Realizing the IoE Opportunity with IoT

ASEAN Internet of Things Forum

IoE and IoT
Regional Forum

Plant Modernization with Pervasive Sensing™ Infrastructure

A Second Layer of Automation for Aging Plants to Meet New Demands – Without Changing the DCS

- Jonas Berge

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http://www.theguardian.com/sport/2015/mar/23/fernando-alonso-sensor-mclaren-malaysian-gp-f1

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Fernando Alonso

Fernando Alonso has special sensor fitted for Malaysian Grand Prix

- McLaren expect Spanish driver to be on F1 grid at Sepang
- Team still searching for reasons behind Alonso's test crash
- Alonso flown to hospital after crash in F1 testing

Paul Weaver

Monday 23 March 2015 20.25 GMT

Fernando Alonso's McLaren will be fitted with a special sensor when he makes his first appearance of the season in Sunday's Malaysian Grand Prix.

The device will help McLaren in their investigation into what caused Alonso's accident in testing and in particular the driver's complaint that the steering was "heavy" immediately before he left the track at the Circuit de Catalunya.

Most popular

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Everything Is Getting More Sensors

Our Parents' Car

- Four sensors
- Hardwired
- The data went to the driver
  - Mechanic had to make his own measurements

Modern Car

- 60-100 sensors
- Digitally networked
  - Bus
  - Wireless
- Simple status to driver
  - Detailed diagnostics data to the mechanic

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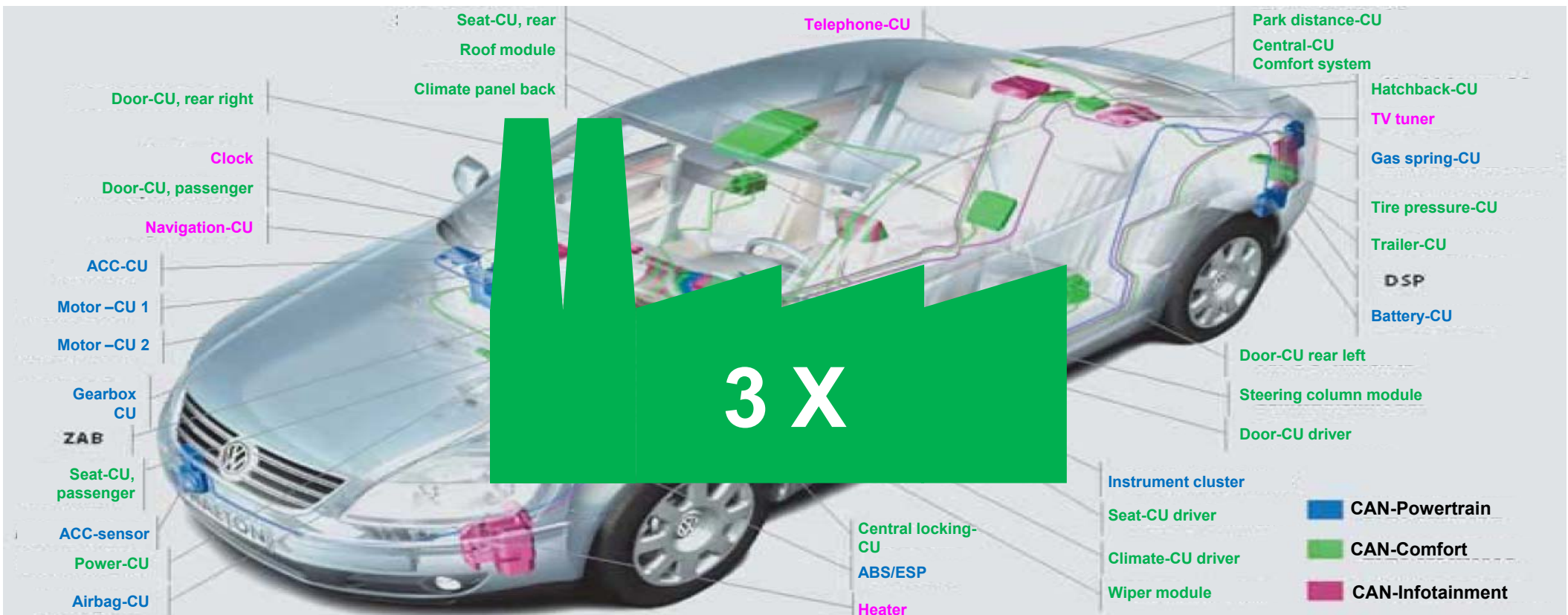
Pervasive Sensing for Smarter Cars - Dramatically More Sensors Everywhere

- More reliable
- More fuel efficient
- Environmentally friendlier
- Safer

CAN bus. OBD-II



Two Systems

Driver

- Only information required for safe driving
- No needless detail
- Real-time

Mechanic

- Detailed description
- Charts
- Includes proposals for solution

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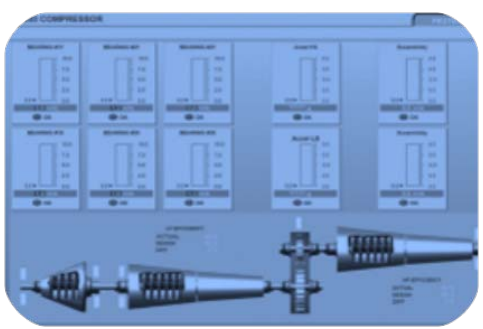
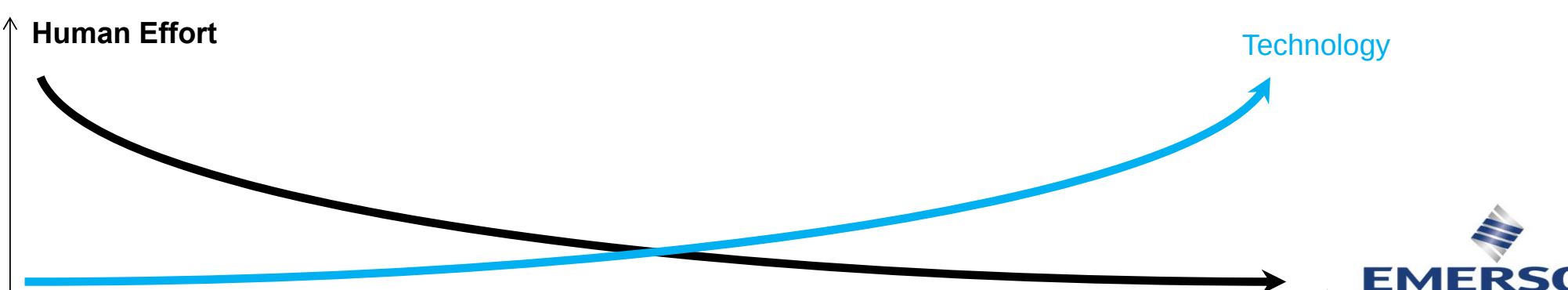
Maintenance – Missing Measurements

- Routine manual inspections
- Continuous automatic monitoring





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Topics Covered

- Missing measurements
  - Reliability & Maintenance
  - Energy Efficiency & Loss
  - Health, Safety, and Environmental (HS&E)
  - Process Operations Productivity
- Infrastructure integration with existing historian and DCS
- Fully automate new plants
  - Beyond the P&ID

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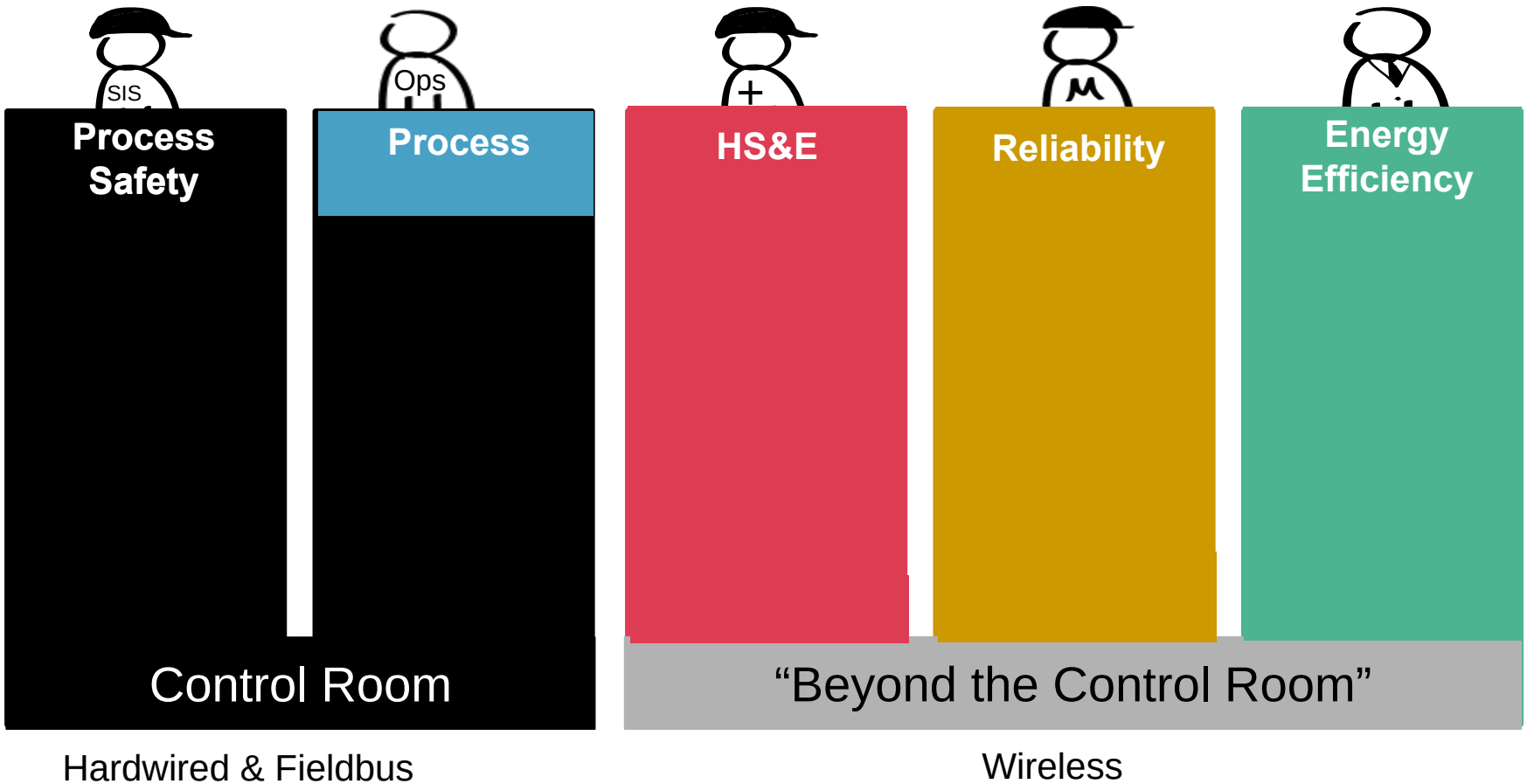
Pervasive Sensing
- More Data Beyond the Control Room



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The Manufacturing Balance Has Changed

It is time to revisit technology justifications

YESTERDAY:

- Cheap Energy
- Cheap Water
- Cheap Waste
- 'Free' Emissions
- Predictable Raw Materials
- Available Talent Pool

- Expensive Controls & Automation Technology
- Expensive Software and IT

TODAY:

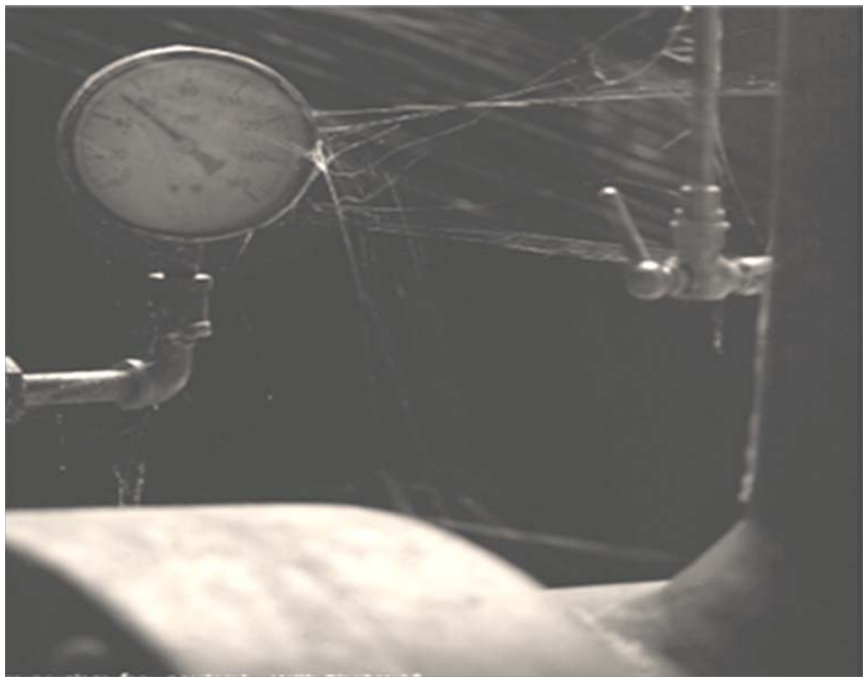
- Energy cost swings
- Water cost rising
- Expensive Waste
- Expensive Emissions
- Unpredictable Raw Materials
- Limited Talent Pool

- Cheap Controls & Automation Technology
- Cheap Software and IT

© ARC Advisory Group

Need to Modernize - Missing Measurements

- Plants are getting old
- Plants were built with minimum instrumentation necessary for operation
- Now pushed to improve
  - Reliability
  - Energy efficiency
  - Reduced maintenance costs
  - Mitigate safety and environmental incidents
  - Productivity
- This requires more automation



