Installed Inspection Sensors & Cloud -based Software for Continuous Corrosion Monitoring & Analytics

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Presentation overview

- Corrosion: an expensive problem everywhere
- Why Corrosion Management?
- Corrosion Management, Conventional Methods
- Implementation of Digital Technologies & Wireless Connectivity
- Implementation of Dry-Coupled Ultrasonic Sensors
- Wireless Communication and Data Acquisition
- Data Analysis Software
- Value Staircase

Corrosion: an expensive problem everywhere

~ $2.5T * | Annual global cost of corrosion across industries

~ $200B** | Annual O&G cost of corrosion

15-35% | The opportunity to decrease the cost of corrosion

- Asset integrity compromised
- Safety risk to staff and community
- Hazardous emissions
- Damage to public reputation
- Revenue-impacting production disruption

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* Source: NACE International, IMPACT – International measures of prevention, application, and economics of corrosion technologies study

** Source: BHGE Analysis of NACE report

Why Corrosion Management?

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Aging

- Most assets are old “some of which now have been in operation for double original design life ”
- 60% of worlds pipelines are ~40y old With high risk of failure.

Cost

- Inspections are expensive / experts, access ..
- unplanned downtime and costly repairs
- Loss of production is biggest cost

Safety

- Dangerous site access “hard-to reach, Confined space entry ..
- Hazardous environments : radiation, extreme temperatures, highly combustible gas, toxic or acidic vapor

Reputation/Image

- Multi-million dollar fines
- Image damage to company when accidents happen
- comply with industry regulations

Corrosion Management, Conventional Methods

Intrusive methods

- Indirect measurement:
  - Corrosion rate of the fluid.
  - Measurement on a shining piece of metal…
- Flow changes: Could create some change on the internal flow → different corrosivity conditions ..
- Installation, maintenance, download data and retrieval would require access.
- Solid deposit → generate misleading results
- Global evaluation of the corrosion process but doesn't indicate where corrosion occurs
- Would measure corrosivity for the position it is in (not area) and could be placed at locations where they are easy to install / collect data.

Ultrasonic inspection

- Measurements are point-in-time, and often infrequent,
- Trained and certified inspector is required
- Gaining access to the site, including scaffoldings, rope access, and insulation removal are time-consuming and expensive
- Hazardous environments, and access during difficult conditions
- Location repeatability …
- Performance and accuracy factors: equipment used, equipment calibration, surface roughness, coupling, curvature, velocity variations, temperature
- Human factor, i.e. expertise of the operator, actual performance of the testing in the field
- Equipment & hardware costs

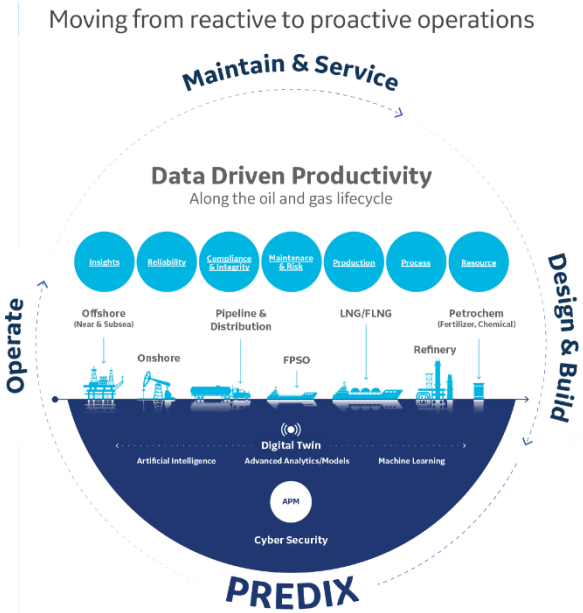
Implementation of New Technologies

Implementation of Digital Technologies & Wireless Connectivity

- Digital technologies and wireless connectivity are revolutionizing all industries.
- Cloud technology has enabled data availability, integration, storage without limits, and computation capacity, The cloud unlocks data so that more-informed decisions can be made across the enterprise.

↑ Safety	↓ Downtime
↑ Productivity	↓ Risk
↑ Data quality	↓ Cost
↑ Asset integrity	↓ Unplanned shutdown

- Sensors have become notably more powerful and cost effective, can provide real-time visibility across assets through a simplified, central view of inspection data, including thermal and thickness measurements.



