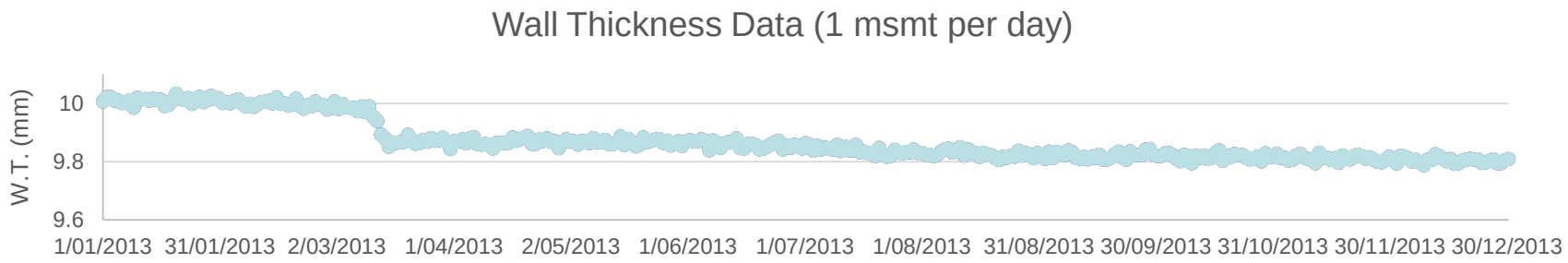

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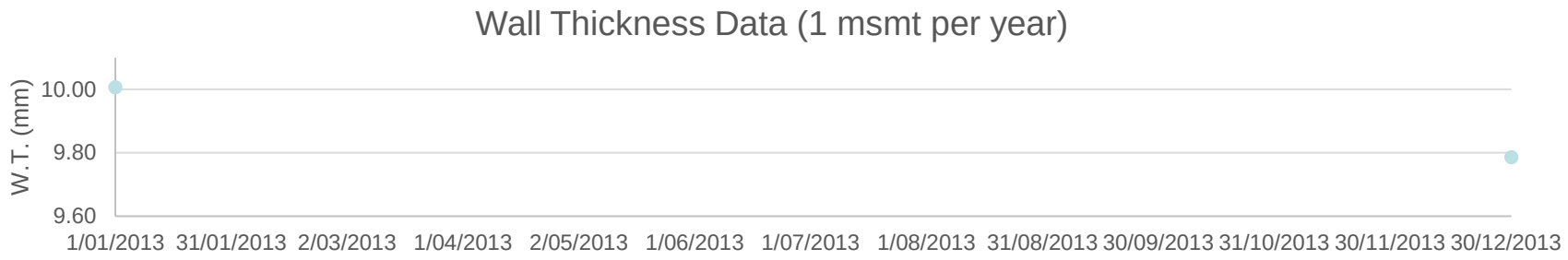
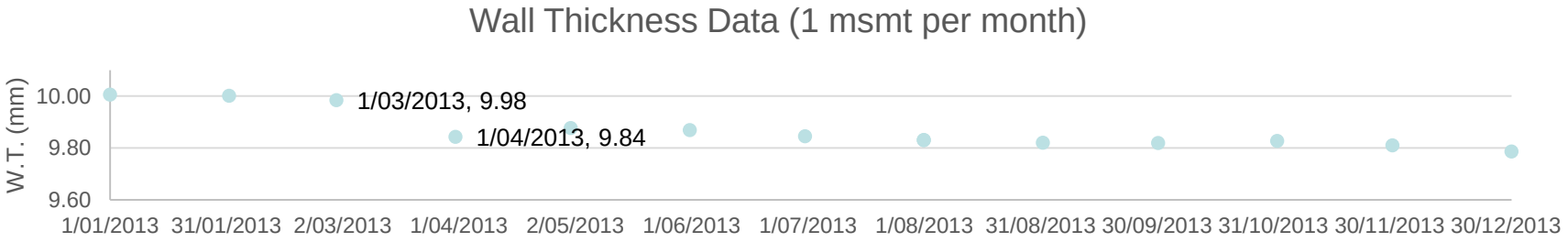
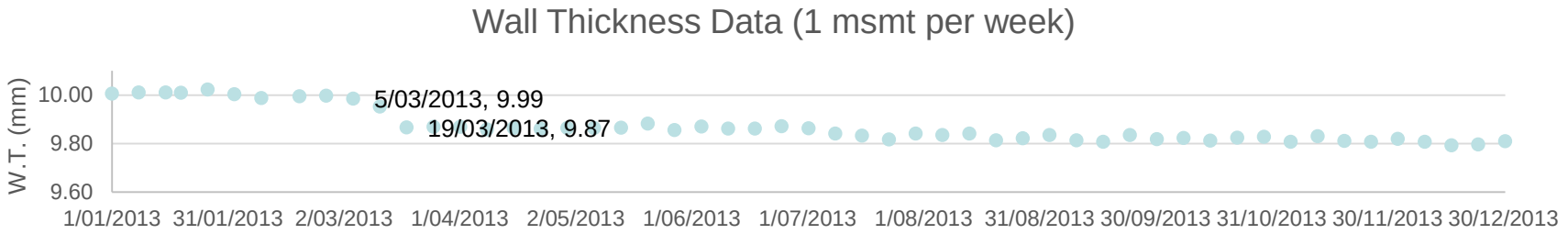
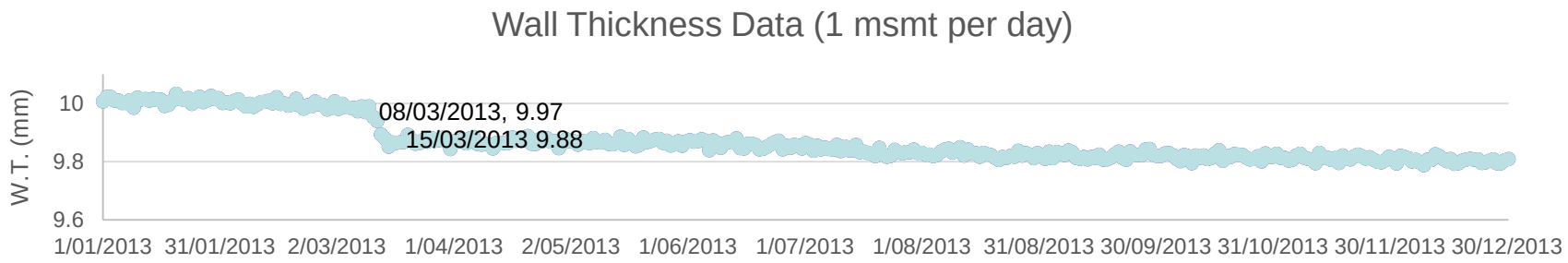