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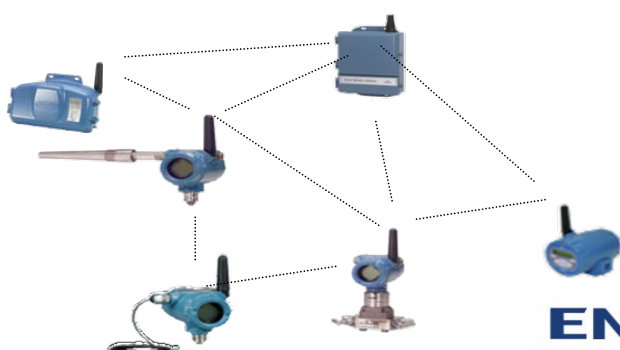
Modernize Existing Plants - Data Beyond the Control Room

- More automation requires more sensors; missing measurements <u>beyond the P&ID</u>
  - Asset monitoring, loss, HS&E, operator rounds,...
- Laying cable has high risk of damaging the plant
  - 4-20 mA wiring for transmitters
  - On-Off wiring for switches
- WirelessHART instrumentation drastically reduces risk: a “second layer” of automation
  - Self-organizing ‘full-mesh’ multi-hop multi-path topology eliminates all cables
  - Pervasive sensing



WirelessHART
Expanding the Possibilities

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Pervasive Sensing
- Non-Intrusive Process Connection

- Low installed cost
  - Clamp-on
  - Strap-on
  - Bolt-on
  - Stick-on
  - Stud
  - Magnetic
  - Slip-in
- Low risk
  - No cut
  - No drill
  - No weld

Slip-in

Bolt-on

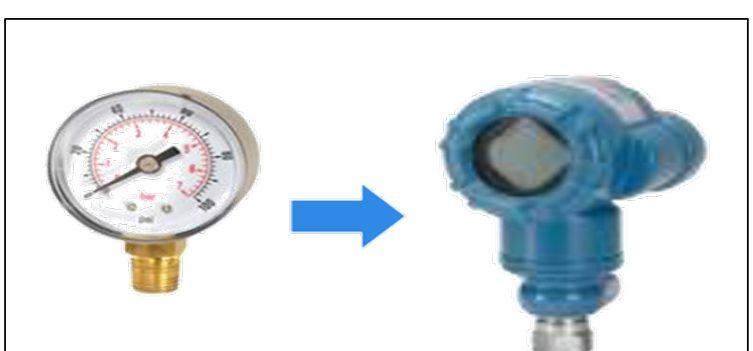
Bolt-on

Strap-on

Lay

Stick-on
Screw-on
Magnetic

Clamp-on



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Areas of Modernization

WirelessHART is here, where do you want it?

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Reliability, Energy Efficiency, HS&E, and Operations Productivity

Reliability & Maintenance	Energy Efficiency & Loss Control
• Pump • Blower • Air cooled exchanger (fin fan) • Non-process compressor • Cooling tower • Pipe & vessel corrosion • Valve • Instrumentation • Manual vibration, temperature, acoustic data collection	• Steam trap failure • Heat exchanger fouling • Cooling tower fan optimization • Relief valve seat leakage • Unit-wise energy consumption metering: water, air (compressed), gas/fuel, electricity, and steam
Health, Safety, and Environmental (HS&E)	**Process Operations Productivity**
• Emergency Safety shower and eyewash • Manual and bypass valve position • Relief valve and rupture disk release • Shutdown valve position confirmation • Hydrocarbon leak/spill detection • Effluent discharge • Tank farm storage tank	• Operator rounds: gauge, sight glass, VA meter • Tank farm storage tank • Wellhead • Separator and test separator

Modernization
User Guide Available

This not all you can do, just a small subset of common applications. Specific to each industry there are many applications possible. Users have discovered hundreds of unique applications.

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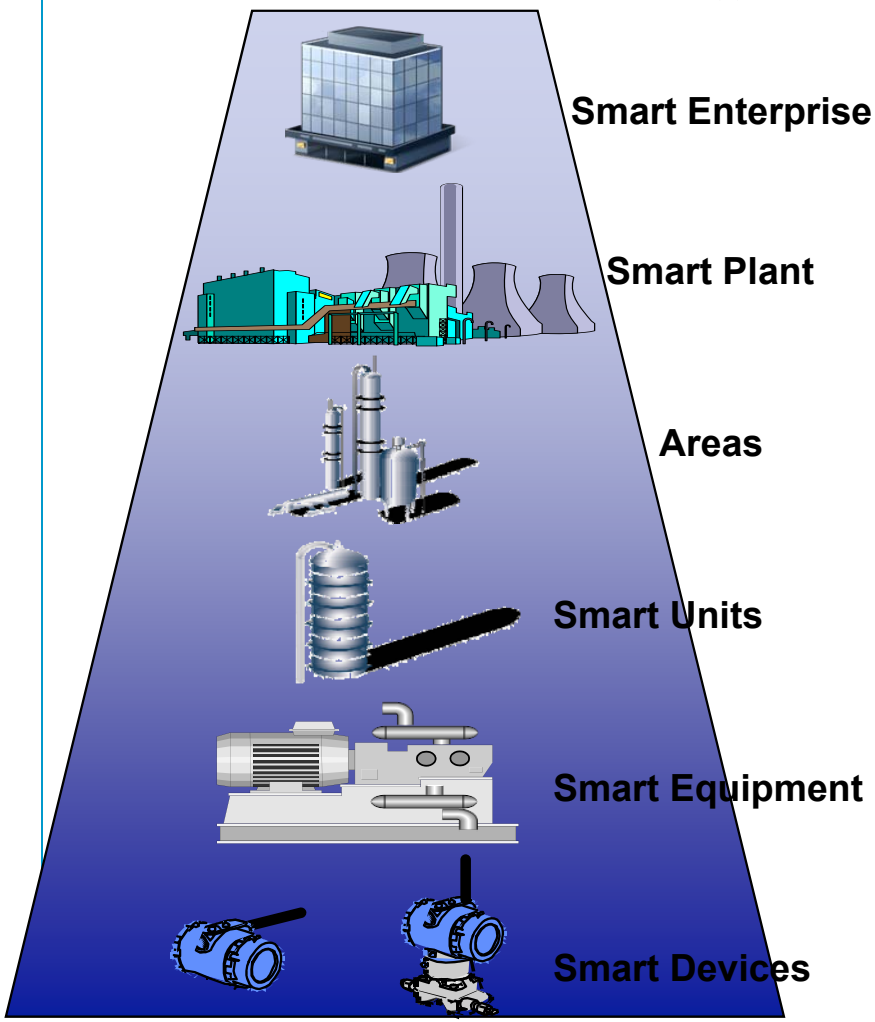
Pervasive Sensing for Smarter Plants



- Smart plants are built from the ground up:
  - Smart instrumentation
  - Smart process equipment
- Smart instruments and smart equipment require a digital network infrastructure
- Smart instruments are well established
- Smart equipment is new

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Reliability & Maintenance

Improve asset reliability and process availability, reduce maintenance cost

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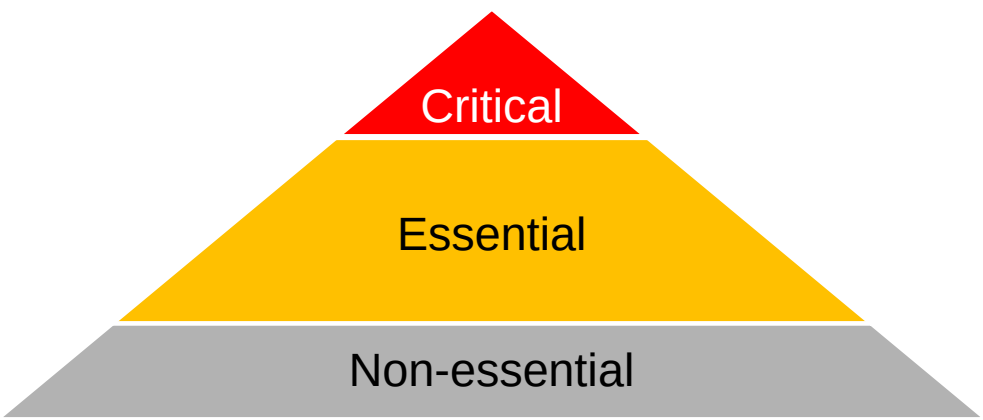
Essential Assets

- Critical assets already have condition monitoring
  - Expensive turbines, process compressors, and large pumps
- Balance of assets are not monitored
  - Many are still essential to operation
- Typically spot-checked periodically
  - Not frequent enough
- Also need condition monitoring

What is the impact on your plant when a pump, blower, or cooling cell fails?



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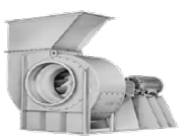
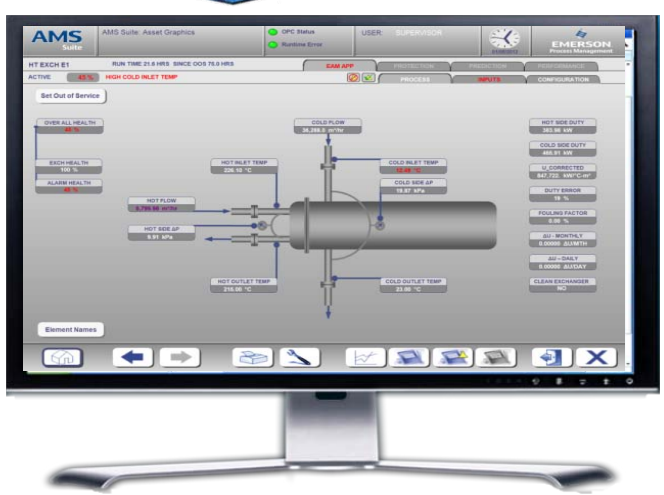
Pervasive Sensing for Reliability - Process Equipment Diagnostics

- Heat exchangers
- Pumps
- Blowers
- Air cooled exchangers (fin fan)
- Non-process compressors
- Cooling towers
- Filters
- Pipes & vessels
- etc.

Pre-engineered packages using WirelessHART and multiparametric software algorithms for smart process equipment diagnostics





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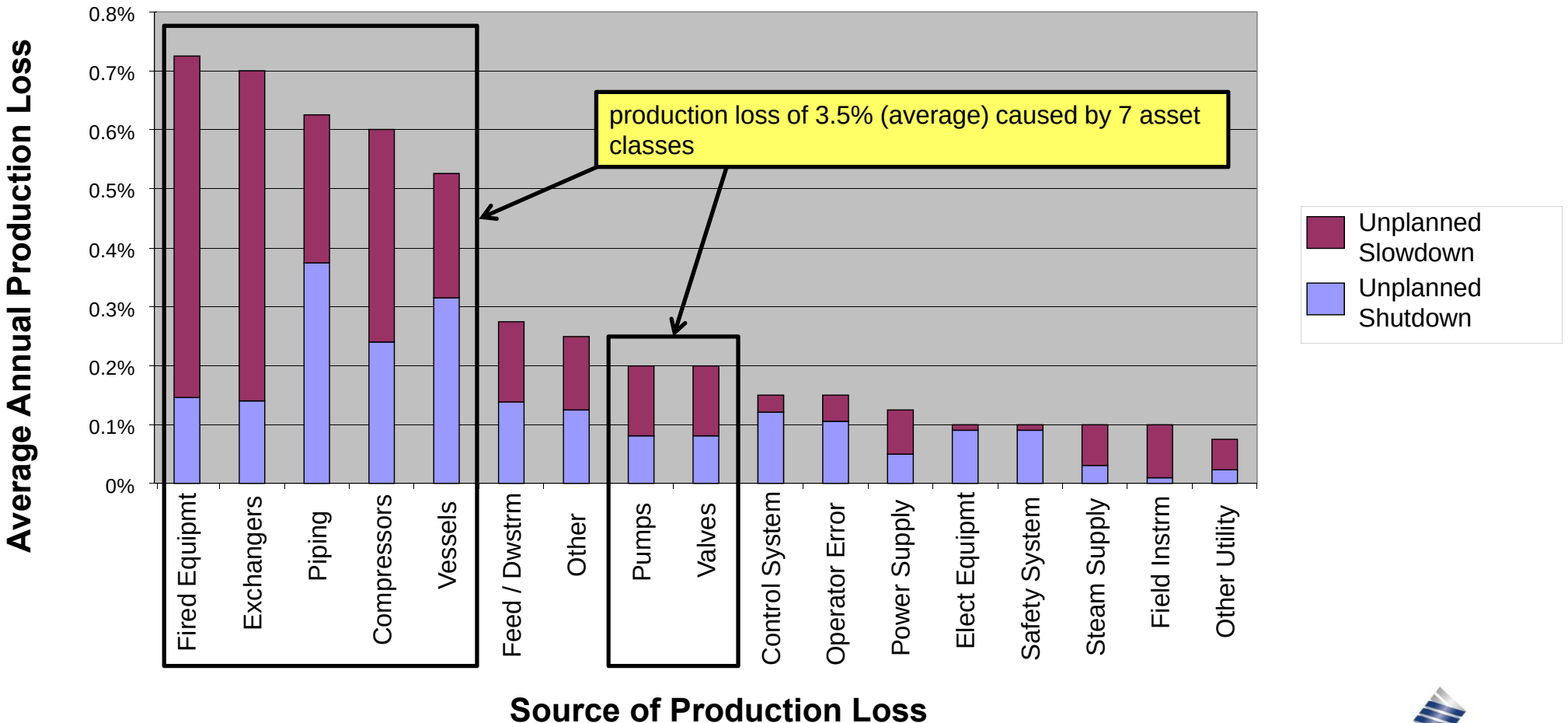
Sources of Production Loss



