

A low-angle photograph of a complex industrial facility, likely a refinery or chemical plant, featuring tall cylindrical towers, a dense network of yellow-painted pipes, and metal walkways with railings against a clear blue sky. A semi-transparent blue circle is overlaid on the left side of the image.

The Era of Corrosion Monitoring

Dr Prafull Sharma – CTO, Co-Founder & Inventor

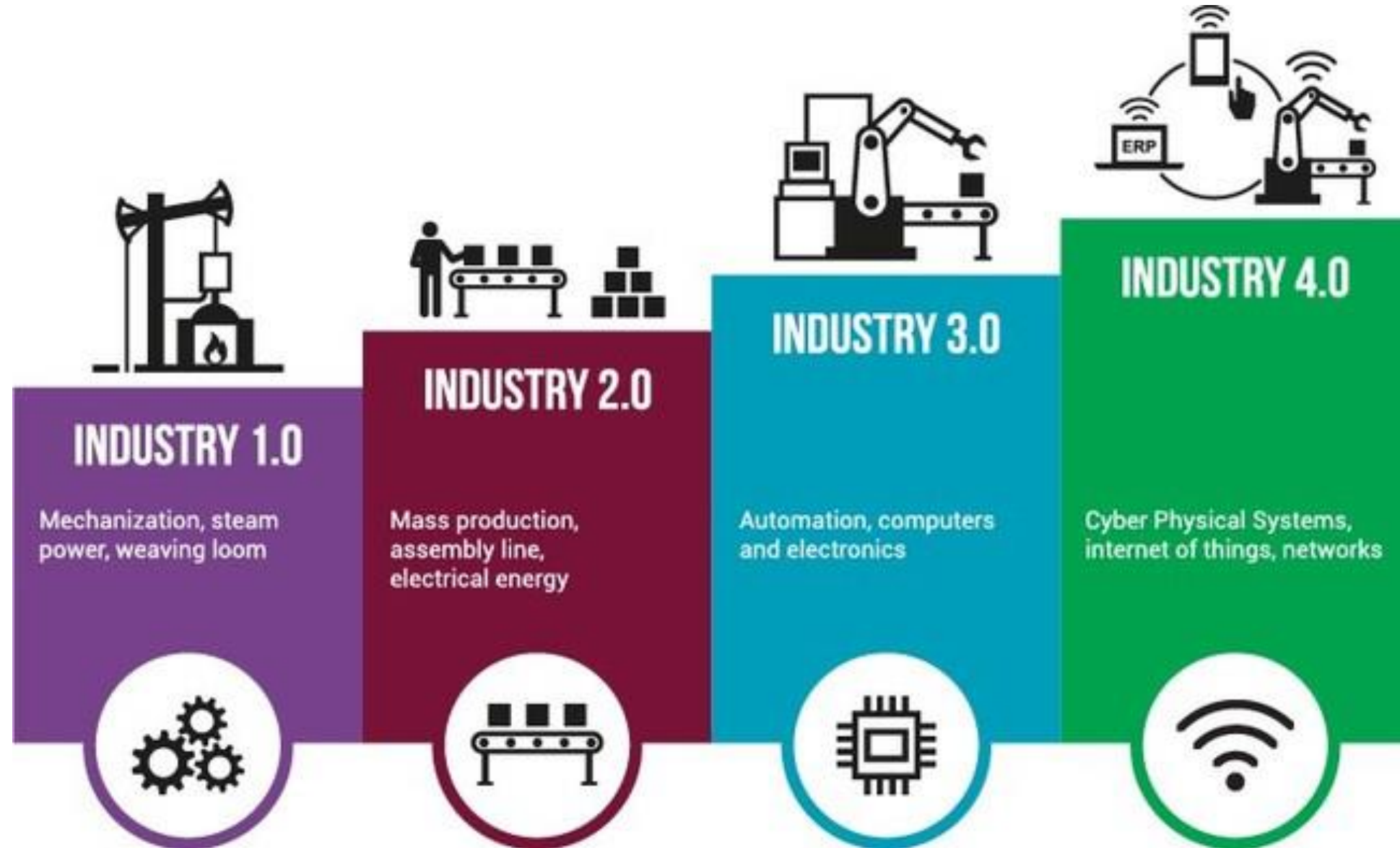
1. Industry 4.0
2. Predictive Maintenance - Opportunity
3. What is Industrial IOT
4. Examples in Corrosion Management
5. CUI Monitoring examples
6. The Business case





Industry 4.0





WARBY PARKER
eyewear

Casper

wayfair

amazon



TESLA

NETFLIX

Digital leaders own asset productivity

- Assets are significantly more efficient
- Create a compelling user experience
- Develop a robust ecosystem
- The software is a vehicle for value creation