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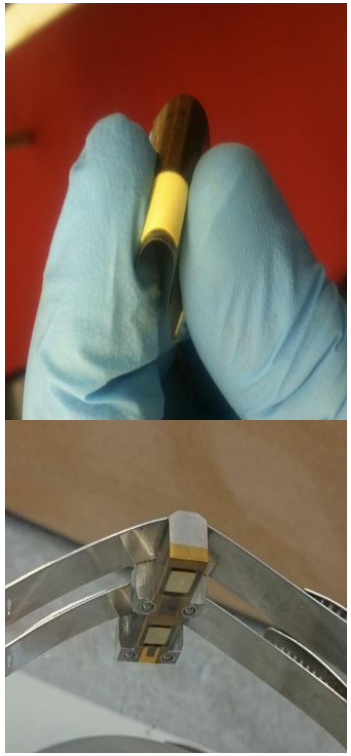
Implementation of New Technologies

Implementation of Dry-Coupled Ultrasonic Sensors

Ultrasonic sensor, applied directly on the pipe provide 0° pulse-echo ultrasound measurements of the wall thickness.

- Footprint of only 1x1”.
- Low profile.
- Accuracy measurements.
- Perfect Repeatability margin.
- Sensors are ATEX certified
- SolGel Ceramic Technology: Dry coupled.
- Minimum of 10 years lifespan.
- Thermocouples are installed with sensors.
- The sensors are clamped on as a non-intrusive method, no welding is required to install.



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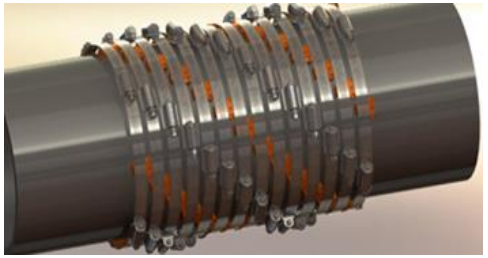
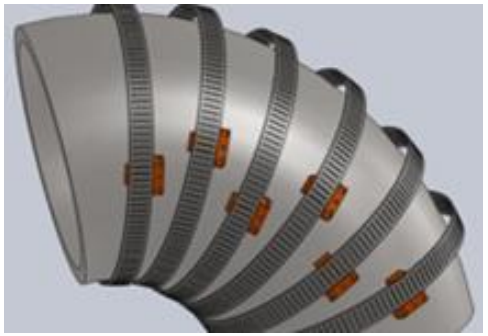
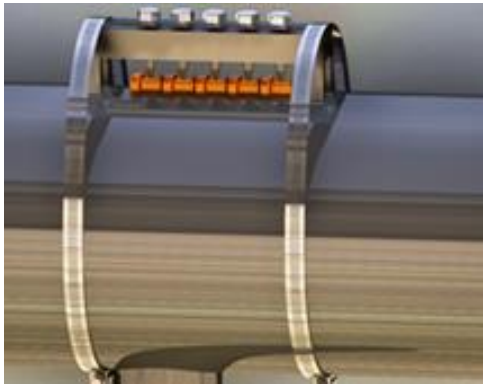
Implementation of New Technologies

Implementation of Dry-Coupled Ultrasonic Sensors

Sensors can be attached using a variety of methods and configurations on straight pipes, elbows, headers on different orientation, corrosion mechanism in combination with the most critical area of a certain asset will drive the probe locations