Source: InTech, 2012." Improve reliability with essential asset monitoring"

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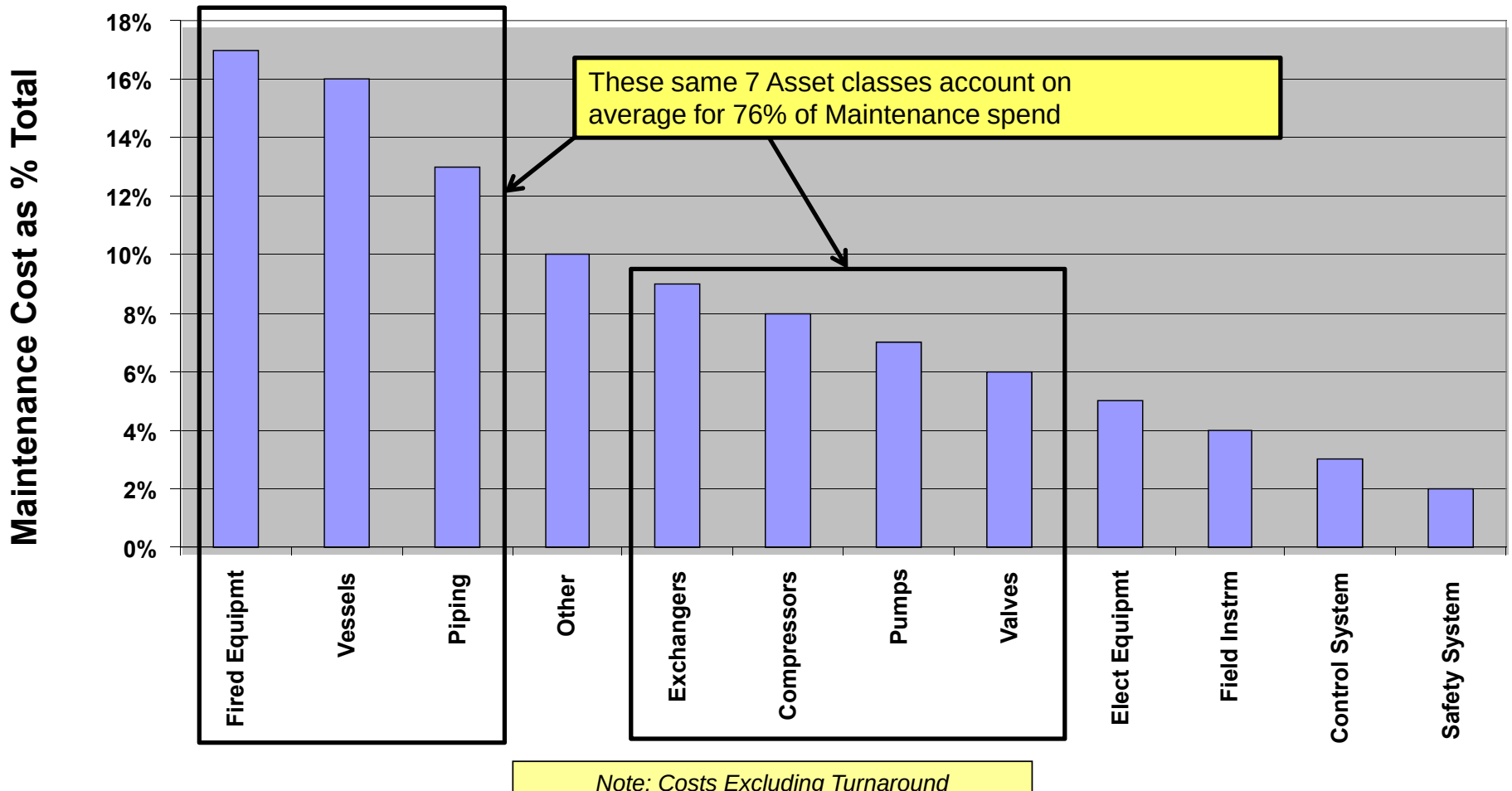
Equipment Maintenance Costs



Source: InTech, 2012." Improve reliability with essential asset monitoring"

When is the Optimal Time to Clean or Service?

Too Late: Reactive

- Equipment fail
  - Costly repair
  - Strains manpower
  - Production downtime
- Equipment foul
  - Reduced efficiency
  - Increased fuel cost

Too Early: Preventive

- High maintenance costs
- Production downtime
- Manpower
- May neglect other equipment that need maintenance

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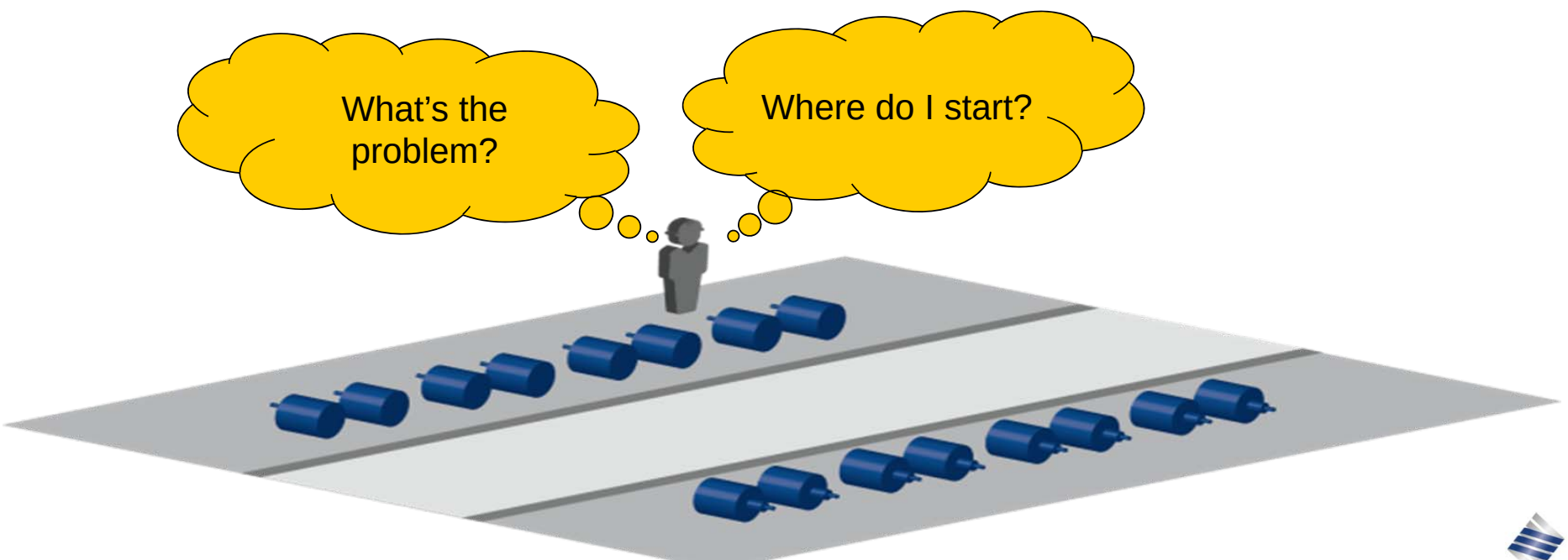
Without Equipment Diagnostics

- Do not know which equipment need maintenance
- Do not know what the problem is



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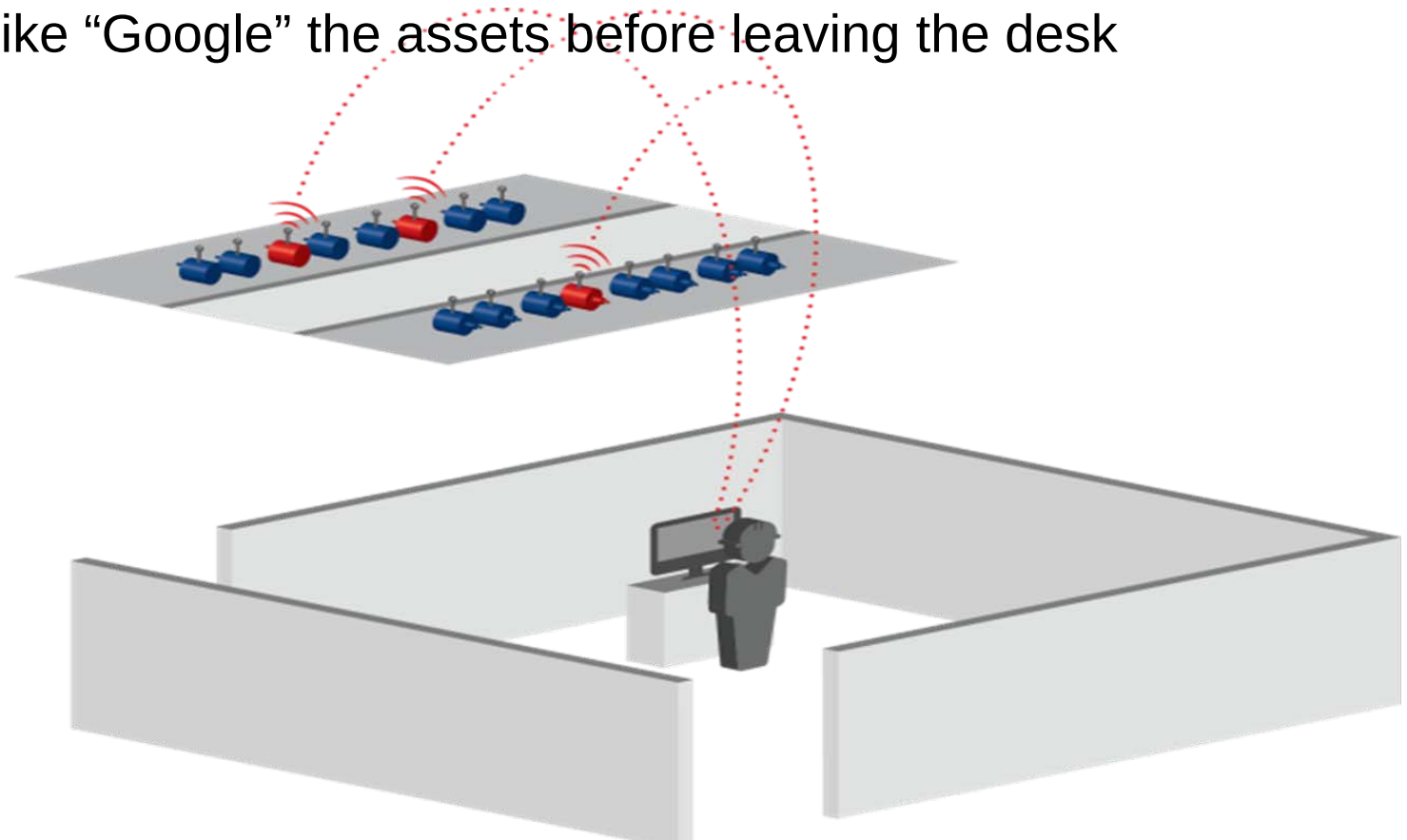
Diagnose Before You Prescribe: - Check the Software First

- New Work Process and Mindset:
  - Check the software before going to the field
  - Like “Google” the assets before leaving the desk



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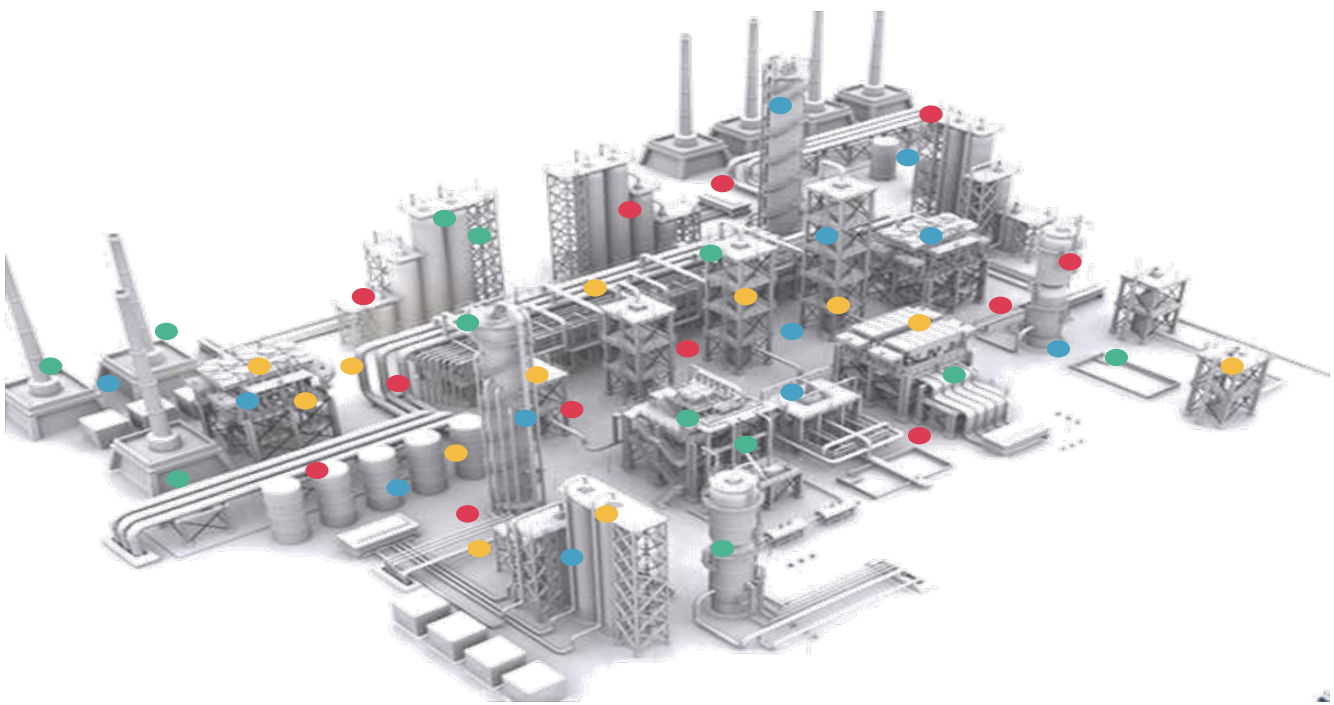
Data-Driven Maintenance Scheduling