Retail

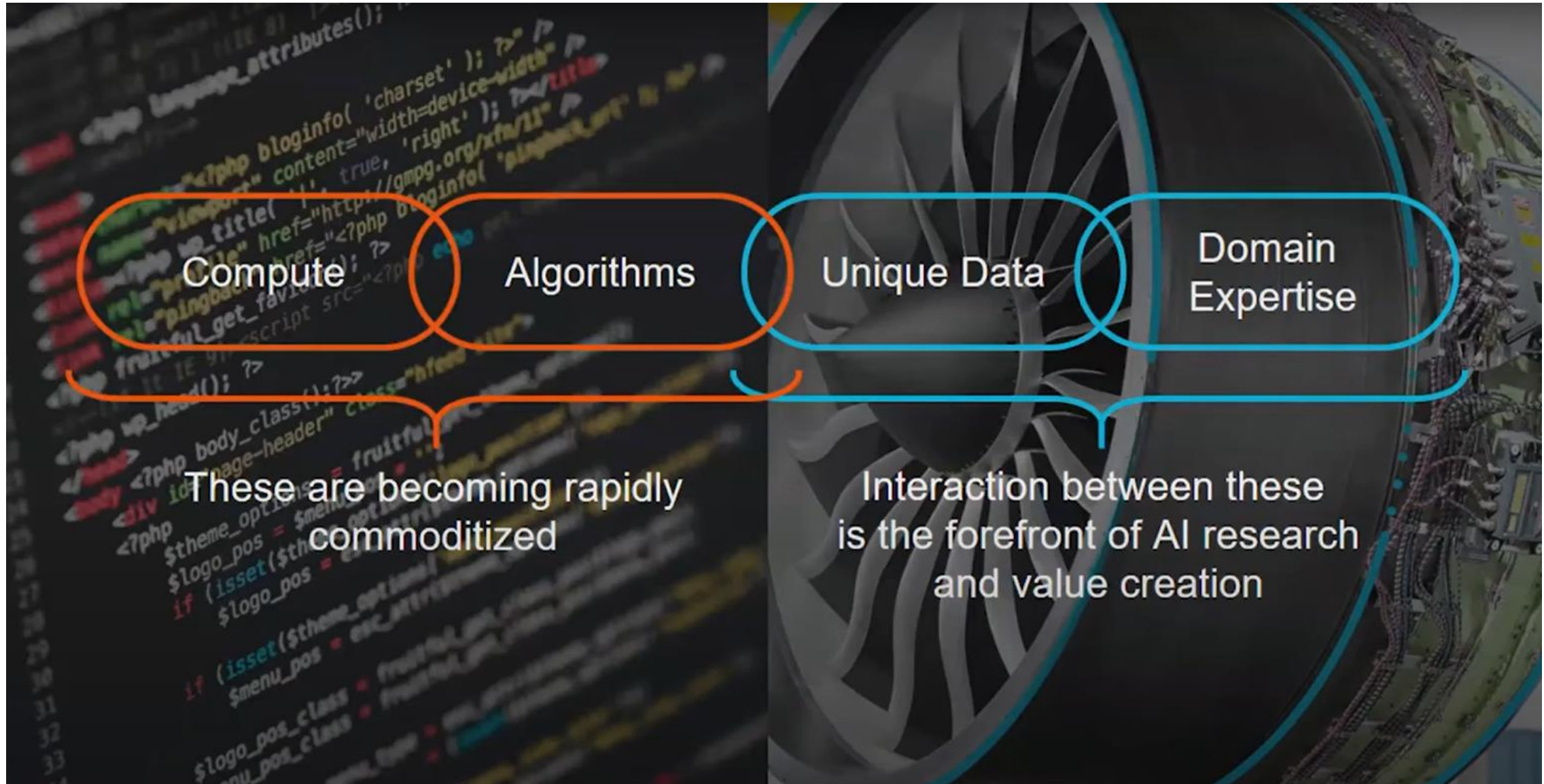
Telco

Entertainment

Automotive

Industrial

Domain Expertise + Unique Data will create value



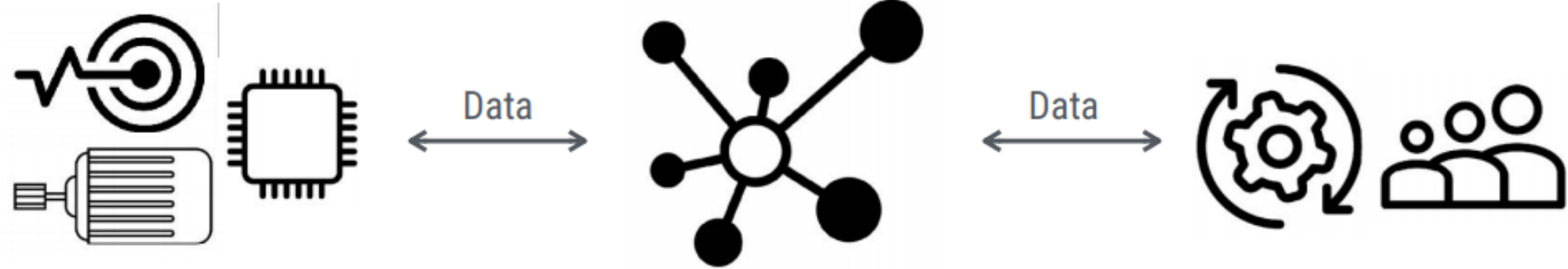


Industrial Internet of Things (IIOT)



What is IIOT

THINGS, CONNECTIVITY AND PROCESSES



Things

(Sensors, actuators, MCU/MPU, network, energy, firmware)

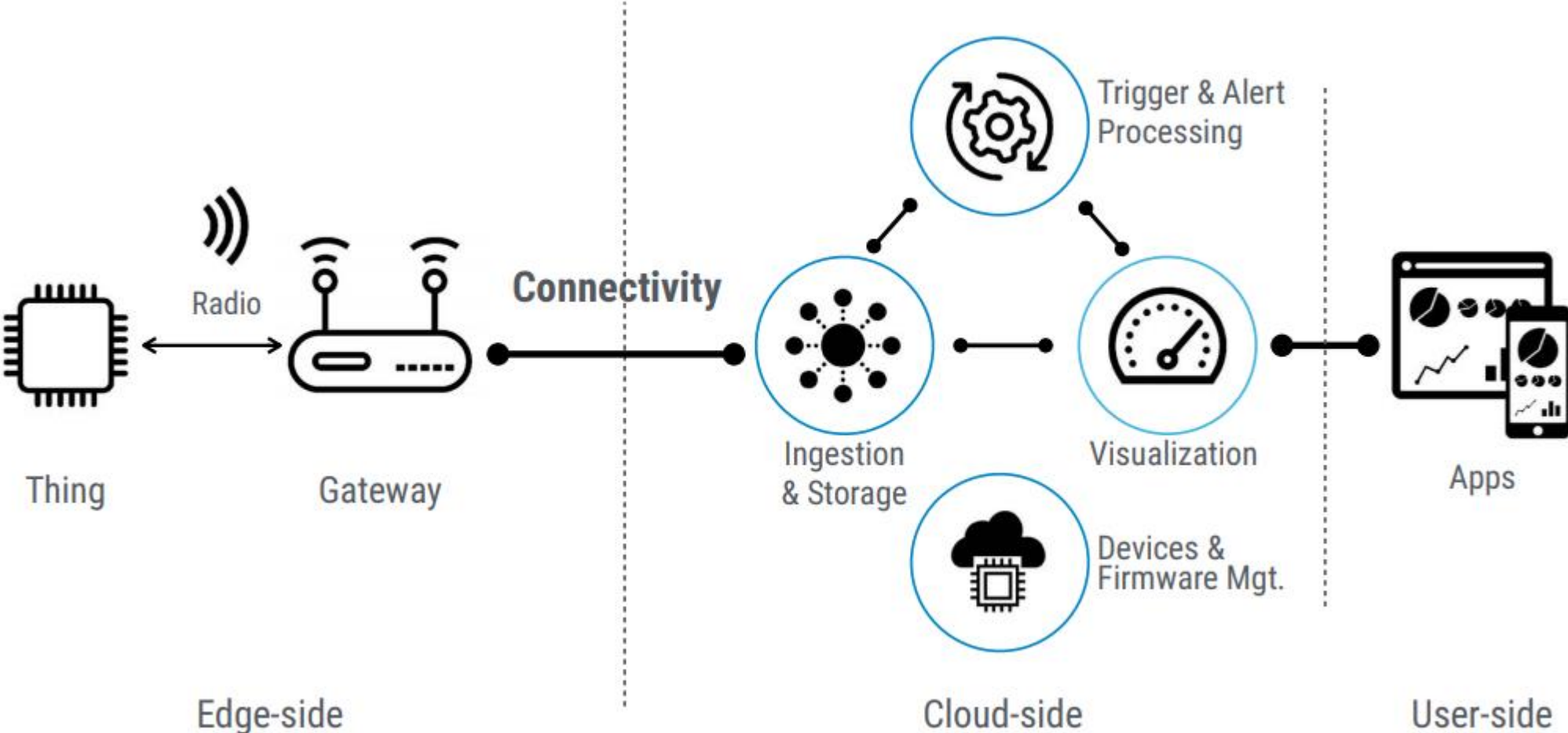
Connectivity

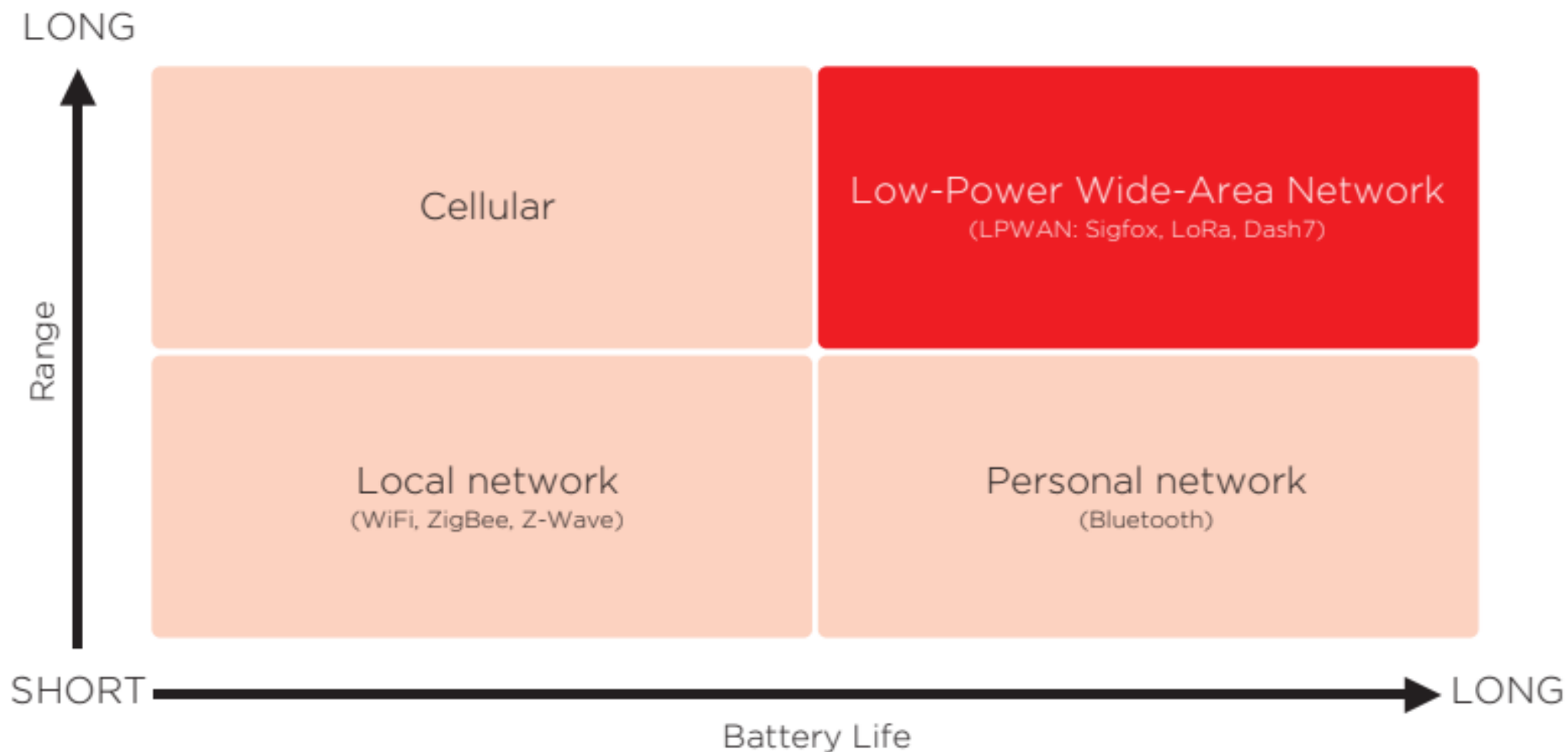
(PAN, LPWAN, Cellular)