FIELD DEPLOYMENTS

Atmospheric Gas-Oil Line Monitoring

Overview: to extend life to next turn-around and make sure that line is no longer corroding.

Application: Atmospheric gas-oil, ~270 °C

- 80 mm Sch 40, subject to severe but uniform corrosion, most piping is < ½" nominal wall

Atmospheric Gas-Oil Line Monitoring

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 cloud software 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

HydroFluoric (HF) Alky Unit Monitoring

Overview: 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 months

Application: HF Alky Unit (HF Isostripper OVHD elbow), ~65 oC (150F)

- 600 mm Sch. 40 … most piping is < 12.7 mm nominal wall but measured at ~ 7.6 mm with pitting and general “low spots”

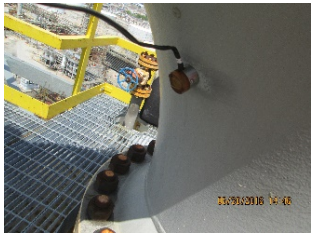
HydroFluoric (HF) Alky Unit Monitoring

Product Used:

- Cellular w/ 8 dual element probes temporarily attached, managed by refinery maintenance team
- Monitoring interval: 12 hours
- Installation time: 4 hours

Outcome: Objectives achieved

- Safe – kept personnel from climbing and cumbersome inspection positions on tower
- Economical – saved >$300K in inspection cost
- Quick & Easy to install/monitor, accurate, and semi-permanent solution



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 SmartPims sensors to monitor pipe intrados, extrados, top and bottom locations