- Instrumented equipment
- Software diagnoses the process equipment
- Enables maintenance and turnaround planning
  - Prioritize asset that need maintenance the most



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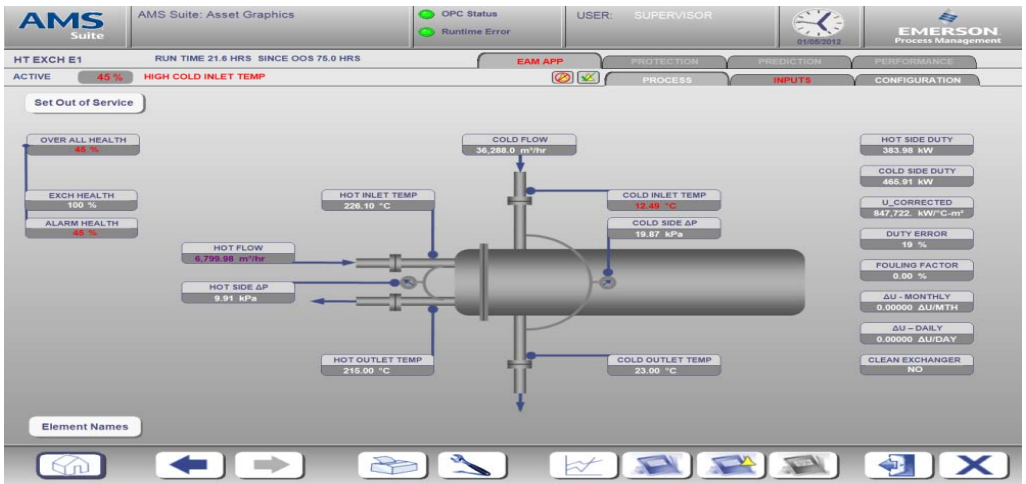
Heat Exchanger Monitoring - Make the Heat Exchanger Smart



- Diagnostics able to detect (per bundle):
  - Fouling / inefficiency
  - Plugging
- Result
  - Reduced manual inspection
  - Lower maintenance cost
  - Lower utility/fuel cost
  - Shorter turnarounds

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DIKW Pyramid

•Root Cause Analysis

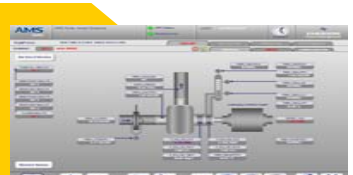
•Clean / not
•Replace /not
•Service / not

•Heat transfer coefficient
•Duty

Wisdom

Knowledge

Information



Data

•Vibration
•Temperature
•Pressure
•Noise

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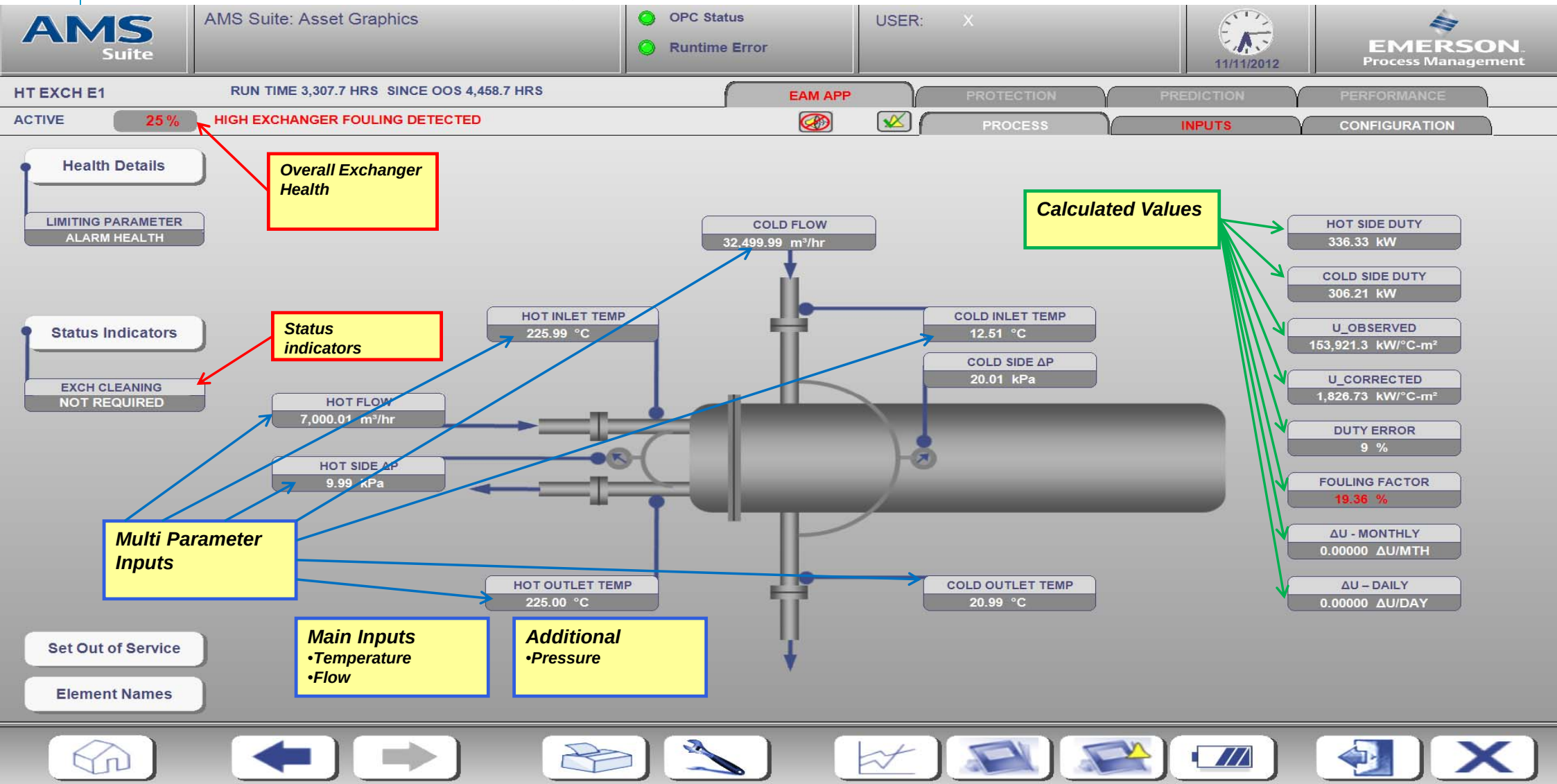
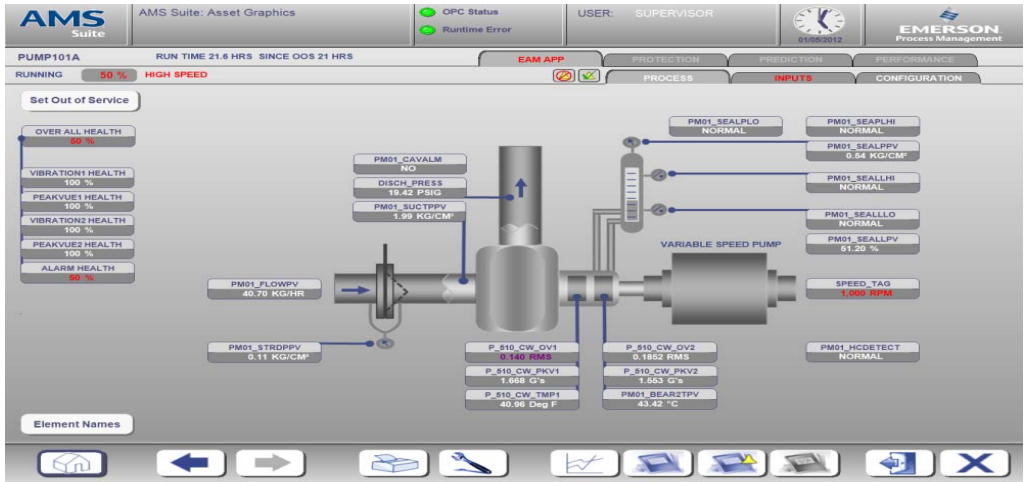
Raw Data and Diagnostic Information



Pump Condition Monitoring - Make the Pump Smart



- Diagnostics able to detect:
  - Plugged strainer
  - Suction pressure drop
  - Discharge pressure
  - Vibration
  - Leak
  - Bearings overheating
  - Motor winding temperature
  - Seal pot level
  - Seal pot pressure
- Result
  - Reduced manual inspection
  - Lower maintenance cost
  - Shorter turnarounds

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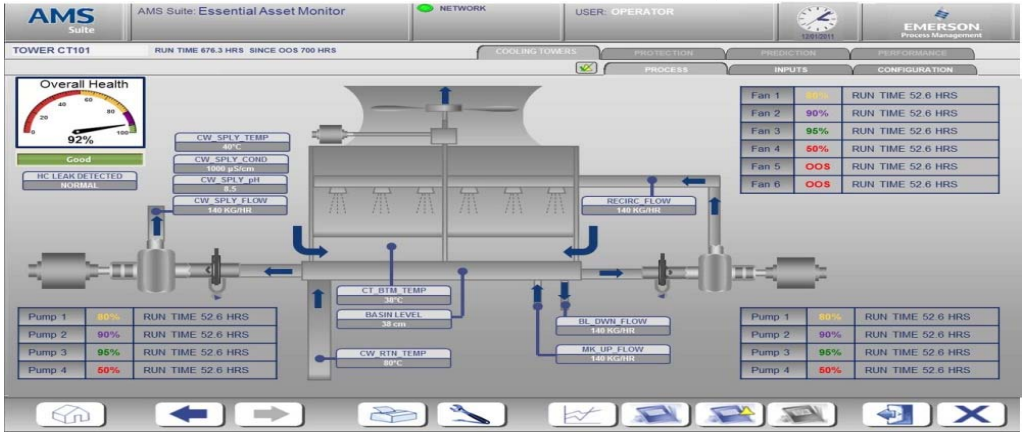
Cooling Tower Condition Monitoring - Make the Cooling Tower Smart



- Diagnostics able to detect:
  - High vibration
  - Bearing fault
  - Bearing temperature
  - Low head
  - Low discharge pressure
  - Low suction pressure
  - Strainer fault
  - Water temperature
  - Fouling
  - Corrosion
  - pH
  - Low flow
  - Windage/water loss
- Result
  - Reduced manual inspection
  - Lower maintenance cost
  - Shorter turnarounds
  - Reduced fan power

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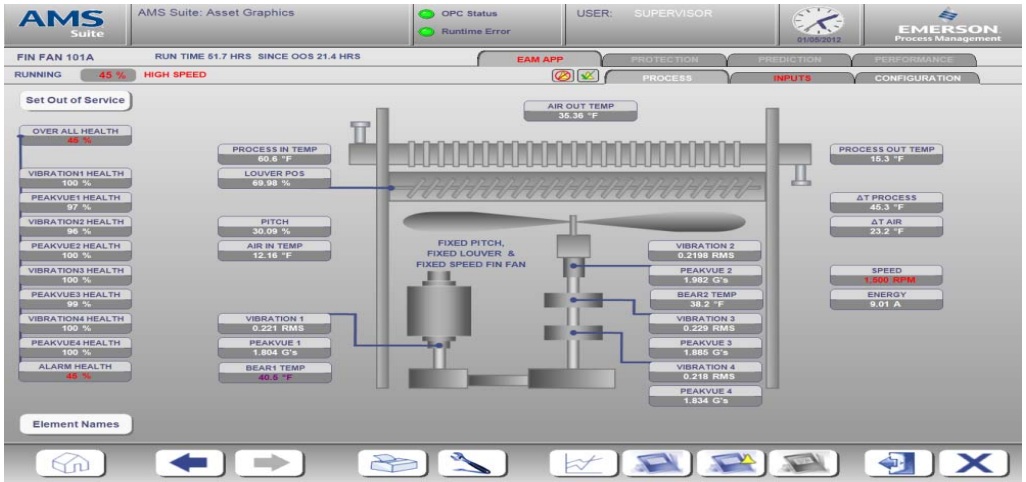
Air Cooled Exchanger Condition Monitoring - Make the Air Cooled Exchanger Smart



- Diagnostics able to detect:
  - High vibration
  - Bearing fault
  - Bearing temperature
  - Louver defect
  - Failed pitch actuator
  - Exchanger fouling
  - Excessive cooling
- Result
  - Reduced manual inspection
  - Lower maintenance cost
  - Shorter turnarounds