People & Processes

(IoT Cloud, Machine Learning, AI)

Core components of IIOT

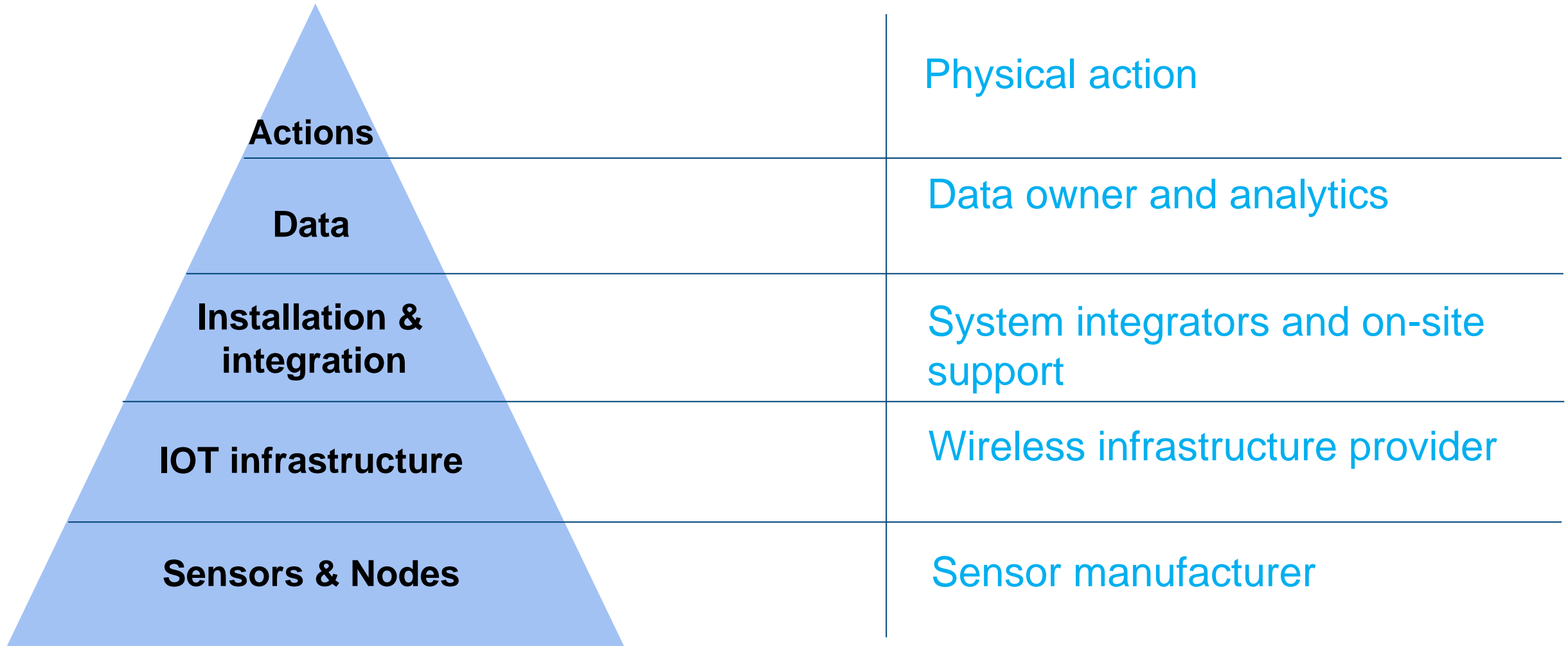




End-To-End Solution Needs Collaboration



Several Parties need to collaborate together for a complete solution





Application to Predictive Maintenance



IOT ANALYTICS

New Research – June 2019

Insights that empower you to understand IoT markets

Predictive Maintenance initiatives saved organizations \$17B in 2018

GLOBAL ANNUAL COST AVOIDANCE

Global Predictive Maintenance Savings

\$17B

2018

\$188B

2024

Driven by parallel advances in many fields, namely:

- Advanced sensing technologies
- New Connectivity options
- Improved IoT architectures
- Cutting edge data science, machine learning & artificial intelligence techniques

REPORT HIGHLIGHTS

- Vendor explosion.** The number of PdM vendors has doubled in 2 years (182 known vendors today)
- Maturing market.** Many projects are starting to scale – some companies now beyond 100k assets
- Increasing role of analytics.** Sophisticated analytics now make up a larger share of the overall PdM budget
- Continued market growth.** PdM Market in 2018 reached \$3.3B, will grow 39% to \$23.5B by 2024.
- Shifting challenges.** Challenges have shifted from being data model-related to data quality and people-related

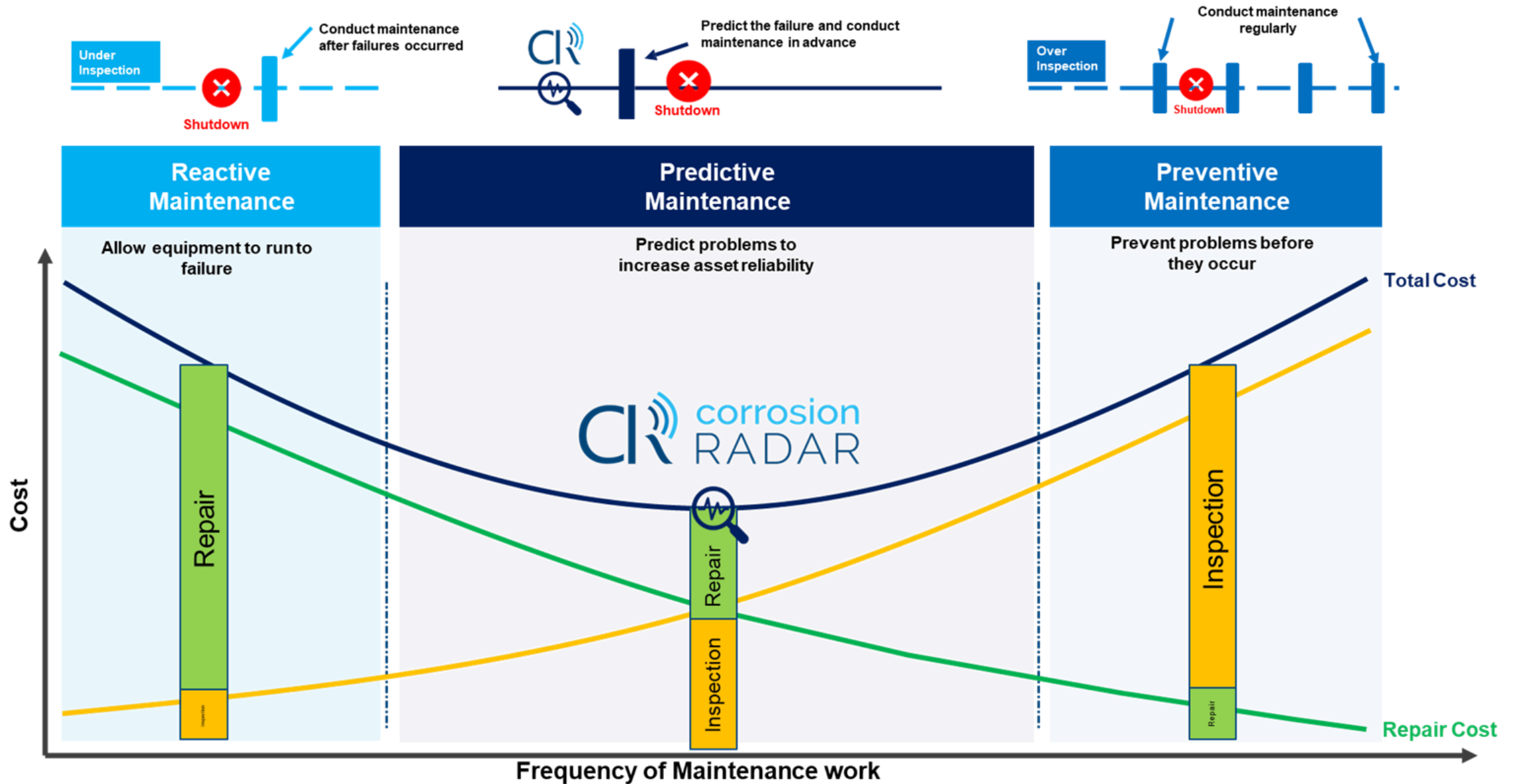
The graph plots Maintenance Costs (Y-axis, LOW to HIGH) against Level of Maintenance (X-axis, LOW to HIGH). It shows three curves: 'Total Maintenance Cost' (U-shaped), 'Lost Production, caused by failures and maintenance' (U-shaped), and 'Cost of Repairs' (increasing). The 'Optimum' level is where Total Maintenance Cost is minimized. A 'Maintenance Budget' line is shown, and 'Predictive Maintenance helps companies reduce their total maintenance costs' is noted.