Application: Crude Overhead Line 100°C-38°, 300 mm Sch. 40 … all nominal wall thickness 10.1 mm +/- 12%

Crude Overhead Line

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:

- Cut Inspection costs – lift, scaffolding, or rope access required to reach locations 12 m off the ground
- Process control – access to more … accurate and quality data to trend corrosion rates

Pipeline Integrity

Overview:

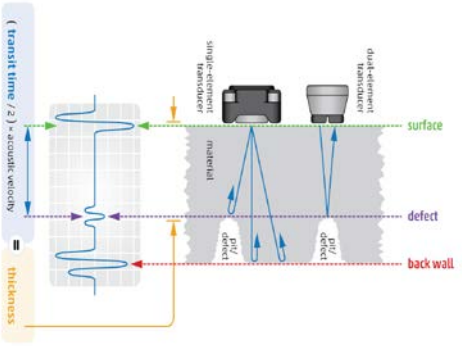
- ILI report showed a number of low spots at three separate locations along a 30 m stretch of gas pipeline.
- On previous ILI performed 7 years prior, these low spots did not exist.
- Operator not only wanted data to tell if corrosion was episodic in nature or active but also did not want to fix/repair the pipeline and did not want to perform another ILI on a shorter interval.
- After mapping the internal corrosion on the pipeline, UT sensors were permanently deployed to monitor the low spots along the excavated line.

Application: Monitoring pits low spots instead of fix/repair

- 30” natural gas transmission line nominal ~ 7.6 mm
- Low spots ranging from 3.1 to 6.1 mm – buried

Product Used: smartPIMS Modbus configuration w/ 8, 7.6 m dual element probes permanently attached and buried to monitor “low spots” as identified by masses screening

- Sensors were attached via epoxy & stopaq and buried
- Enclosure used to house DSI & act as collection point for techs
- Operator will vary frequency of data downloading



Conclusions

Deployment of Smart UT Sensors for Corrosion Monitoring can offer:

- High-Frequency & High Quality Data
- IoT: Data on Cloud available, alarm settings, e-mail warnings, potential issues flagging for maintenance planning
- Integrity status without dispatching technicians to dangerous, remote or inaccessible sites.
- Save in Opex budget by using resources only when needed
- Flexible with a wide temperature range of applications
- Can be temporarily installed without welding - Sensors can be easily moved
- Short Term Installation/Data, Re-useable Sensors

  - Quick Deploy, Experimental research, Evaluation, ….

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"Thanks for your attention"

Any Questions?