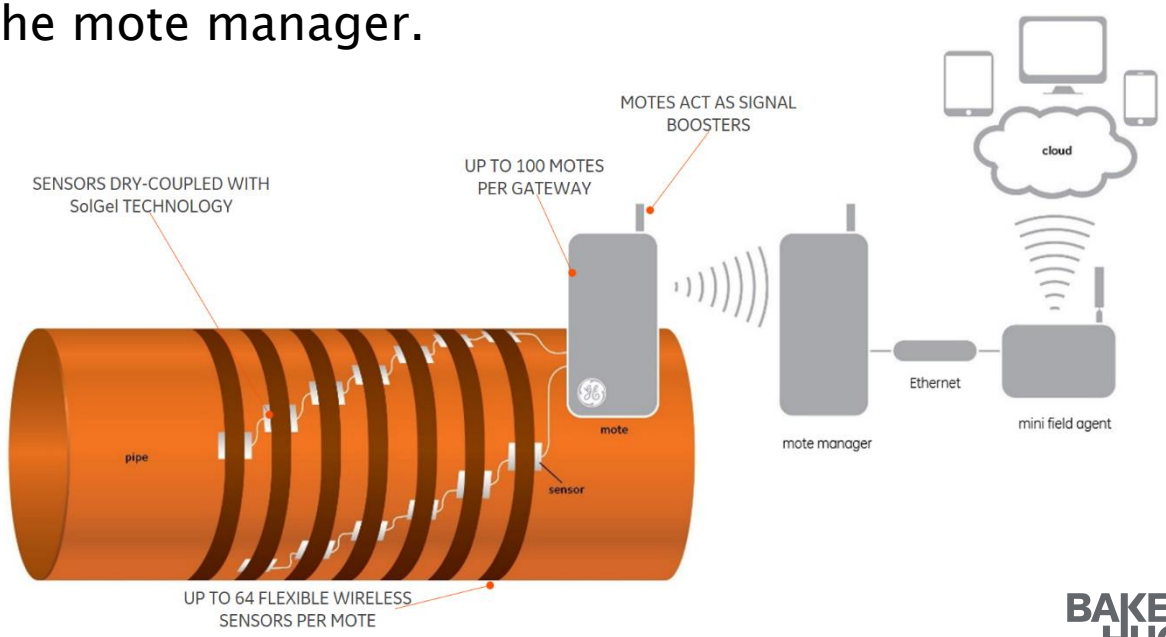




Wireless Communication and Data Acquisition

This marriage of the latest digital technologies, wireless connectivity, and dry-coupled ultrasonic sensors can offer real-time thickness measurement, and the ability to perform advanced data analytics.

Each probe is controlled by a battery-powered controller box called the ‘mote’ capable of serving up to 64 probes and powered by battery with a minimum of 5 years battery life.
The Mote manager gathers and transfers measurements from multiple motes to the mini field agent. Up to 100 motes can communicate to the mote manager.



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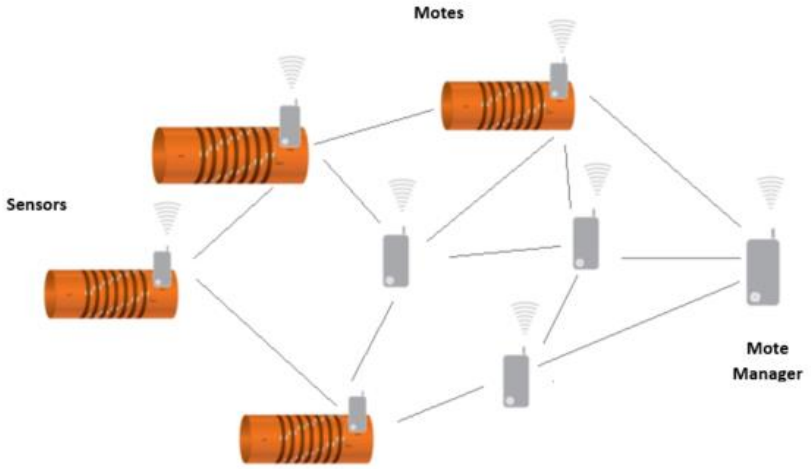
Wireless Communication and Data Acquisition

Making a mesh network. Within a mesh network, every device can communicate to the mote manager either directly or via one or more other devices in the network.

The mote managers powered via Power Over Ethernet, and hard wired with an Ethernet cable to the Mini Field Agent.

The mini field agent orders the motes through the mote manager to wake up and take measurements and sends the data to the Predix Cloud.