Source: IoT Analytics– June 2019 – New market report publication: **Predictive Maintenance Market Report 2019-2024**

Predictive Maintenance (Reduce Cost and Risk)



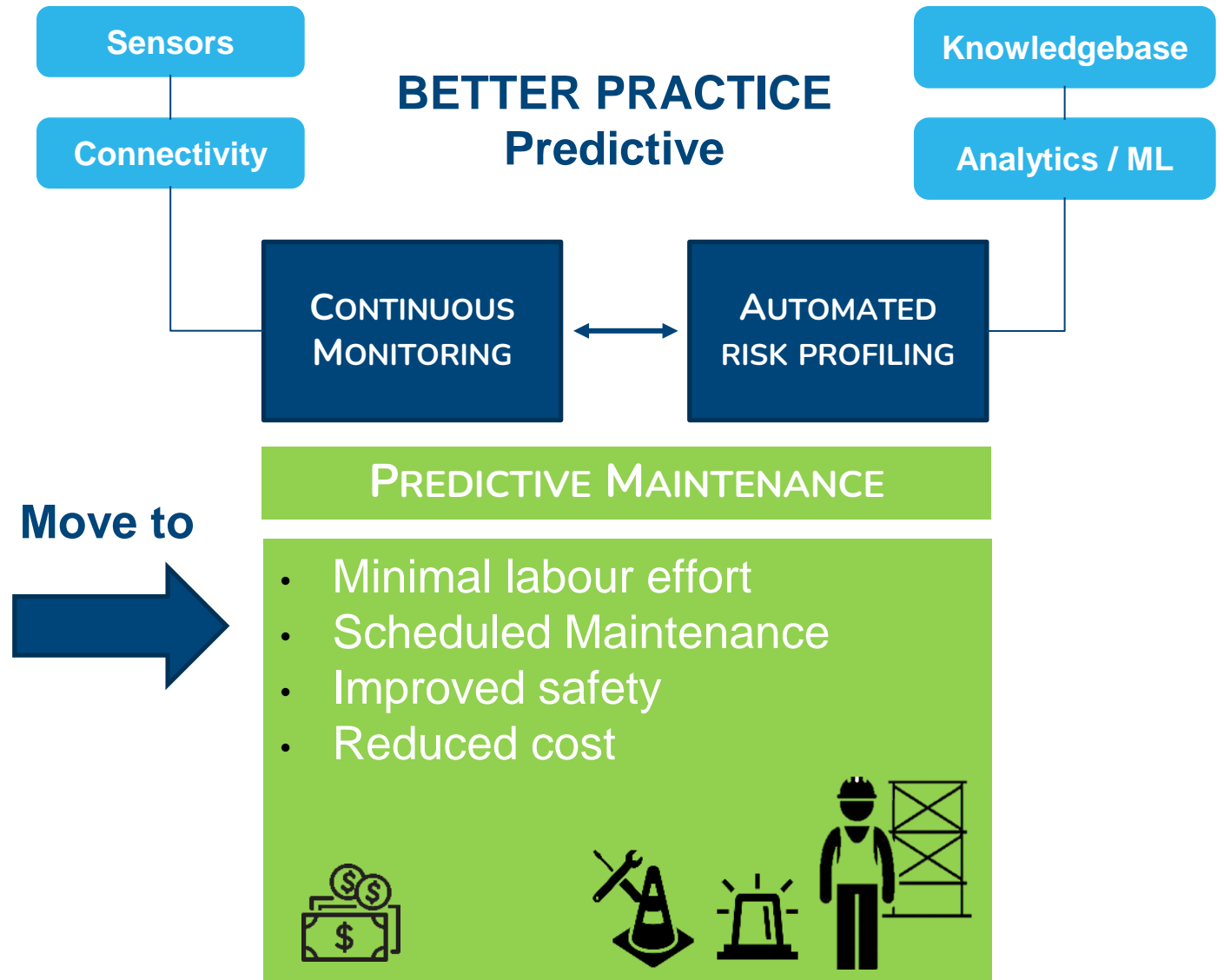
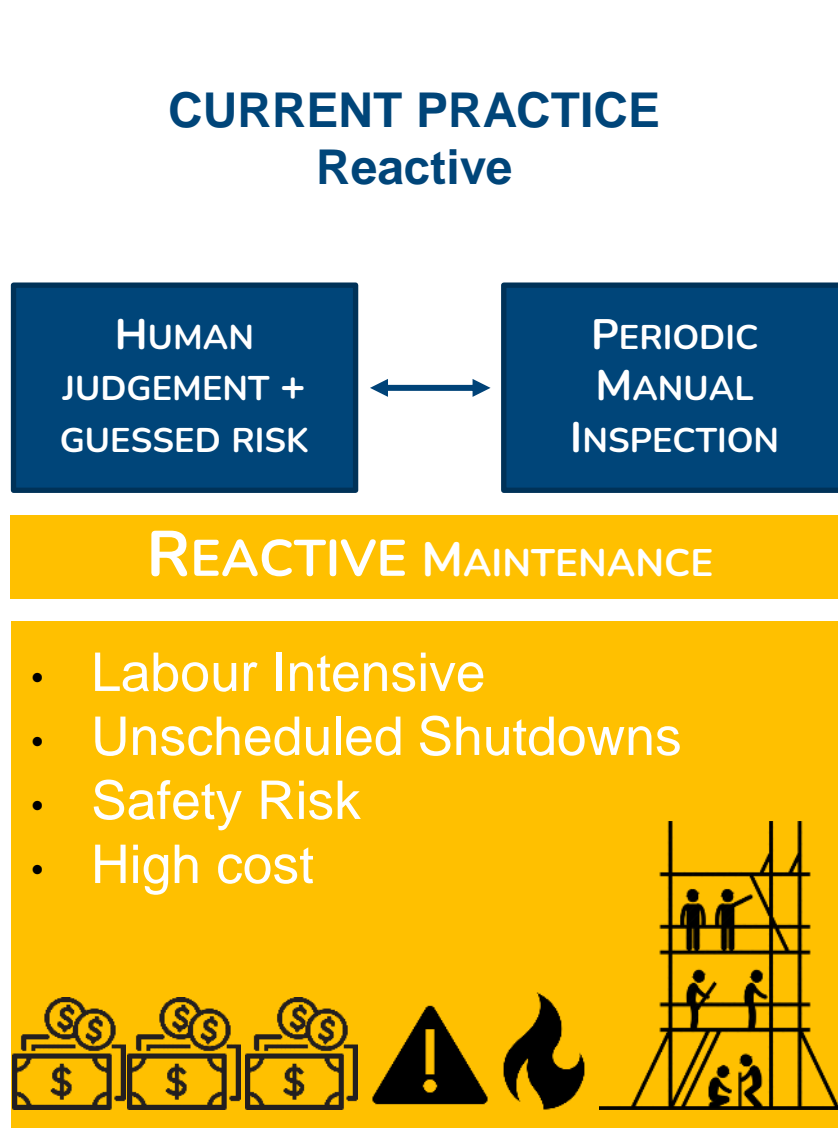
OPTIMISATION OF INSPECTION AND MAINTENANCE