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SN Integrity
Australia

SENSOR® NETWORKS, INC
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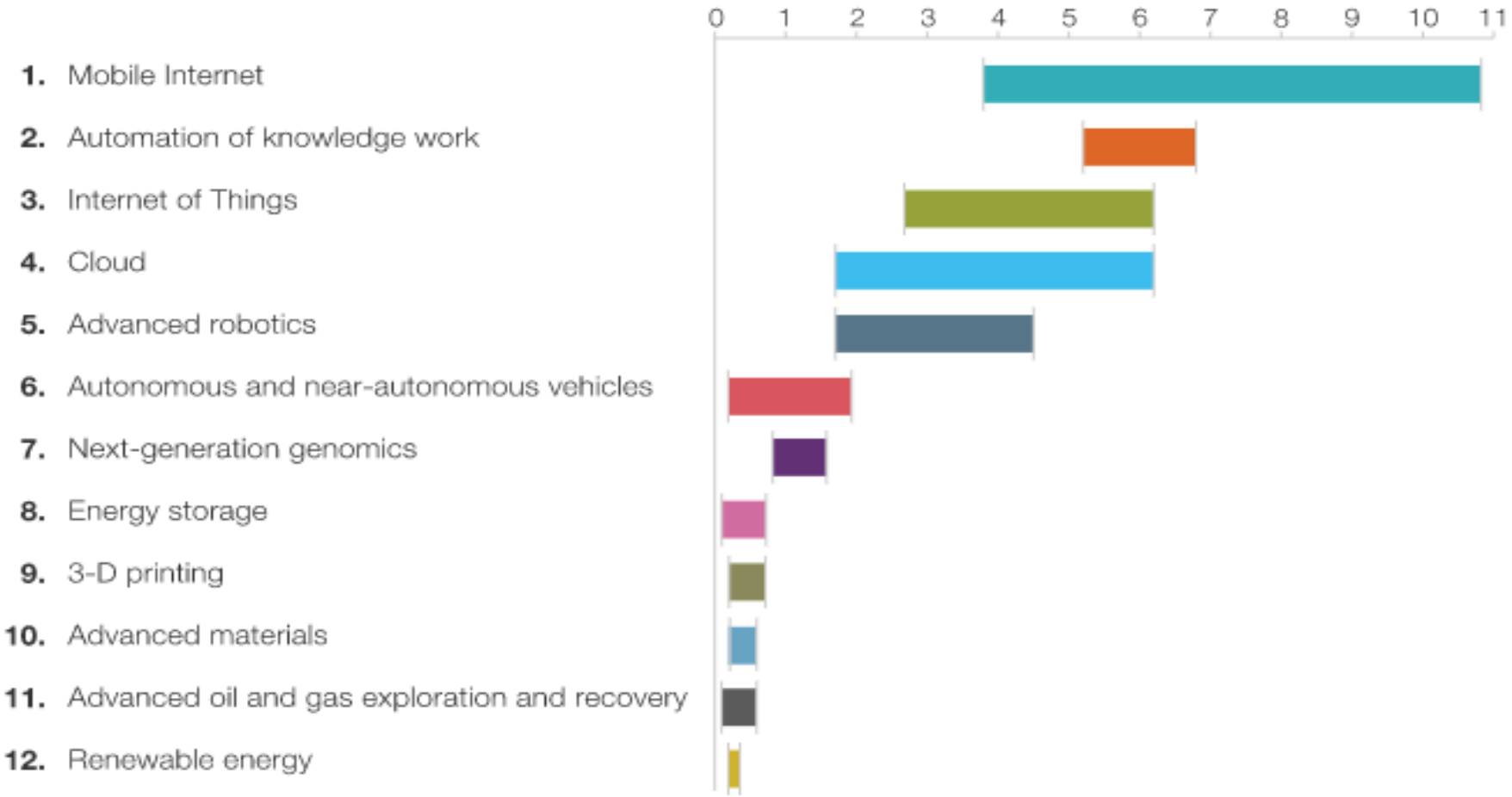
Smarter Solutions For Your Complex Asset Integrity Challenges

A gallery of **disruptive technologies**

Estimated potential economic impact of technologies across sized applications in 2025, $ trillion, annual



SOURCE: McKinsey Global Institute

Notes on sizing: These economic impact estimates are not comprehensive and include potential direct impact of sized applications only. They do not represent GDP or market size (revenue), but rather economic potential, including consumer surplus. The relative sizes of technology categories shown do not constitute a "ranking," since our sizing is not comprehensive. We do not quantify the split or transfer of surplus among or across companies or consumers, since this would depend on emerging competitive dynamics and business models. Moreover, the estimates are not directly additive, since some applications and/or value drivers are overlapping across technologies. Finally, they are not fully risk- or probability-adjusted.


