Capturing Refinery Operational Value Through IIOT – The Industrial Internet of Things

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Consumer Use of Internet of Things (IOT)
Data Example: Edyn- Smart Gardens

- Sensor - Monitors soil moisture and nutrition (conductivity), sunlight hours, humidity
- Connects to app on smart phone that accesses local weather forecasts to determine how much water is needed for garden
- Smart phone app connects via wifi to smart valve that controls water to garden based on current and forecast conditions – if rain is forecast it defers watering
- Can manually control watering remotely via your smart phone
- Provides recommendation on soil nutrition based on specific plants in garden
- Solar rechargeable batteries in sensor and valve

Source: https://edyn.com/
What if You Didn’t Have to Take Your Car In For Service?

Car
• Must periodically be sent for service
• Critical components inspected
• You can’t use it
• What happens between inspections?

BMW 7 Series (with ConnectDrive)
• Continuously monitored with car data and analysis sent to the dealer of your choice
• Early warning of problem with critical components
• Dealer contacts you if maintenance required on critical item
• Less disruptive
• Greater availability and performance
Topics Covered

• What is IIoT
• Why should you care? - IIoT benefits
• Who is benefitting today? - IIoT examples
• What is the architecture of IIOT?
• What about Security?
• How To Get Started
What is it? - Industrial Internet of Things (IIoT)
Internet of Things (IOT)

Internet of People
Human interfaces
• Computers
• Tablets
• Smart phones

Internet of Things
Networked autonomous devices
• Refrigerator
• Car
• Aircon
Industrial Internet of Things (IIoT)

- **Industrial things**
  - Industrial equipment
    - Smart pump
    - Robot
    - Smart valve
  - Can also be instrument itself

- **Using industrial protocols**
  - WirelessHART
  - Fieldbus
  - PROFIbus

- **Unique identifier**
  - IPv6 address
  - MAC address
  - Any other kind of unique ID
Internet Enables Remote Monitoring of Equipment

- Enterprise level
  - Global technology center of excellence
- By equipment manufacturer
  - Pump, valve, ACHX, CT, etc.
- By third-party plant services provider

IIoT is a group of enabling technologies
IIoT Concept

Sensors for Any App

“Big Data” Storage & Analytical Tools

Distributed Anywhere

To Anyone

INTERNET PROTOCOLS

INTERNET PROTOCOLS

Diverse, Rich Data Sets (Big Data)
“Unlimited” Storage & Processing
(Cloud) Automated Analysis & Info

NOT JUST CONTROL:
Energy, Reliability, Safety, etc.

Results Distribution to Anywhere
Automation and the Industrial Internet of Things

Why is everyone talking about it?
Improved sensing technologies
Cost-effective connectivity
Advanced computing and analytical methods
Why should you care? - IIoT Benefits
Plant Operational Excellence - The Four Zero’s

- **Safety** – the goal is zero serious safety incidents
- **Sustainability** – the goal is zero significant environmental incidents, excess energy use and excess waste
- **Availability/ Reliability** – the goal is zero unscheduled downtime
- **Financial** - the goal is zero lost profit opportunities

*How can IIOT support these objectives?*
Industry Benchmarks Reveal Significant Business Improvement Opportunities from Average to Top Quartile Performers

Safety

3X fewer recordables and process incidents

Availability/ Reliability

4% higher availability

Half the maintenance costs

Financial/ Production/ Optimization

20% lower operating costs

Sustainability/ Energy/ Emissions

30% lower emissions

30% less energy use

10% higher Utilization Rate

4th Quartiles 1st

Operational Costs Utilization

4th Quartiles 1st

Recordables Process Incidents

4th Quartiles 1st

Maintenance Availability

4th Quartiles 1st

CO₂ Emissions Energy Use

4th Quartiles 1st

Sources: Refining and Petrochemical Benchmarks, API, Solomon, OSHA, IHS Market and Company Reports

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How can IIOT Impact These Metrics? – Plant Decision Cycles

To have a financial impact IIOT has to improve the plant decision cycle – reduce delays, reduce uncertainty, etc.! Data driven decisions!
What Impact Can IIOT Have?