Predictive Maintenance



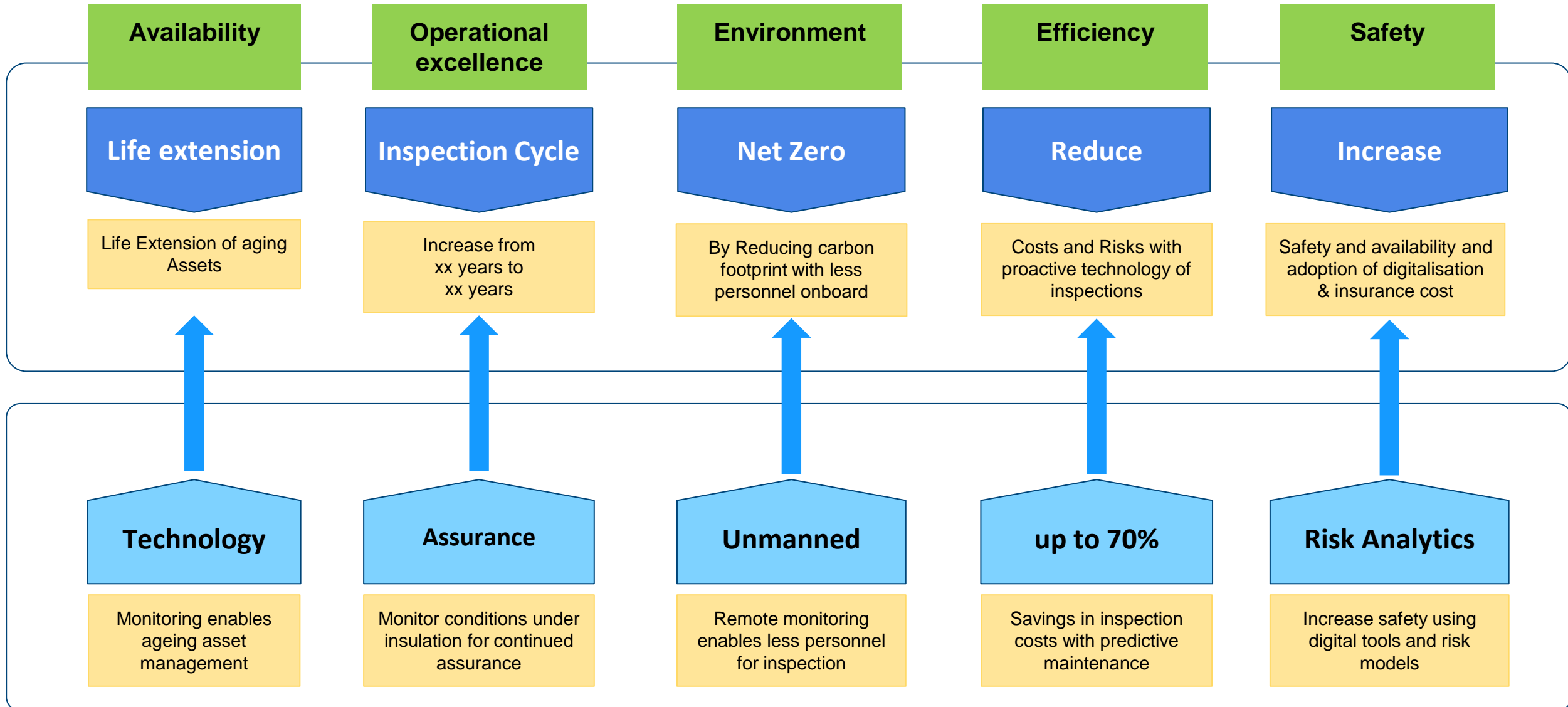
ENABLED BY MONITORING AND PREDICTIVE ANALYTICS



Move to

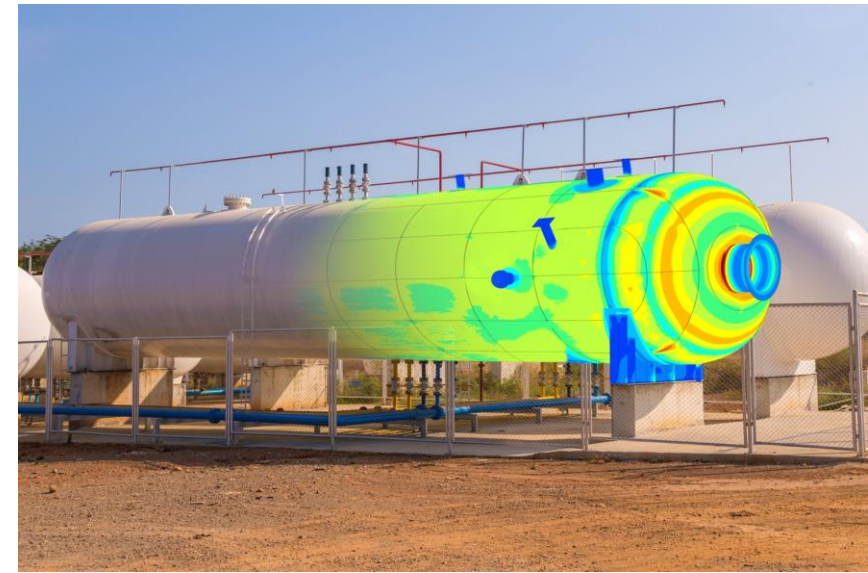
Some Benefits of Predictive Maintenance

AND MANY MORE

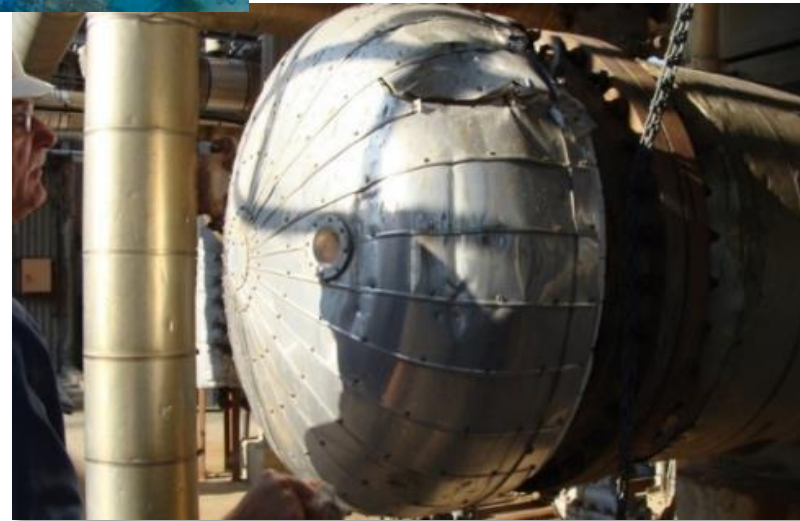




Example Corrosion Risk Monitoring



Corrosion - The biggest failure mechanism



From Inspections to Monitoring



Inspection 1.0

Manual observation,
Leaks



Inspection 2.0

Visualisation,
NDT instruments



Inspection 3.0

Statistics, RBI

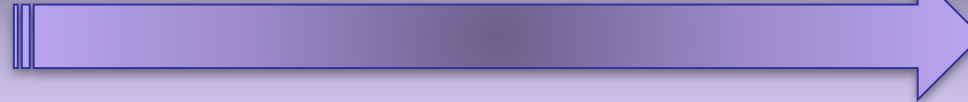


Inspection 4.0

IIOT, Automated,
Analytics, Prediction



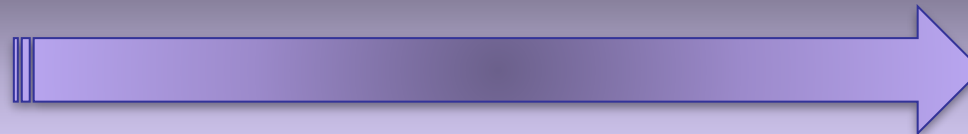
Manual



Automated



Detection



Prediction



Reaction



Prevention





Example CUI Risk Monitoring



NACE Corrosion 2021
MP Innovation of the year
National Association of Corrosion Engineers
International

Example - Corrosion Under Insulation (CUI)