The system operates a private, segregated wireless mesh network for sensor data collection. It is not required to be integrated into existing wireless deployments, and does not interfere with site standards adoptions

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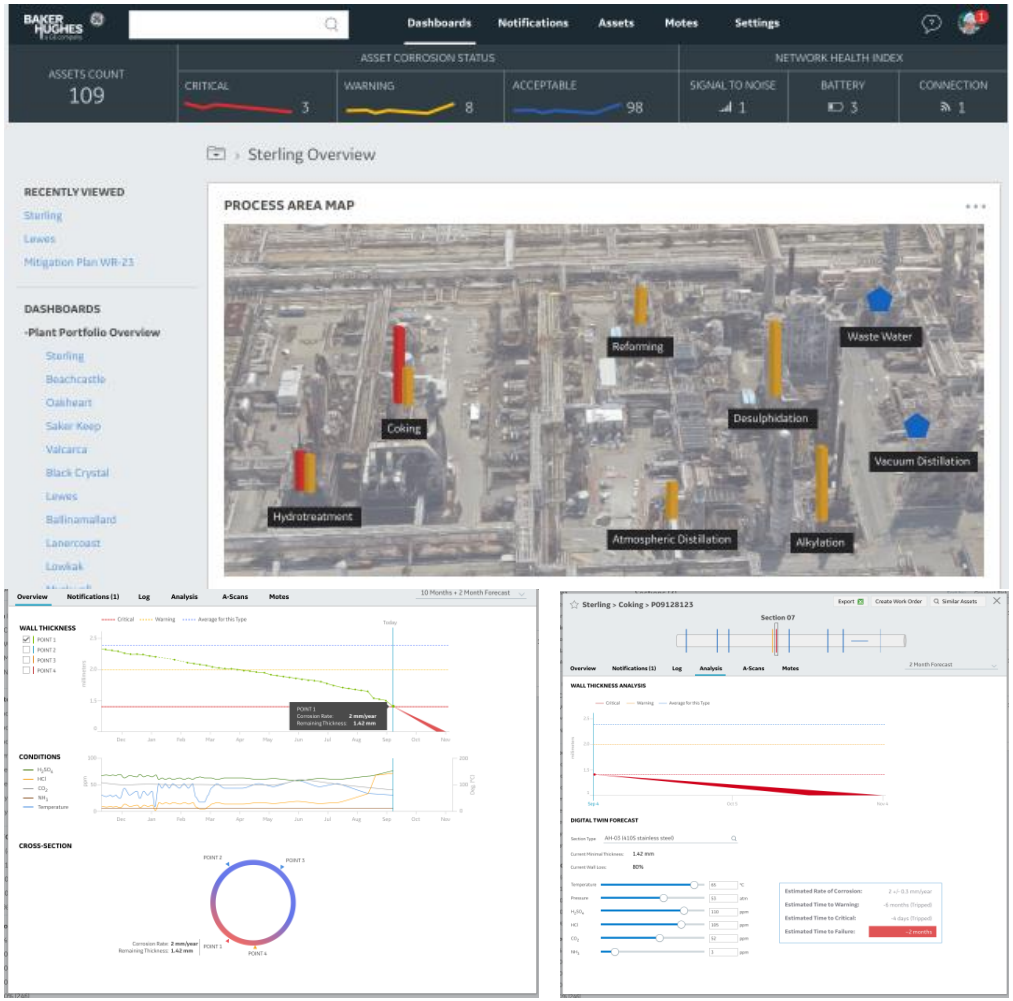
Data Analysis Software

The sensors are continuously collecting interior piping wall thickness and temperature readings, and feeding them into the cloud-based software.

- Geo-spatial view – see your assets in real-time
- Plant summary with areas of concern.
- Te full A-scan UT data and calculated thicknesses
- Data analysis, reporting and exporting
- Remote control, automatic scheduling
- Diagnostic review of Hardware.
- Temperature adjusted thickness readings



Data Analysis Software

This information will improve the reliability of inspection data, and enables users to trend and predict piping failures due to corrosion. The result is enables asset owners to extend the life of piping assets across a facility

Application: Wide variety of crudes with varying acid/ Total Acid Number (TAN) content result in rapid, unpredictable wall loss; The solution contributes to early detection of accelerated wall loss

- Heavy crude vacuum heater line
- Distillation unit headers
- Flow headers

Application: Sand in crude can cause significant unpredictable erosion at T-junctions; alarm triggers at minimum thickness level; The solution can eliminate the need for periodic manual UT measurements