• Safety
  – Avoiding incidents through early detection of potential hazardous situations
  – Monitoring safety equipment use for detection of events
  – Monitoring staff location relative to safety events
• Availability/ Reliability
  – Increasing availability
  – Anomaly detection – identifying precursor events to unscheduled equipment outage or problems
  – Performance monitoring – detecting loss of process/ equipment performance before it impacts production capacity
• Sustainability
  – Reducing per barrel energy usage
  – Comparing current usage of resources such as energy to its expected usage under current conditions and determining possible causes of variation
  – Energy supply/ demand optimization
• Financial Optimization
  – Increasing yields of most valuable products
  – Detecting and dissecting complex interacting constraints on production
  – Determining reasons for product quality/ yield issues
  – Understanding patterns and relationships – developing statistical models that explain them
Infrequent, Manual Data $\rightarrow$ Reliable, Real-Time Digital Data

- **Reduce Field Manual Readings**
  - Dial Gauges
  - Sight Glasses
  - Dip Sticks
  - Corrosion Checks
  - Vibration Checks

- **Results**
  - Fewer Field Operator Rounds
    - Less Exposure to Hazardous or Unpleasant Plant Areas
    - Accurate Readings in Bad Weather
  - Early Indication of Potential Problems
IIoT Examples

Some plants are already benefitting from IIoT
IIOT Examples - FCC

Detection of catalyst flow stability
With 3051 ASP

Monitor unit performance with field mounted GC-
For catalyst regeneration efficiency & minimize light naphtha losses

Wet Gas Compressor-
Surge detection and Rotating equipment health

Advanced control –
SmartProcess Fractionator Optimizes product separation
At low energy consumption

Separation Columns- Column flooding, tray malfunction

Blower – vibration monitoring
surge protection

Maximize feed rate and unit mass balance with accurate Mass flow measurements
(Composition and Density Independent)

Pumps- cavitation detection
Vibration and pump seal health

Heat Exchangers-monitor fouling rate and alert fouling

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**IIOT – Refinery Cooling Tower**

- **Problem Description:**
  - Cooling Tower instrumentation was old and most of it was out of service.
  - Local operators spend a lot of time to get process information.
  - The Cooling Tower efficiency couldn’t be measured accurately.

- **Challenges:**
  - Implement a low installation and maintenance cost solution.
  - Improve cooling tower operator safety; measurements are taken in-place, manually.
  - Increase cooling tower reliability and efficiency.

- **Solution:**
  - Instrumentation of critical process variables, including: Rosemount wireless pressure transmitters, Rosemount wireless temperature transmitters, Rosemount wireless discrete input transmitters, Rosemount Analytical wireless pH transmitters, CSI wireless vibration transmitters and Smart Wireless Gateway.

- **Results:**
  - Smart Wireless technology reduced turnaround time and improved operator safety.
  - Improved Cooling Tower efficiency through accurate information from on-line measurements.
IIOT – Corrosion Monitoring
IIOT – Sulfur Handling – Corrosion Monitoring

- Refinery with four amine absorber / regeneration trains
- All similarly configured, all stainless steel – corrosion NOT expected
  - Much faster and unexpected corrosion in train 4 – 1 year to retirement even in stainless!
  - High CO2 content feed due to preferential routing of FCC off-gas to this train
  - Carbonic acid attack mechanism

Results From IIOT Corrosion Monitoring
- Feeds redistributed to dilute effect of CO2 corrosion across trains and extend run length
IIOT Service Example: Control Valve Condition Monitoring

Major Chemical Company Freeport, TX

**CHALLENGE**
- Connectivity to control valve diagnostic capabilities
- PM activities were not data-driven and were very expensive

**SOLUTION**
- Installed WirelessHART THUMS on Fisher DVCs
- Used WirelessHART connectivity to provide a Control Valve Condition Monitoring service

**RESULTS**
- Identified a potential failure on a critical valve that would have caused a **plant shutdown** for 2-3 days resulting in millions of pounds of lost product.
- Improved maintenance **work process** on control valves (data-driven)

“We would not have caught this condition ourselves. We would have run this valve to failure and it would have shut the train down for at least 2 days. This would have also affected a downstream plant that relies on this plant for product.” - Associate Reliability Manager

Submitted abstract for 2017 Emerson Exchange

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IIOT Architecture
IIOT Architecture – Many Options