CUI IS AMONG THE BIGGEST ASSET INTEGRITY THREATS

CUI is among top asset integrity issue in O&G and Petrochemicals

Upto **60%** of all pipeline failures are due to CUI globally

Upto **10%** of the overall plant maintenance cost in O&G globally

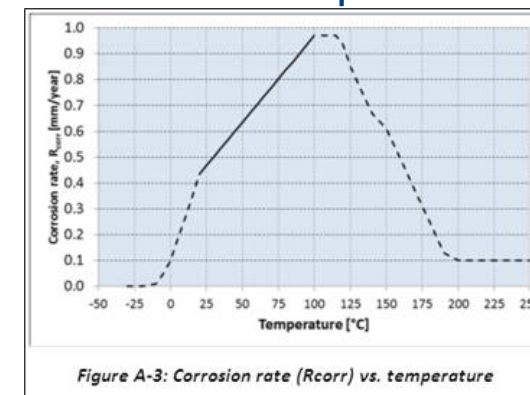
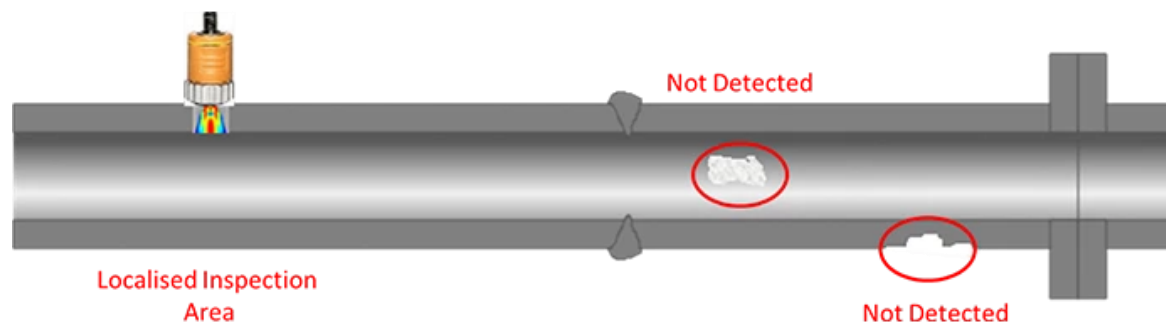
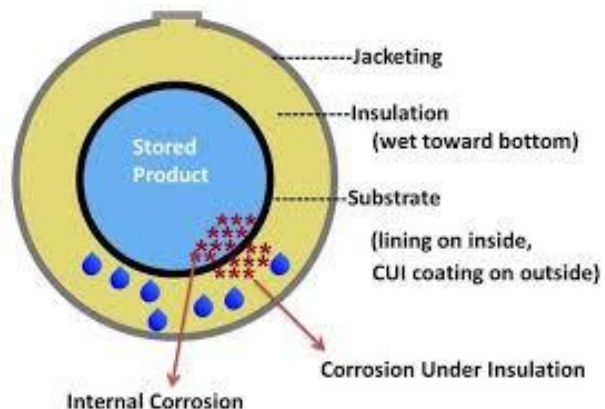


How CUI happens

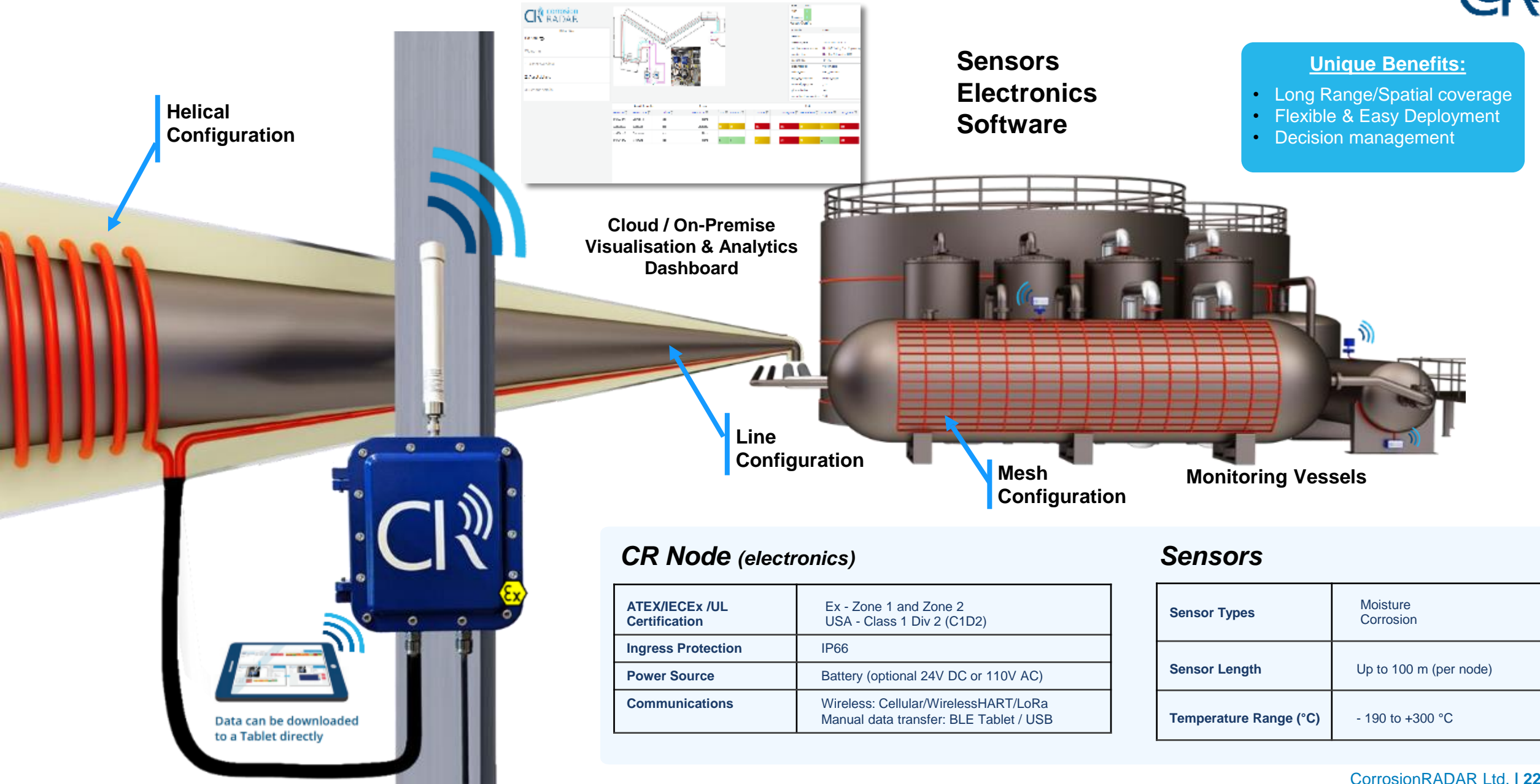
Water ingress into insulation

Unpredictable location

Suitable temperature



CUI Risk Monitoring system with Moisture and Corrosion Sensing



Helical Configuration



Cloud / On-Premise Visualisation & Analytics Dashboard

Sensors
Electronics
Software

- Unique Benefits:**
- Long Range/Spatial coverage
 - Flexible & Easy Deployment
 - Decision management

Line Configuration

Mesh Configuration

Monitoring Vessels

Data can be downloaded to a Tablet directly

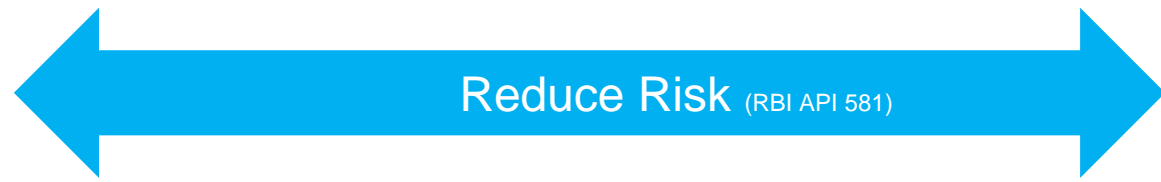
CR Node (electronics)

ATEX/IECEX /UL Certification	Ex - Zone 1 and Zone 2 USA - Class 1 Div 2 (C1D2)
Ingress Protection	IP66
Power Source	Battery (optional 24V DC or 110V AC)
Communications	Wireless: Cellular/WirelessHART/LoRa Manual data transfer: BLE Tablet / USB

Sensors

Sensor Types	Moisture Corrosion
Sensor Length	Up to 100 m (per node)
Temperature Range (°C)	- 190 to +300 °C

Optimisation of CUI Risk and Inspection Scoping



Site Survey
Select assets with high risk

System Installation
Hardware and Software

Remote Monitoring
Detection and Localisation

Risk Analytics
Software modules

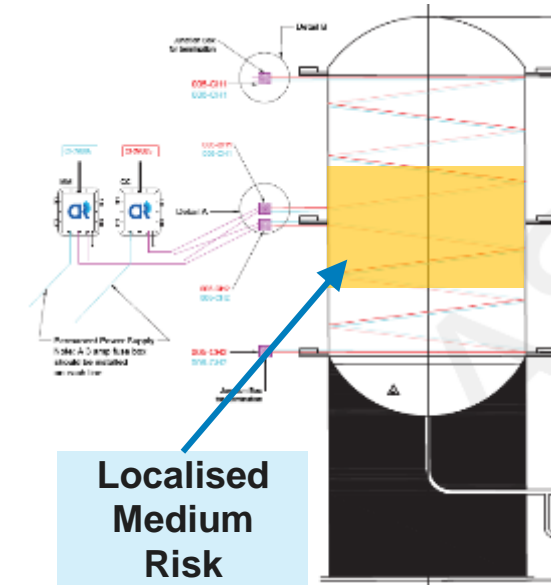
Inspection Scoping
Inspection only when and where needed