$1 TRILLION
$1,000,000,000,000

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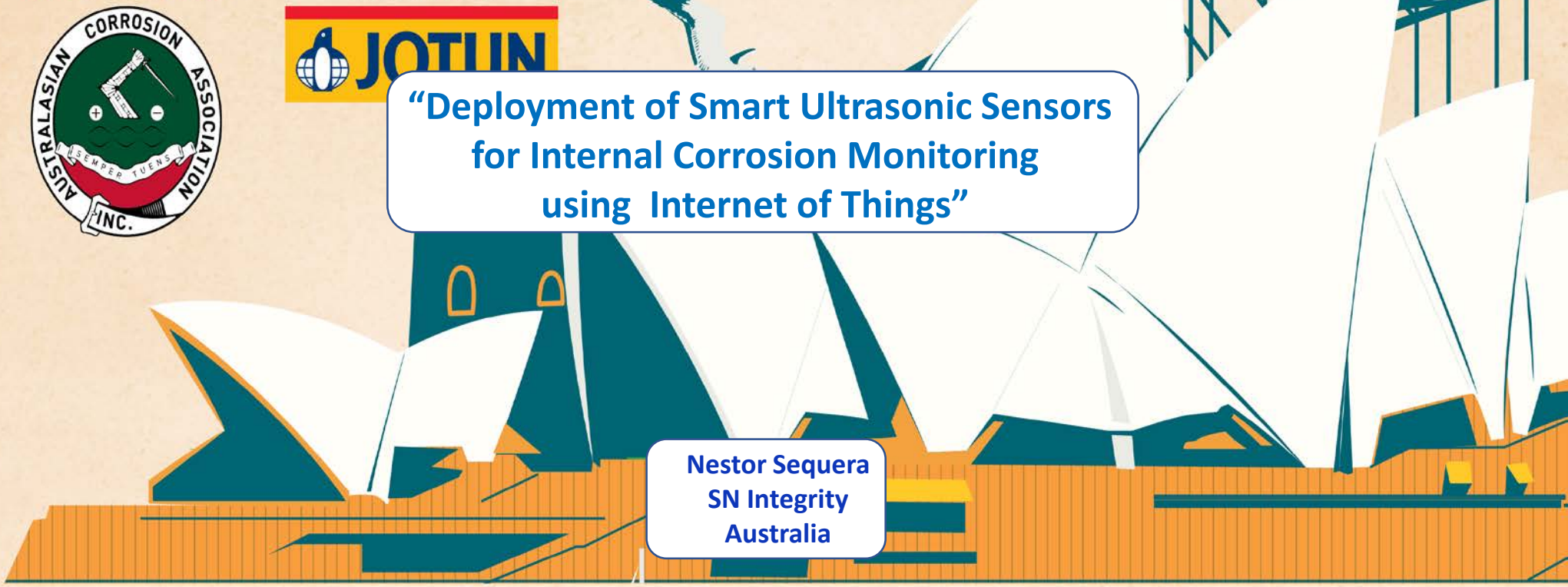

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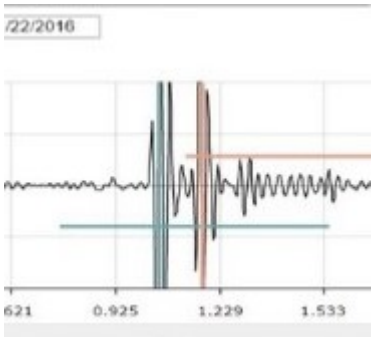
INTERNATIONAL CONVENTION CENTRE SYDNEY

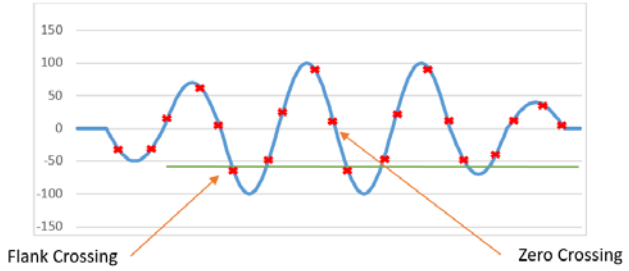
Minimizing variability for Precision Ultrasonic Measurements

Precision UT is a time-based measurement:

Thickness = (Time / 2) x Acoustic Velocity

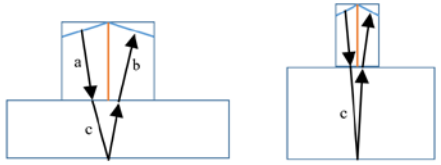
1. **Same spot with exact same equipment**
2. Gating a precise time measurement
3. Correcting for temperature change
4. More frequent data with higher data fidelity allows precise trending





Digitized waveform and measurement references.

Single-element transducer: Thickness = (Measured Time x Material Velocity) / 2



Dual-element, delay-line transducer concept.

Thickness = [(Measured Time – 'a' – 'b' – V-path Correction value) x Material Velocity] / 2

$$d_1 = \frac{1}{2} C_1 \Delta t \qquad (2)$$

$$C_1 = C_0(1 + k(T_1 - T_0)/100) \qquad (3)$$

Sensor UT Parameters setup