Heavy Crude Heater Outlet Line

Value Staircase

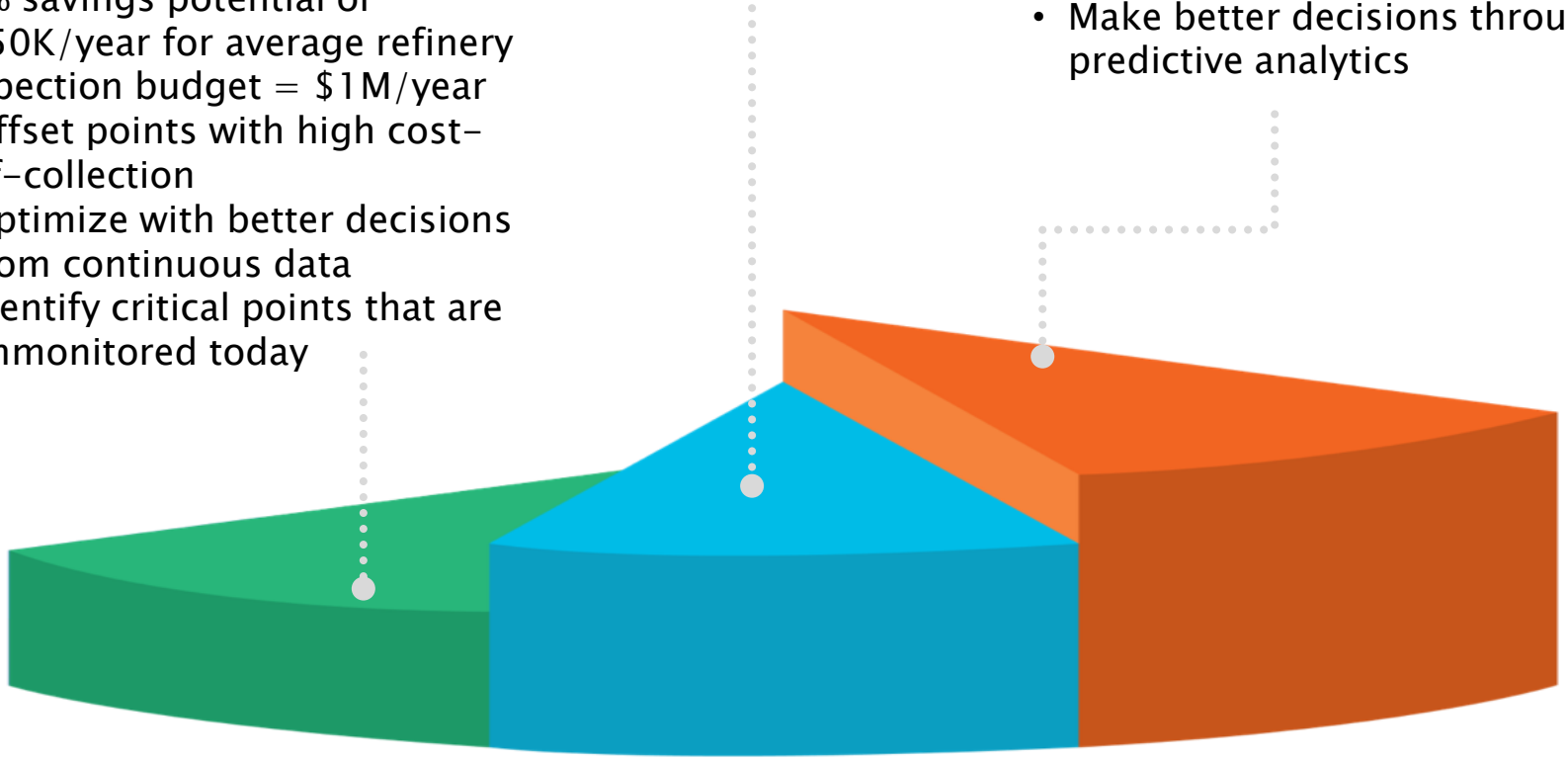
Improve asset performance:
15% asset life extension potential, through better maintenance and the identification of equipment that may need modification to its operating profile or chemical treatments.