Overall CUI susceptibility

Asset ID	Asset Name	Asset Type	Overall CUI Susceptibility
1	Asset 1	Asset Type 1	High
2	Asset 2	Asset Type 2	Medium
3	Asset 3	Asset Type 3	Low
4	Asset 4	Asset Type 4	Very High
5	Asset 5	Asset Type 5	Very Low
6	Asset 6	Asset Type 6	High
7	Asset 7	Asset Type 7	Medium
8	Asset 8	Asset Type 8	Low
9	Asset 9	Asset Type 9	Very High
10	Asset 10	Asset Type 10	Very Low



Risk			
SHE	Last Change	Business	Last Change
H	09/11/2021	H	09/11/2021
M	15/01/2021	M	15/01/2021
M	23/02/2021	H	23/02/2021
L	05/04/2020	L	05/04/2020
M	11/10/2020	M	11/10/2020
M	01/09/2020	M	01/09/2020
L	09/08/2019	L	09/08/2019

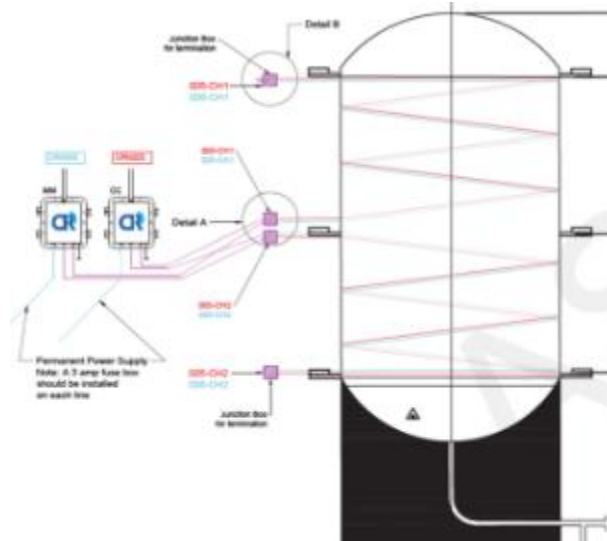


Dryer Monitoring Solution – Risk Reduction



INTERMITTENT TEMPERATURE SERVICE

Dryer (Molecular Sieve absorption)



Problem

- High CUI risk in Dryers in a petrochemical plant leading to proactive inspection costs

Asset Type

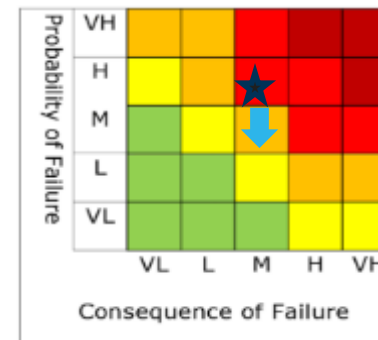
- Molecular Sleeve Dryer
- Cyclical temperatures (-25 DegC to 180 DegC)
- Foamglas insulation

Solution

- 2 units of CUI monitoring system for a dryer

Outcome and Benefits

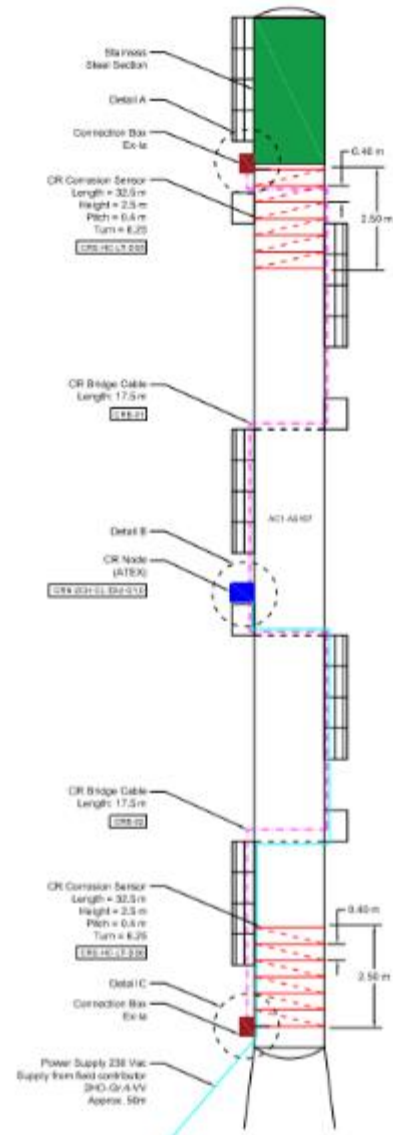
- Risk Reduction in RBI (High to Medium)
- Inspection frequency to increase from 5 yrs to 7 yrs
- 1 month extra production + saving of ~\$100k in an inspection cycle



ROI
61% Savings

Column Monitoring Solution – Inspection optimisation

PRODUCTION COLUMN CORROSION MONITORING TO INSPECTION WHEN AND WHERE NECESSARY



Problem

- High scaffolding + labour costs of > \$1M
- Regulatory requirements & proactive inspection cycles of 6 years

Asset Type

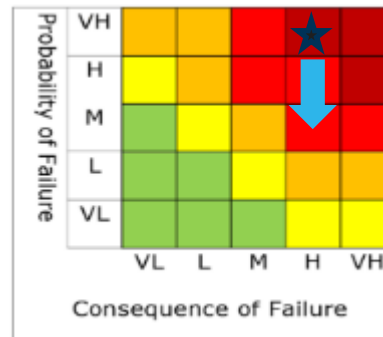
- Production Column
- CUI temperature range zones (90 DegC to 180 DegC)
- Hot insulation and no coating

Solution

- 2 units of CUI monitoring systems

Outcome and Benefits

- Risk Reduction in RBI (Very High to High)
- Inspection optimisation to zones only with risks
- Scaffolding to rope access leading to cost savings