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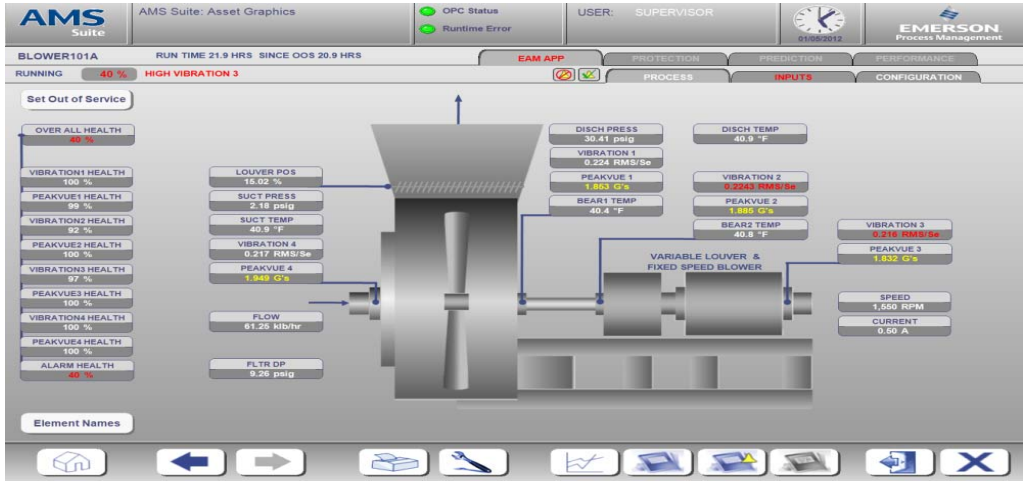
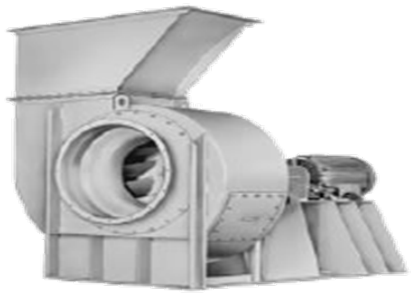
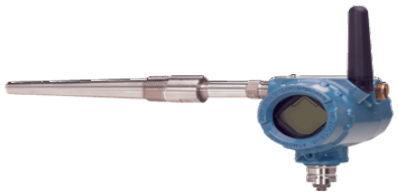
Blower Condition Monitoring - Make the Blower Smart



- Diagnostics able to detect:
  - High vibration
  - Bearing fault
  - Louver defect
  - Bearing temperature
  - Plugged suction filter
  - Flowmeter defect
- Result:
  - Lower maintenance cost
  - Lower electricity cost
  - Shorter turnarounds





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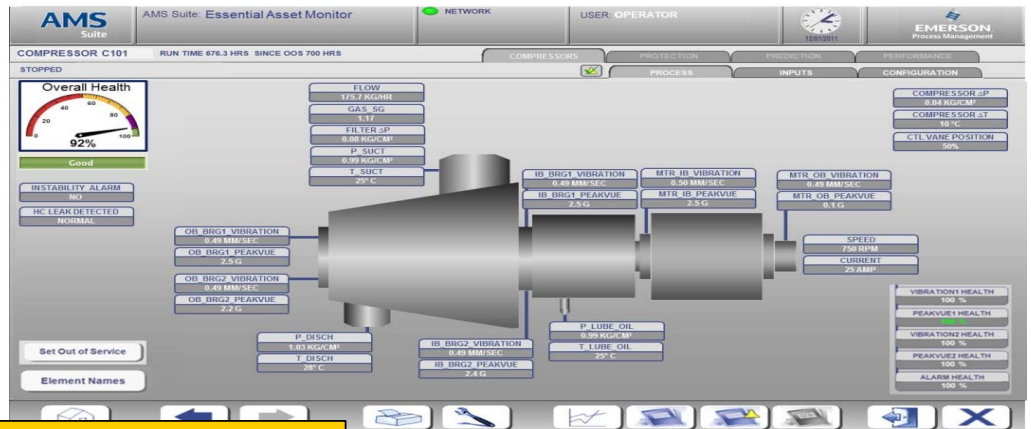
Compressor Condition Monitoring - Make the Compressor Smart



- Instrument air
- Nitrogen
- Fuel gas

- Diagnostics able to detect:
  - High vibration
  - Bearing fault
  - Plugged intake filter
  - Process instability
  - Low differential pressure
  - High differential temperature
  - Lube oil
  - Control vane defect
  - Gas composition change
- Result
  - Lower maintenance cost
  - Shorter turnarounds

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Pipe & Vessel Condition Monitoring - Make the Vessel Smart

- Diagnostics able to detect:
  - Corrosion
- Result:
  - Ensure integrity, avoid failures, spills, and fires

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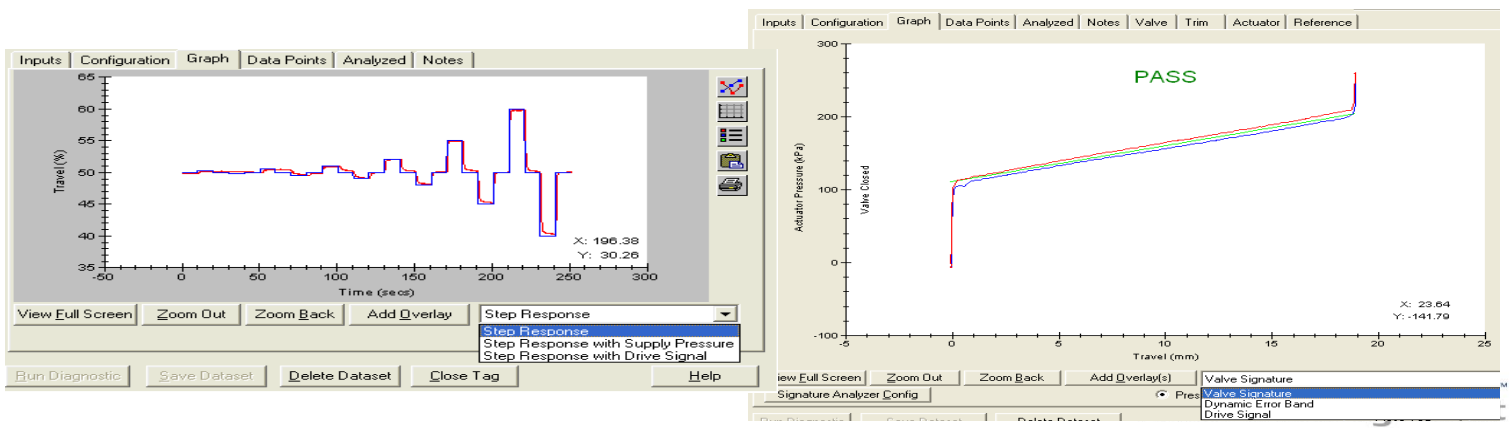
Valve Condition Monitoring - Make the Valve Smart

- Diagnostics able to detect:
  - Actuator diaphragm
  - Air leaks
  - Friction
  - Stem integrity
  - Stick-slip
- Result
  - Shorter turnarounds
  - More “time on pipe”

Also on package units

•Valves you planned to overhaul that do not need service
•Valves you did not plan to overhaul but which require service



Energy Efficiency

Reducing waste and loss

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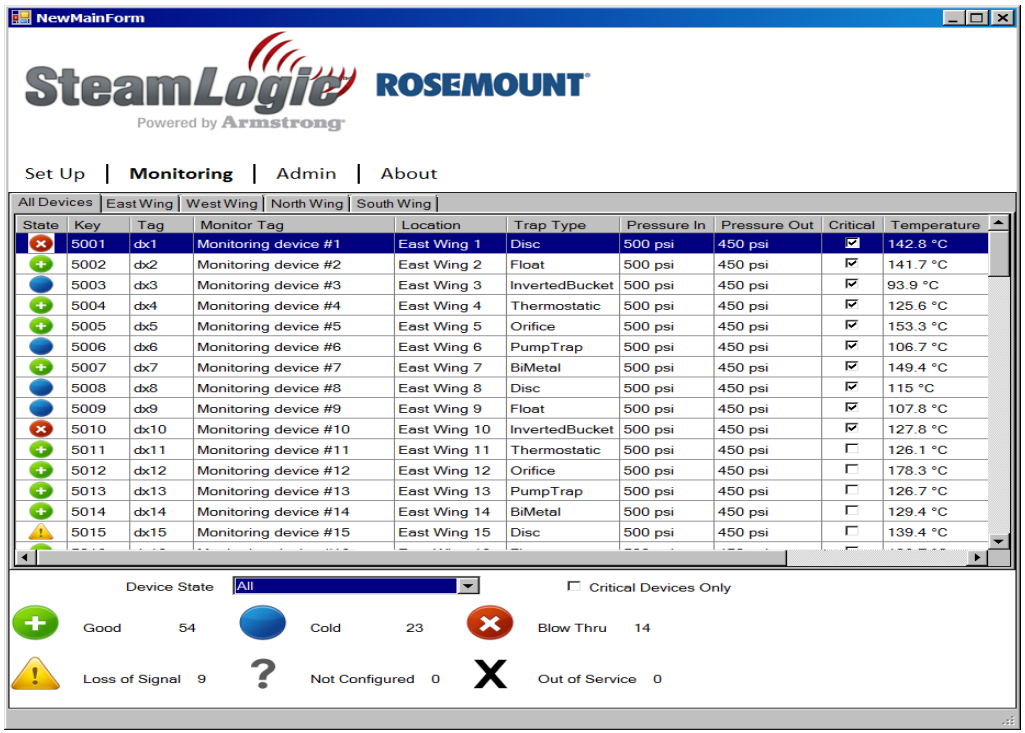
Steam System Monitoring

- Diagnostics able to detect:
  - Steam trap failure
    - Blow-thru: Energy loss
    - Cold: Water hammer
- Result:



Example:

8000- 10,000 Traps in a plant

8000- 10,000

5- 10% Percent of steam traps are failed (if no regular inspection it can be 15-25%

5- 10%

400 5% of 8000 traps

400

$10,424 Annual fuel loss per trap

$10,424

$4,169,760 Annual fuel loss for 400 traps

$4,169,760

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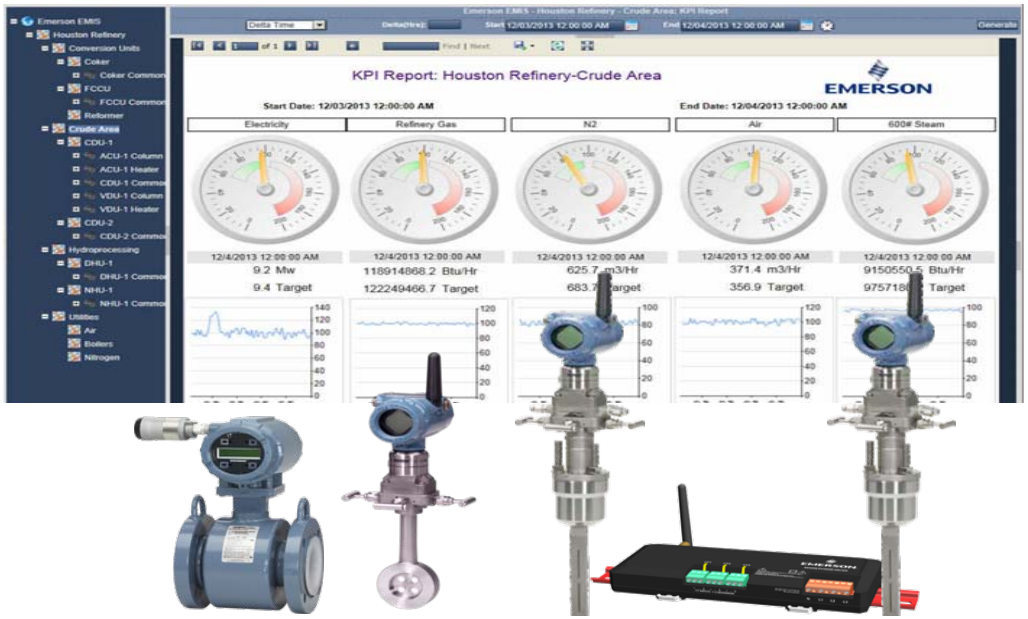
Sub-Metering for Utilities Consumption Cost Accounting and Energy Performance

- Energy Management Information System (EMIS)
- Ability to
  - Measure consumption of W.A.G.E.S:
    - Water
    - Air (compressed)
    - Gas (fuel)
    - Electricity
    - Steam
  - Detect increase
  - Water balancing
- Result
  - Reduced utility cost



W Water **A** Air **G** Gas **E** Electricity **S** Steam

ISO 50001 energy management

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Condition of Essential Assets Play a Part in Energy Efficiency Too

- Ability to monitor condition:
  - Heat exchangers
  - Cooling tower
  - etc.
- Result
  - Lower utility/fuel cost
  - Maintain throughput
  - Optimize maintenance