Optimize process/operations:
15% improvement in process efficiency

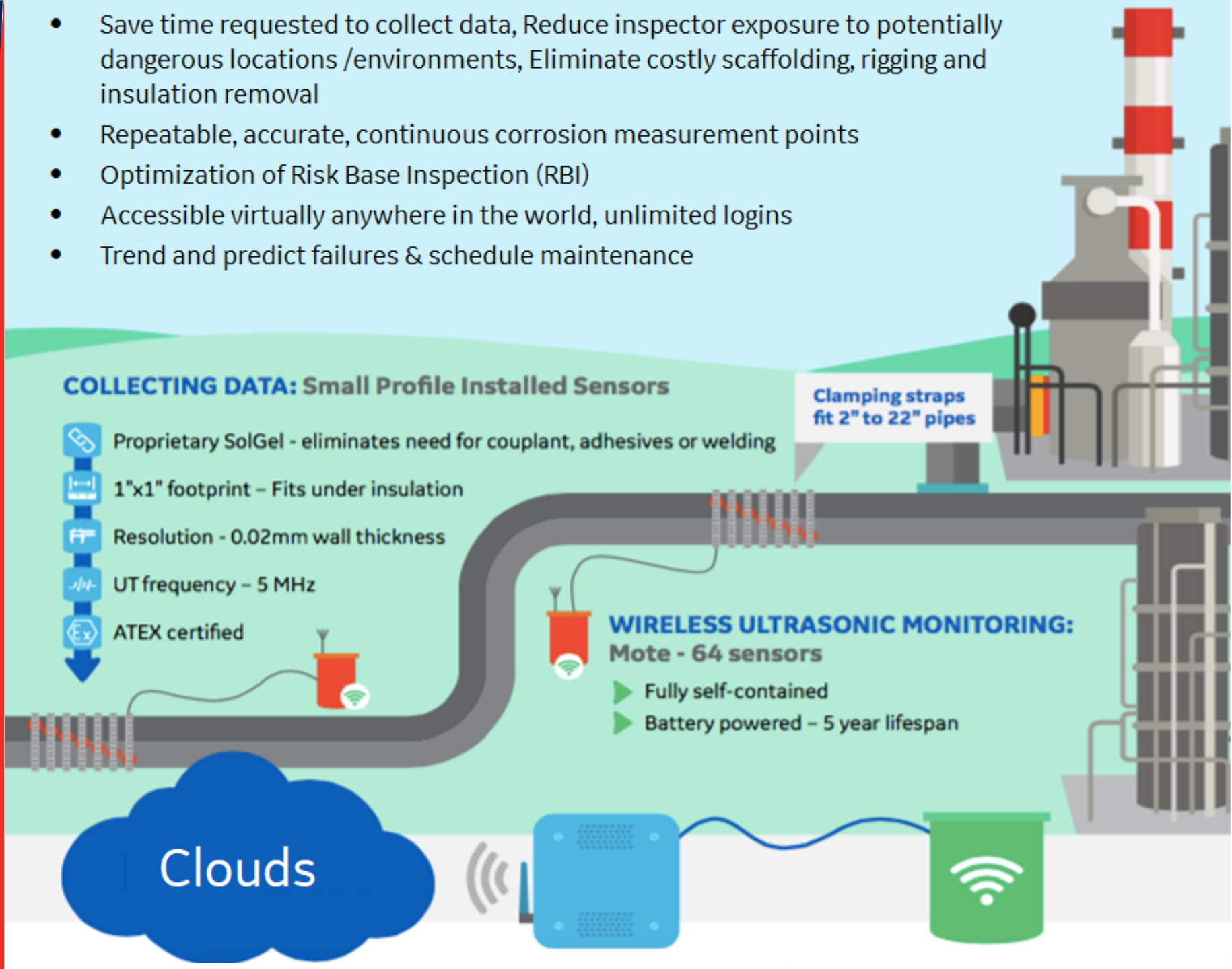
- Extend run-times
- Optimize corrosion inhibition
- Make better decisions through predictive analytics

Decrease inspection costs:
25% savings potential or $250K/year for average refinery inspection budget = $1M/year

- Offset points with high cost-of-collection
- Optimize with better decisions from continuous data
- Identify critical points that are unmonitored today



- Save time requested to collect data, Reduce inspector exposure to potentially dangerous locations /environments, Eliminate costly scaffolding, rigging and insulation removal
- Repeatable, accurate, continuous corrosion measurement points
- Optimization of Risk Base Inspection (RBI)
- Accessible virtually anywhere in the world, unlimited logins
- Trend and predict failures & schedule maintenance



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Thank you

Q&A

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