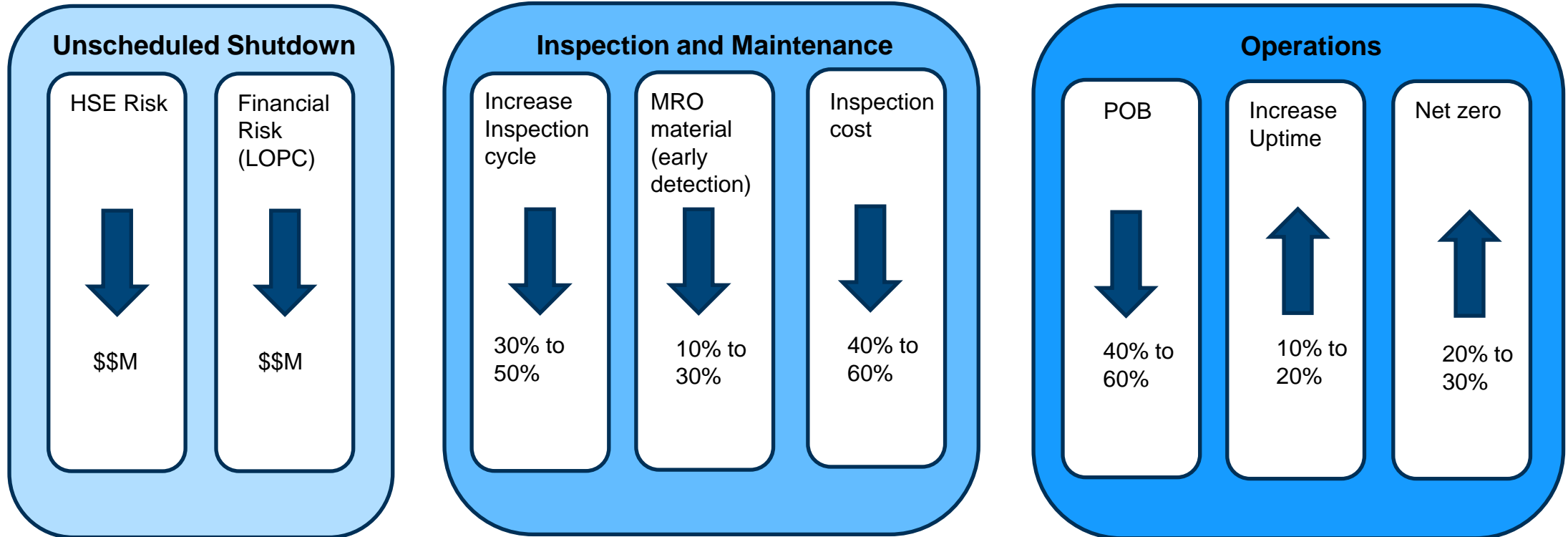


ROI
55% Savings

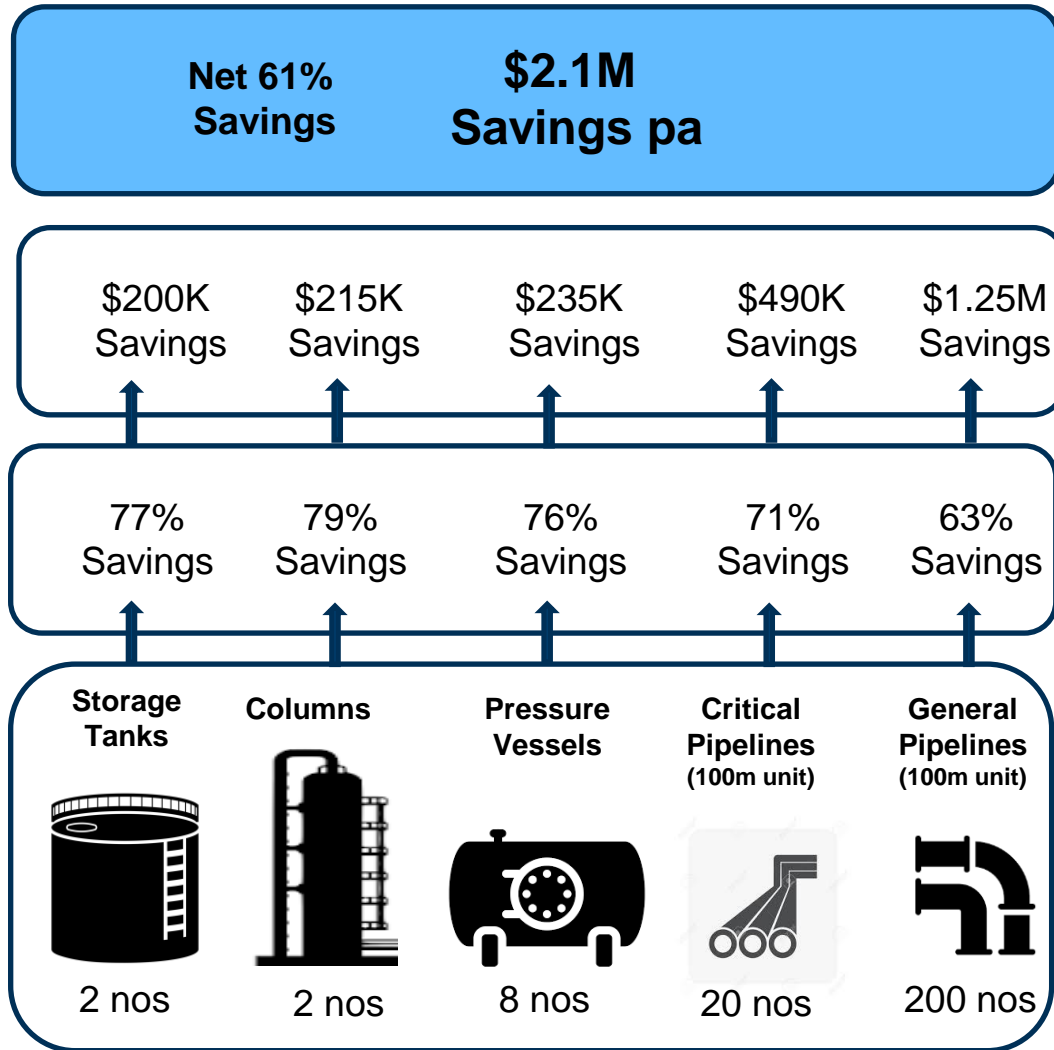


The Business Case

CR Savings and Benefits – example

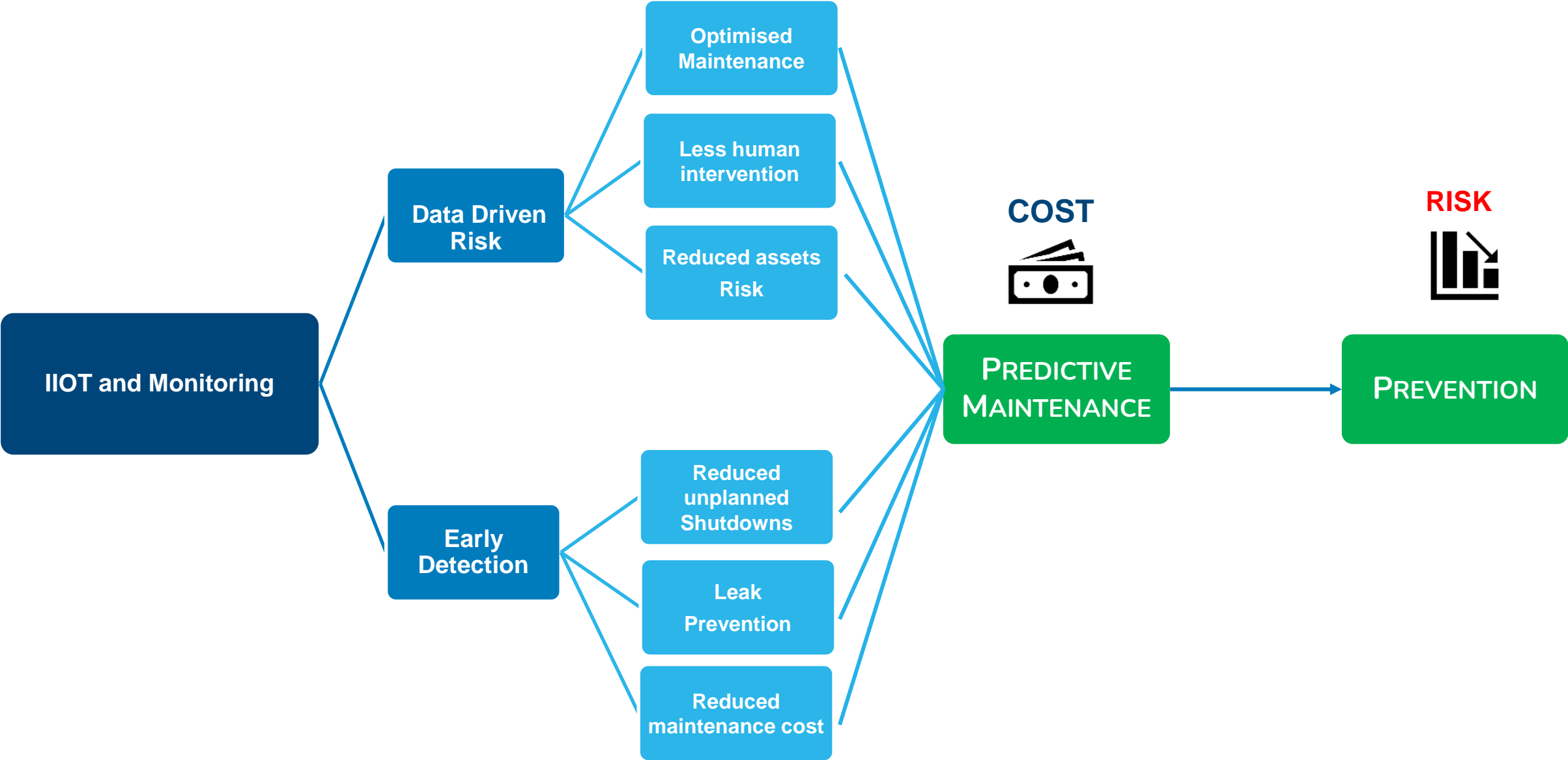


Example ROI - A PLANT WITH ~\$3.5M ANNUAL CUI COST



Inspection Tasks	No Monitoring	With CUI Monitoring
Scaffolding Per year	\$1.5M	\$0.48M
Insulation Per year	\$1.3M	\$0.42M
Other Costs Per year	\$0.7M	\$0.23M
CR cost	Nil	\$0.27M
TOTAL CUI COST	\$3.5M	\$1.4M
Net Saving	Nil	\$2.1M
Net Saving %		61%

Benefits of IIOT For Predictive Corrosion Management



- **New infrastructure in the era of Industry 4.0**
- **Predictive Maintenance - A big opportunity**
- **Industrial IOT - Enabling Predictive Maintenance**
- **Predictive Corrosion Management is a big IIOT application**
- **CUI Monitoring examples and case studies**



Thank You

Q & A