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Reduce HS&E Incidents

Improved situational awareness to reduce incidents and response time

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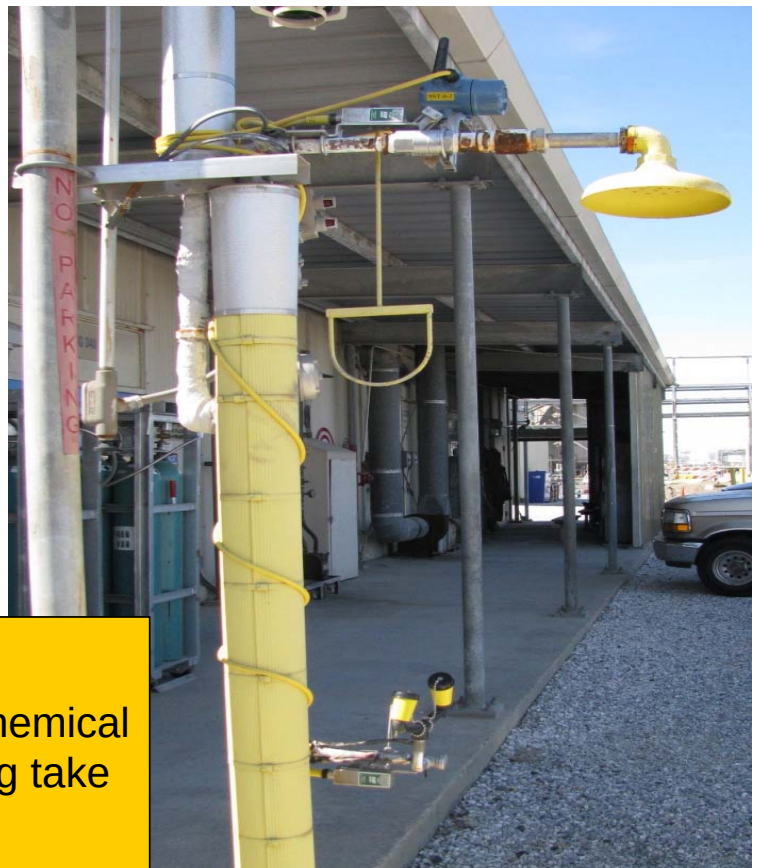
Situational Awareness: Emergency Safety Shower & Eyewash Stations

- Able to detect personnel in distress
- Result
  - Faster response by first aiders



Cold climates also pressure and temperature

In areas where chemical transfer or mixing take place

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Situational Awareness: - Manual and Bypass Valve Feedback

- Able to know if valves are opened or closed
- Results
  - Reduced risk
  - Fewer mistakes
  - Fewer manual checks

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Situational Awareness: - Relief Valve Monitoring

- Able to detect
  - Release
  - Seat leakage
- Result
  - Ability to overhaul to stop passing
  - Ability to correlate release with process conditions
    - Improve process
  - Know which valve lifted
    - Schedule overhaul
  - Estimate release amount
    - Reduce fines

Which one is it?
There might be 100 relief valves venting to the same flare

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Process Operation Productivity

Automate manual tasks

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Substitute Field Operator Rounds

- Able to reduce field work
  - Dial gauges
  - Sight glasses
  - Variable area flow meters
  - Dip sticks
  - Portable testers
    - Vibration
    - Temperature
    - Ultrasonic (leak)
  - Grab samples
- Result
  - Fewer field operator rounds

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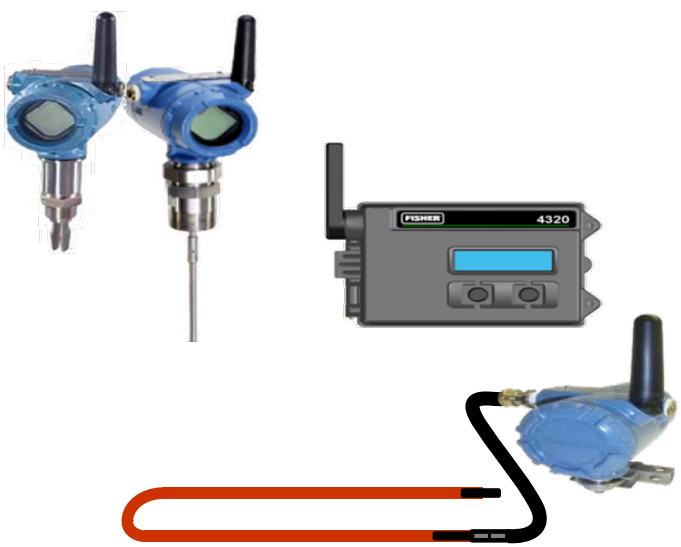
Tank Farm Storage Tanks

- Ability to detect
  - Product level/inventory
  - Floating roof tilt
  - Dyke valve position
  - Hydrocarbon leak
  - Overfill
  - Sump pit level
  - Floating roof water
  - Transfer valve position line-up
- Result
  - Greater productivity (less manual inspection)
  - Improved safety
  - Reduced environmental incidents
  - Reduced risk of damage



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Wellhead

Basic Production Well
Flowline Pressure
Flowline Temperature
Casing Pressure
Wellhead Pressure
Bradenhead Pressure
Flow switch

Plunger Lift
Annulus Pressure
Plunger arrival sensor

Steam injection Well
Steam Injection Pressure
Steam Injection Temperature
Water Injection Differential
Pressure to monitor flow

Gas Lift
Gas Lift Pressure
Gas Lift Temperature
Gas Lift Differential Pressure

Chemical Injection Well
Inj. Pressure
Inj. Temperature
Inj. Flowrate

Gas Injection Well
Gas Inj. Pressure
Gas Inj. Differential Pressure
Gas Inj. Temperature
Wellhead Pressure
Casing Pressure
Gas Inj. Choke Valve

Water Wash
Water Wash Pressure
Water Wash Differential Pressure

Chemical Injection
Chemical Inj. Pressure
Chemical inj. Differential Pressure
Chemical inj. Flow

Water injection Well
Water Inj. Pressure
Water Inj. Differential Pressure

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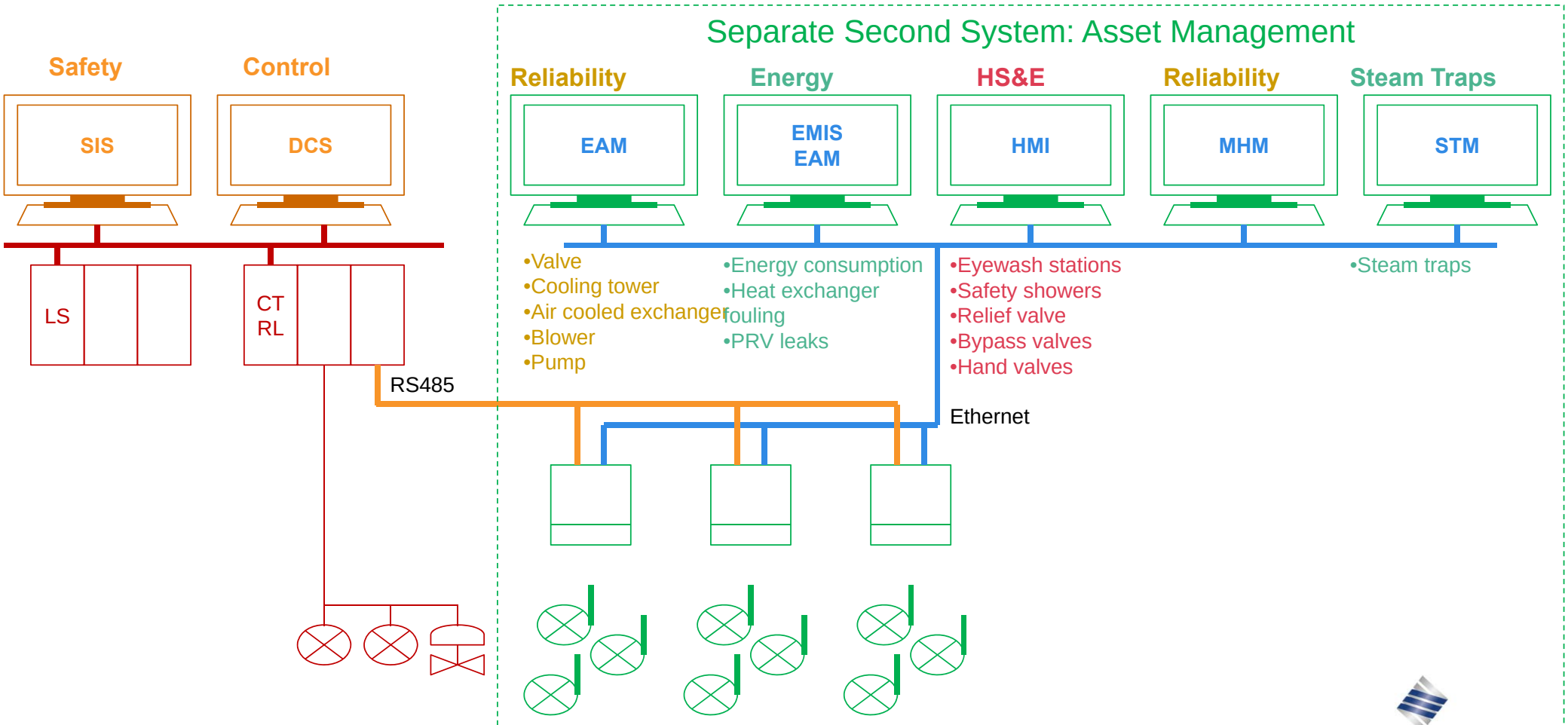
Infrastructure Integration with Existing Historian and DCS

WirelessHART on Any System – No Need to Replace It

Architecture: Separate "Second System" for Asset Management



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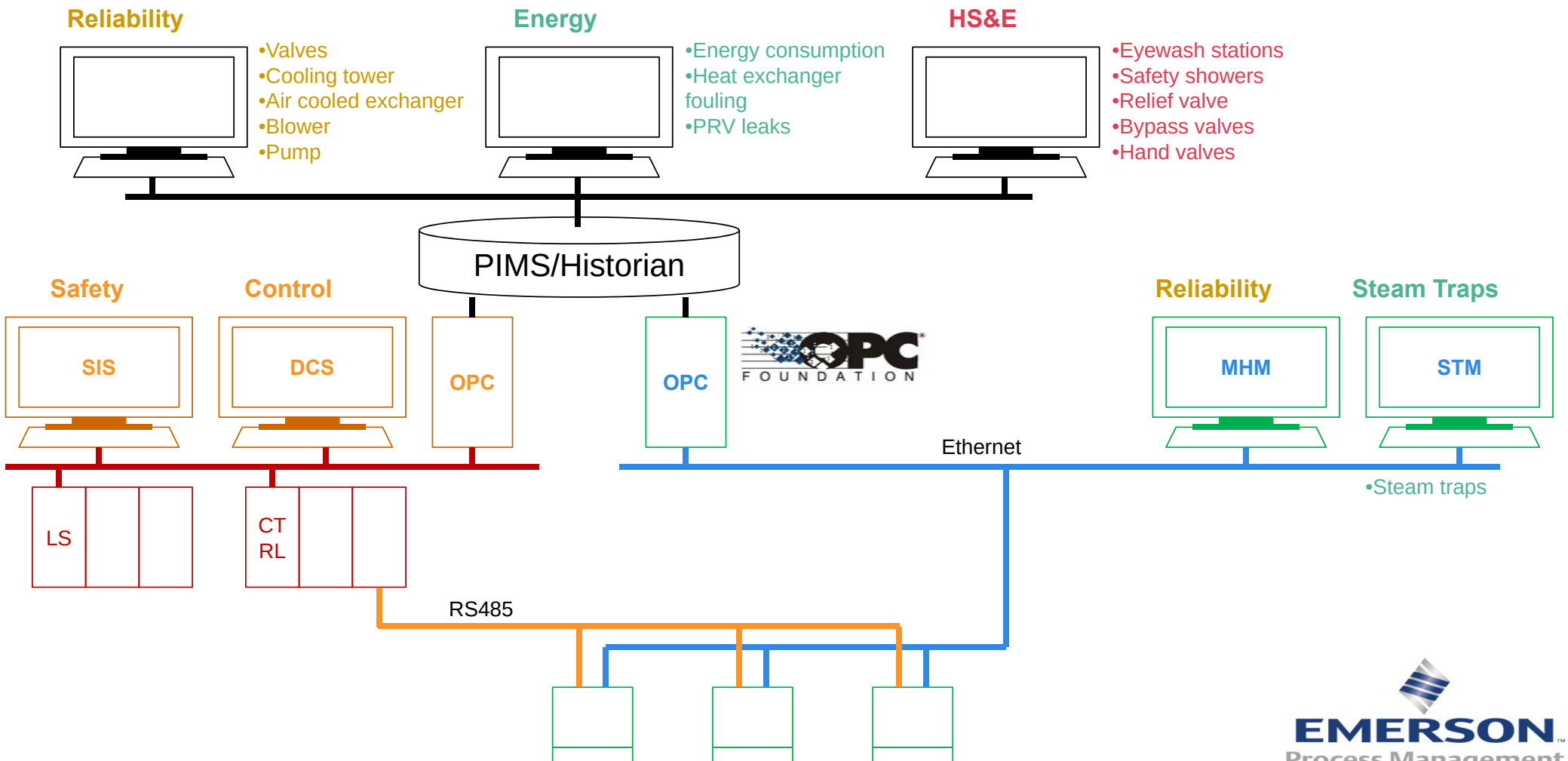
Architecture: Separate PIMS/Historian



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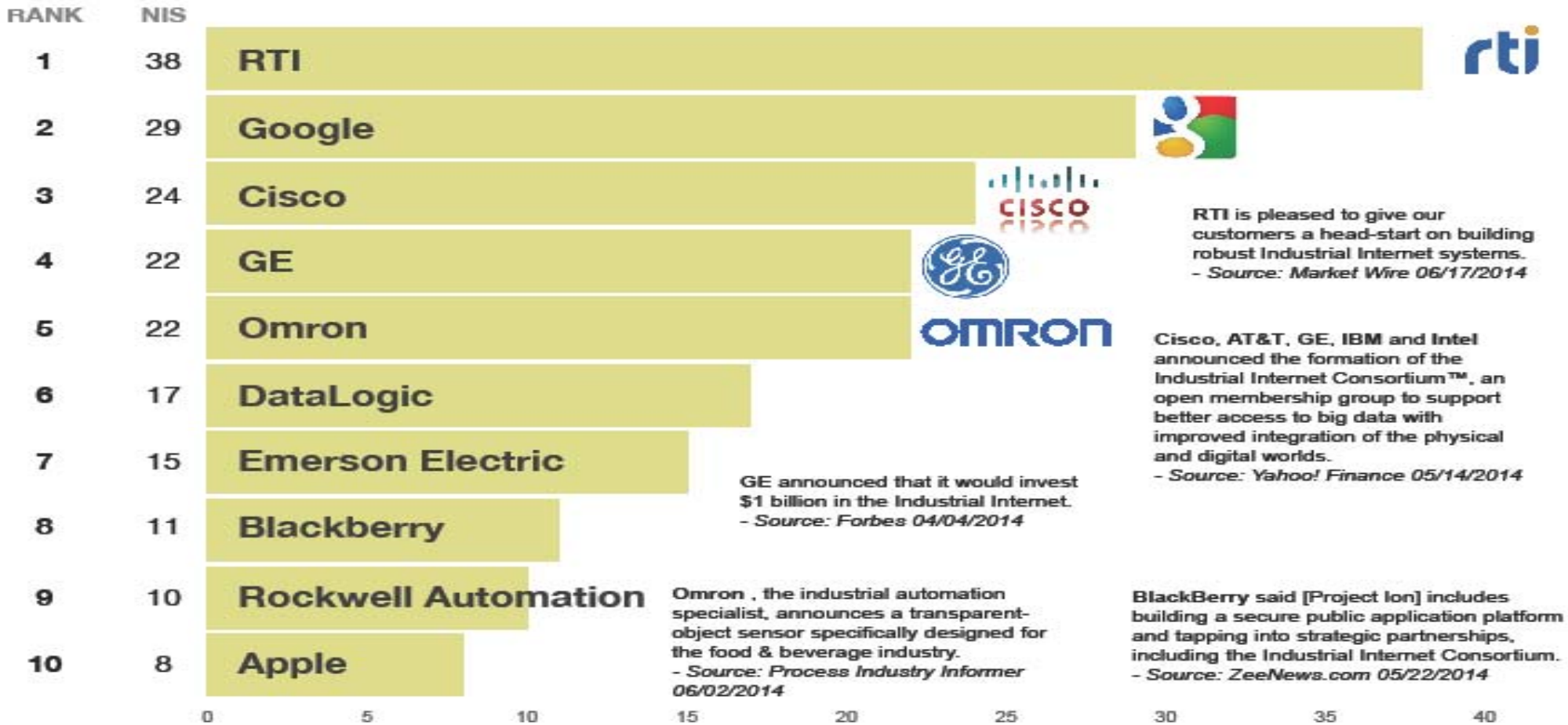
The 10 Most Influential Industrial IoT Companies



RTI is pleased to give our customers a head-start on building robust Industrial Internet systems.
- Source: Market Wire 06/17/2014

Cisco, AT&T, GE, IBM and Intel announced the formation of the Industrial Internet Consortium™, an open membership group to support better access to big data with improved integration of the physical and digital worlds.
- Source: Yahoo! Finance 05/14/2014

GE announced that it would invest $1 billion in the Industrial Internet.
- Source: Forbes 04/04/2014

Omron , the industrial automation specialist, announces a transparent-object sensor specifically designed for the food & beverage industry.
- Source: Process Industry Informer 06/02/2014

BlackBerry said [Project Ion] includes building a secure public application platform and tapping into strategic partnerships, including the Industrial Internet Consortium.
- Source: ZeeNews.com 05/22/2014

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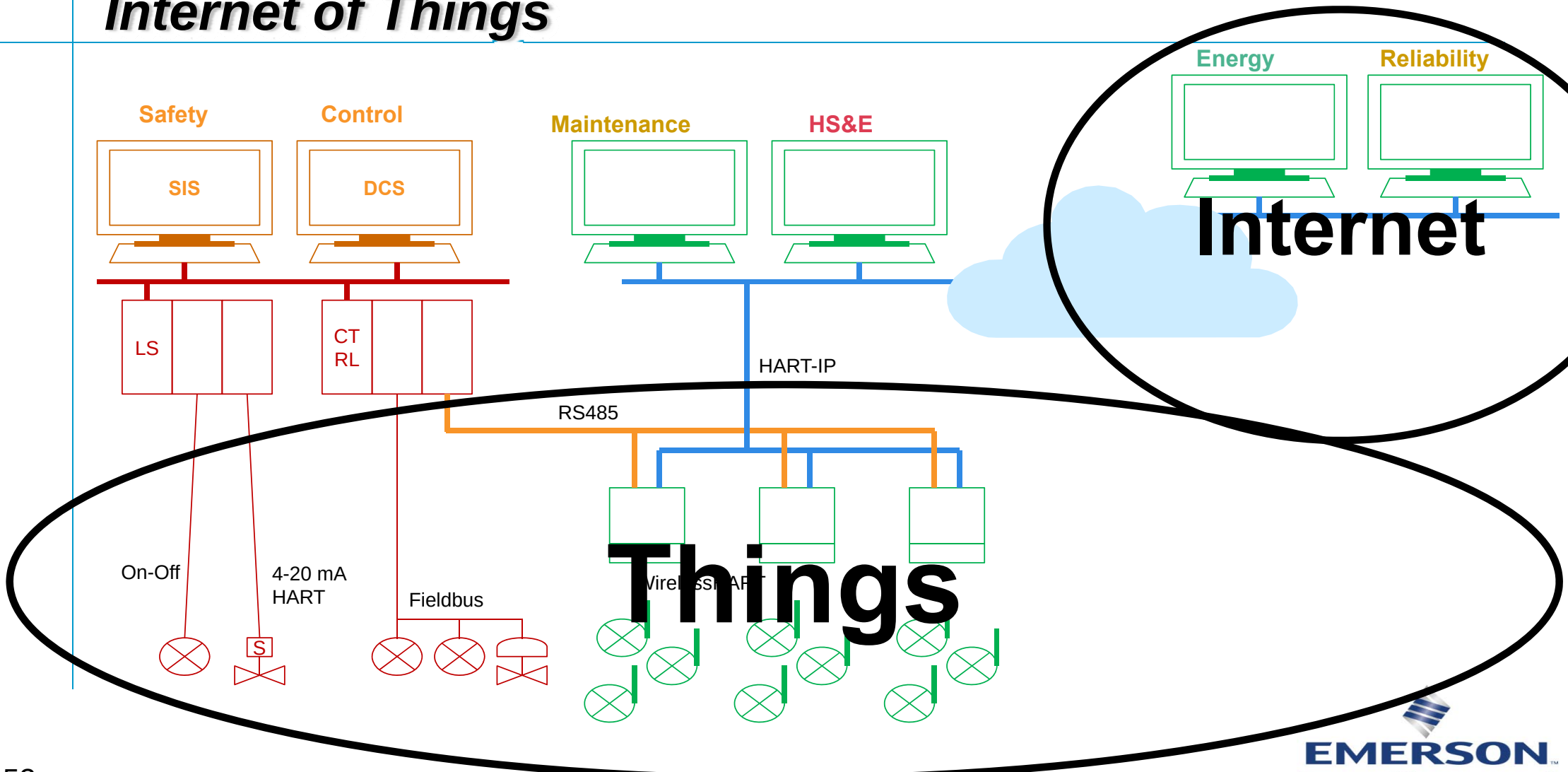
Internet of Things



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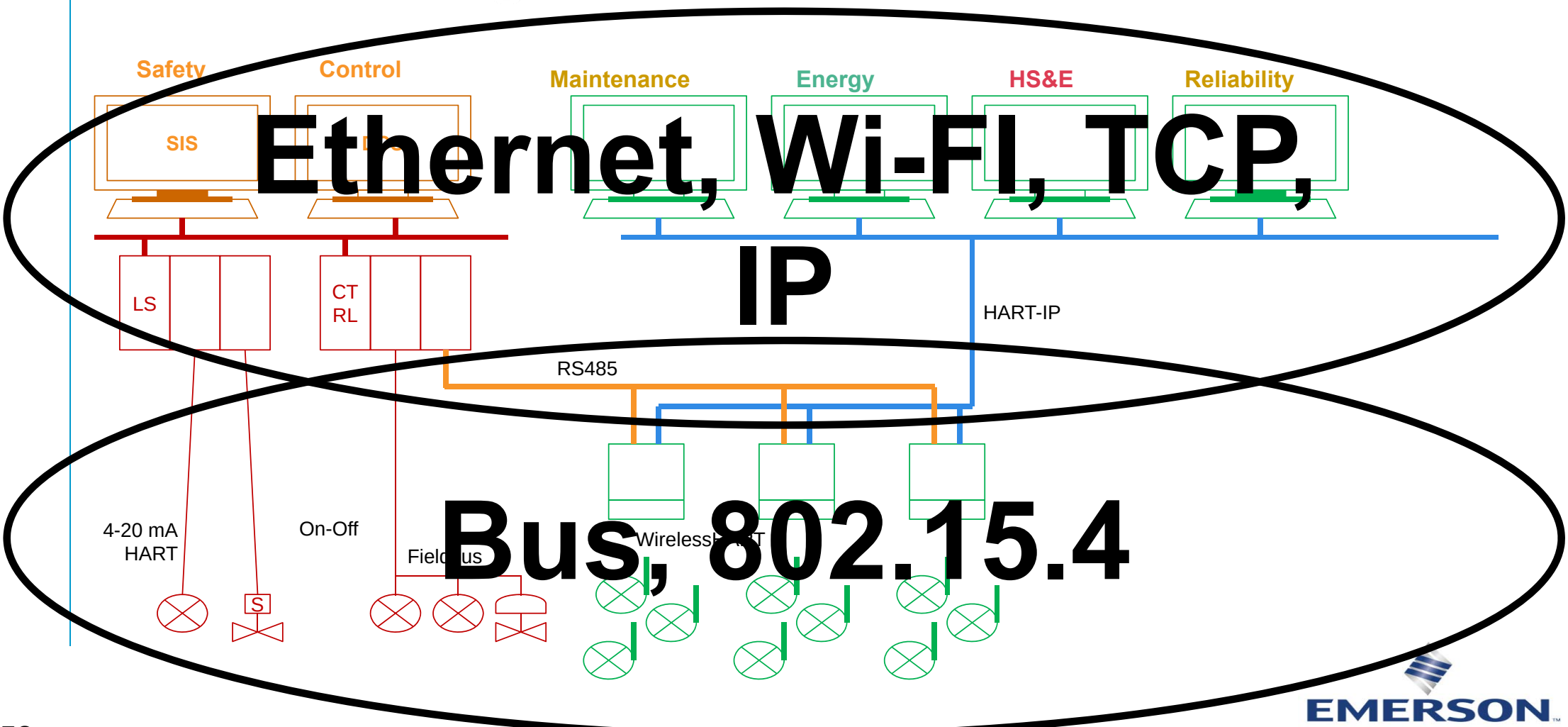
Internet of Things



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Smart Wireless Networking

WirelessHART Expanding the Possibilities IEC

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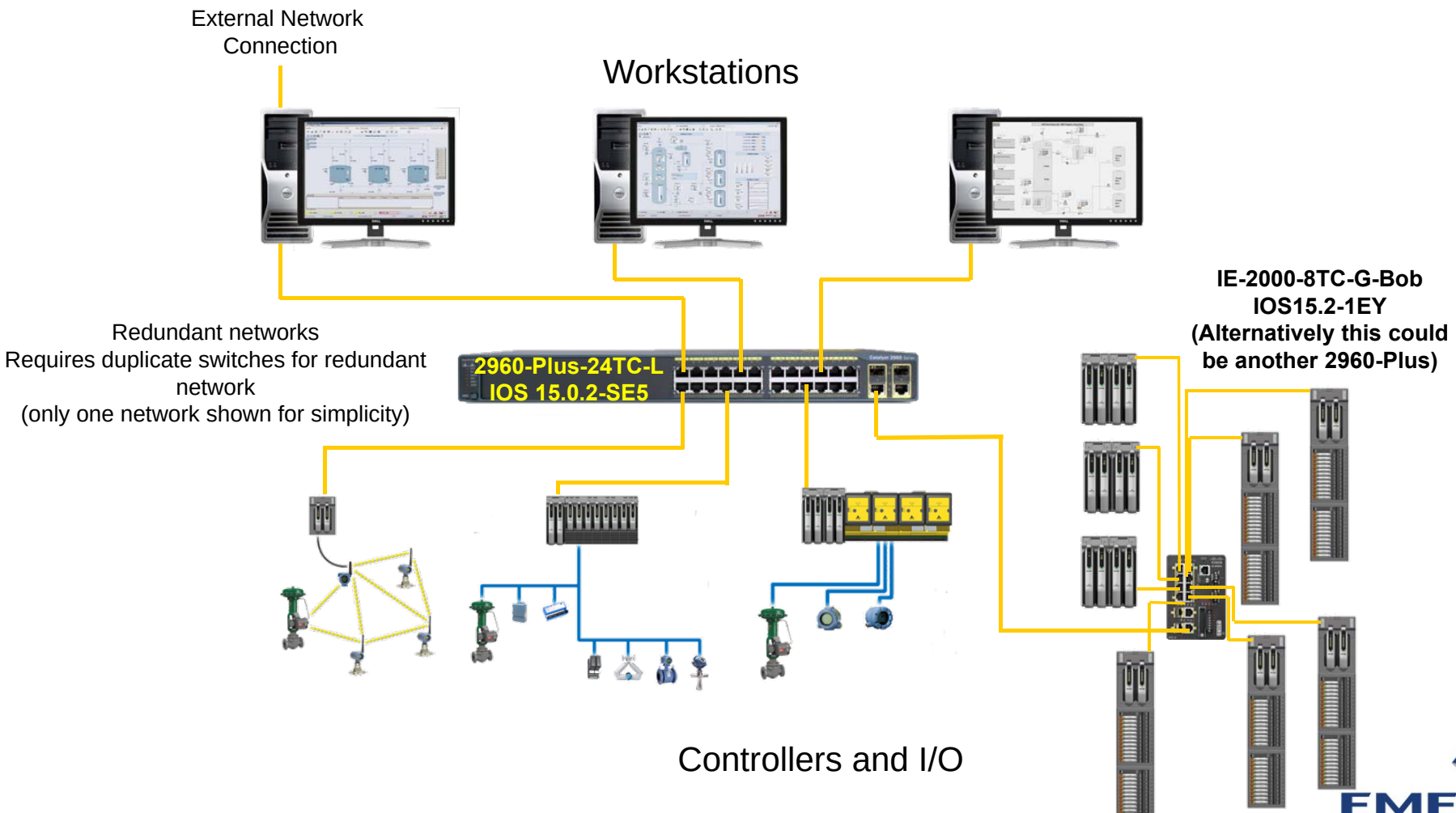
Where Cisco Switches are used in the control network



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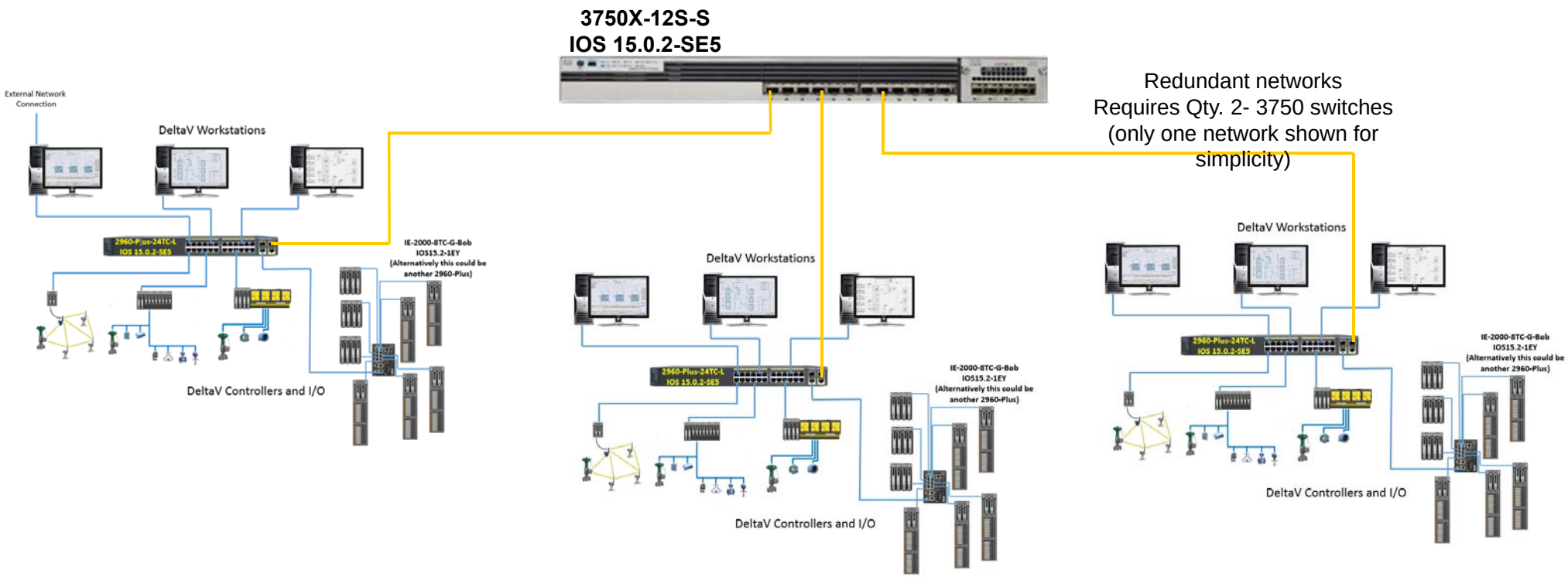
Where Cisco Switches are used in the control network



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Beyond the P&ID

Don’t build your new plant old

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Don't Build Your New Plant Old

- New designs also do not make provisions for automation beyond operation and safety per P&ID
  - Not included in process licensor's design
- These missing measurements must be added
  - But the project may have passed the FEED stage...
- No redesign
  - With WirelessHART additional measurement points do not affect DCS I/O count, cable layout, or junction boxes etc.

WirelessHART
Expanding the Possibilities

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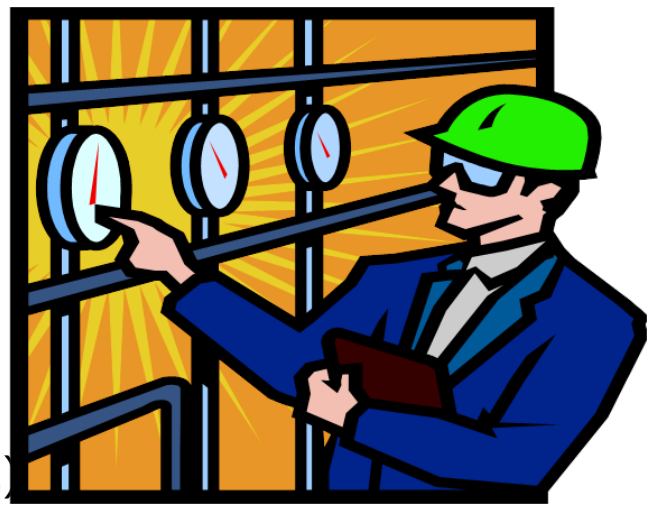
Don’t Operate New Plants the Old Way

- Don’t design-in clipboard rounds and manual labor in a new plant
  - Labor cost will go up – I promise
- Points not on the P&ID
  - Operation clipboard rounds:
    - Essential pump monitoring
    - Gauges, dipsticks, and clipboard rounds
    - Asset temperature monitoring
  - Missing measurements:
    - Valve position feedback (hand operated, On-Off, control...)
    - Essential pumps, motors, and other machinery
    - Steam traps
    - Relief valves
    - Grab samples of product or effluent for lab analysis



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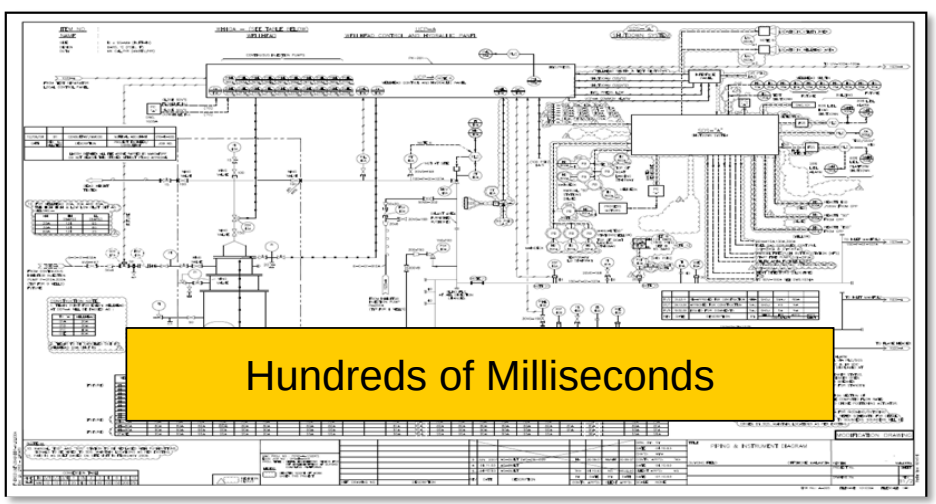
Beyond the P&ID: A Second Layer of Automation for Missing Measurements

On the P&ID:

Primary layer of Automation

- Control System
  - Closed loop control
  - Process alarms
- SIS
  - Functional safety
- Core Business and Data



Hundreds of Milliseconds

Beyond the P&ID:

Second layer of Automation

- Second system beyond the control room
- Balance of plant
  - Reliability and maintenance productivity
  - Energy efficiency
  - HS&E
  - Operator productivity
- Non-core Business and Data

Seconds-minutes-hours

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Conclusion

Beyond the P&ID

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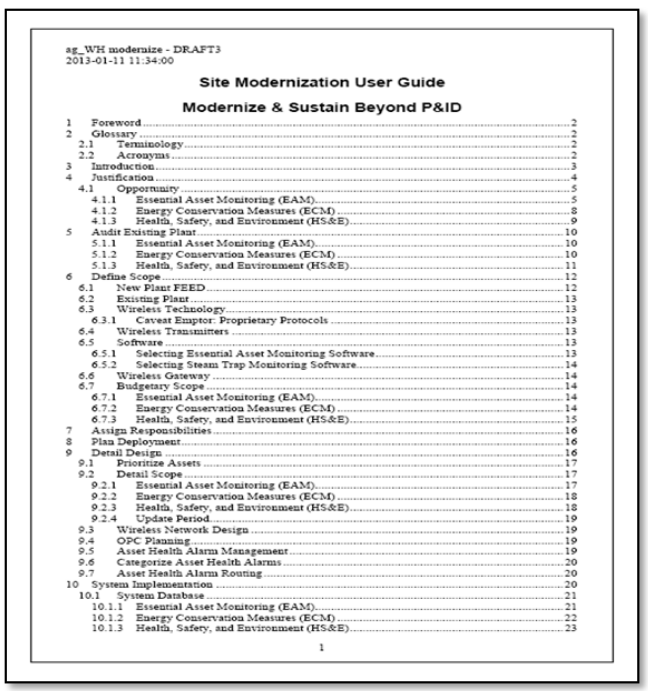
Plant Modernization Deployment Work Process

- Justify
- Audit
- Define
- Assign
- Plan
- Detail Design
- Implement
- FAT
- Installation
- Commissioning
- Site Integration
- Develop Procedures
- Training
- Handover

- User guide for plant-wide deployment of modernization solutions



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Site Modernization User Guide

Modernize & Sustain Beyond P&ID

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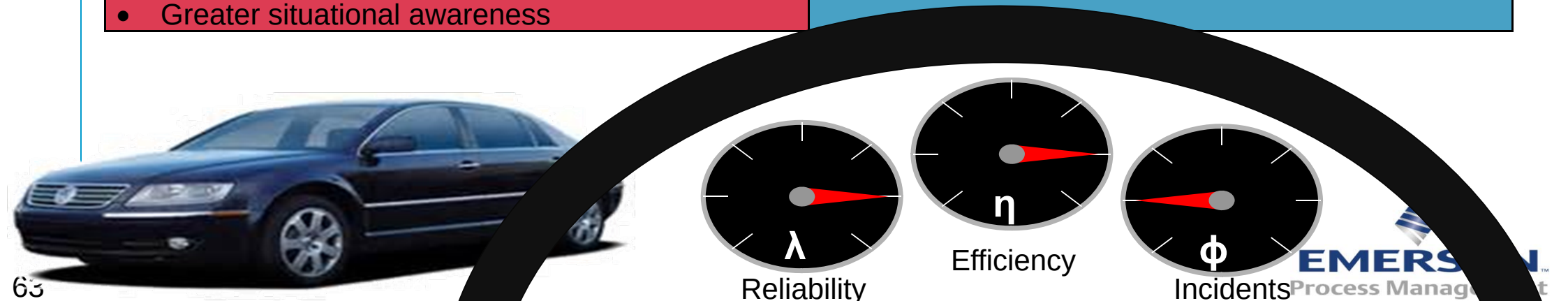
Results for Everyone: Modernization / Pervasive Sensing Value

Reliability & Maintenance	Energy Efficiency & Loss
• Improved equipment reliability • Reduced scheduled plant downtime • Reduced unscheduled plant downtime • Reduced preventive maintenance • Shorter turnarounds • Longer between turnarounds	• Reduced loss and consumption of WAGES (Water, Air, Gas, Electricity, and Steam) • Reduced loss of product
Health, Safety, and Environmental (HS&E)	**Process Operations Productivity**
• Reduced incidents • Faster incident response time • Regulatory compliance • Greater situational awareness	• Greater productivity • Greater situational awareness • Greater well recovery factor



Conclusion

- Modernize for greater visibility of the plant
  - Reliability & Maintenance
  - Energy Efficiency
  - Health, Safety, and Environmental (HS&E)
  - Process Operations Productivity
- Integrate with existing historian and DCS
- Fully automate new plants
  - Beyond the P&ID

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Let's Stay Connected

- Jonas Berge

http://www.linkedin.com/in/smartdigital

EMERSON EXCHANGE 365
Learn. Share. Network.

http://community.emerson.com/members/jonas.berge/

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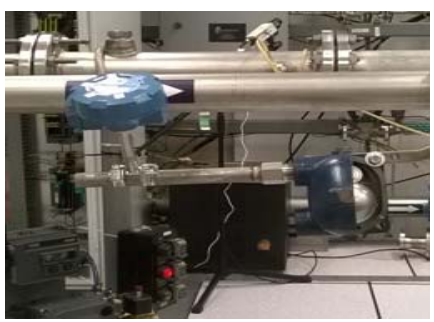
THANK YOU

Pervasive Sensing Solutions Live Demo

- **Process & HSSE:** Relief valve release and leak
  - Peter Lee
- **Reliability:** Pump and seal failure
  - Ismail Khan
- **Energy:** Steam trap failure
  - Emmy Lim



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THANK YOU