**Analytic Apps:**
Diagnose / predict anything you can imagine!

**BI / Analytics Engine:**
SAS, Tableau, Seeq, Azure ML, Batch Analytics

**Platform & Programming:**
PI, Hadoop, SQL, DocumentDB, MongoDB, Cassandra, Java, Python

**Connectivity:**
HART, FF, OPC, Profibus, EthernetIP, MQTT, AMQP, DDS

**Cloud Environments:**
- Azure
- Predix
- Bluemix

**Sensors:**
Emerson, Others

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Prototype Plant Architecture For IIoT Service

- HART
- HART Multiplexer
- TCP/IP
- DCS Wireless HART I/O
- Data Diode
- AMQP
- IT Network Firewall(s)
- Microsoft Azure IoT Hub
- Cellular Modem
- AMQP
- WirelessHART
- HART Multiplexer
- TCP/IP
- Data Diode
- AMQP
- AMQ P
- AMQ P
- AMQ P
What About Security?
Multi-Vendor Cyber Security

• Multiple vendors may need access
  – Many asset classes
  – Many equipment manufacturers
• Proper access rights for each vendor
• Note – Read-Only Monitoring (No remote equipment changes)
• Such solutions already exist
How To Get Started
Barriers To IIOT

Figure 3: Key barriers in adopting the Industrial Internet

Q: What are the greatest barriers inhibiting business from adopting the industrial Internet?

- Lack of interoperability or standards: 65% overall, 60% North America (n=43), 67% Europe (n=30)
- Security concerns: 64% overall, 60% North America (n=43), 72% Europe (n=30)
- Uncertain ROI (e.g., insufficient business cases): 63% overall, 60% North America (n=43), 53% Europe (n=30)
- Legacy equipment (e.g., no connectivity or embedded sensors): 38% overall, 33% North America (n=43), 47% Europe (n=30)
- Technology immaturity (e.g., large-scale analytics): 24% overall, 21% North America (n=43), 27% Europe (n=30)
- Privacy concerns: 14% overall, 19% North America (n=43), 20% Europe (n=30)
- Lack of skilled workers (e.g., data scientists): 12% overall, 15% North America (n=43), 20% Europe (n=30)
- Societal concerns (e.g., economic dislocation): 3% overall, 5% North America (n=43), 3% Europe (n=30)

Source: World Economic Forum Industrial Internet Survey, 2014
IIOT Program

Assessment → Initial Implementation → Sustaining Savings
Assessment Steps

- Get Organized
- Management Sponsor
- Find The Pain
- Pick The Low Hanging Fruit
- Estimate The Costs And Benefits
- Get Funding
Assessment Methodology

- **Current Performance Assessment**
- **Potential Actions Development**
- **Cost/Benefits Analysis**
- **Prepare Implementation Plan**

**External Benchmarks**

**Future Applications**

**Benefits Catalog**

**Process Information**

**Business Goals**

**Plant Economics**

**Local Costs**

**Project Investment Components**

**Maintenance Resource Requirements**

**Assessment Checklists**

**IIOT Assessment Team**

**Site**

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Prioritize Business Challenges

- Can I increase throughput?
- Am I looking at the correct leading indicators?
- Are my plans on target?
- How do I find sources of fluctuations?
- Is my equipment performing correctly?
- How do I detect future events before they happen?
- Will my equipment make it to the next turnaround?
Technology with a Purpose
- Not technology for technology’s sake

- Conduct a plant modernization audit...
- Collect needs from each department in the plant
- Pervasive use of sensors
- Each and every sensor has a purpose

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<th>Availability/Reliability</th>
<th>Maintenance</th>
<th>Integrity</th>
<th>Energy</th>
<th>HS&amp;E</th>
<th>Operations</th>
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<td>Heat exchanger fouling</td>
<td>Inhibitor injection</td>
<td>Water balance</td>
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<td>Mechanical seal failure</td>
<td>Fouling in cooling towers</td>
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<td>Flare and vent reduction</td>
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Sustaining The Program

Keys To Long Term Program Success

• Accountability – Need To Have A Specific Individual Or Group Responsible
  – Need Top Management Sponsor And Support

• Visibility – Need Regular Reporting Of Results And Trends To Plant Management ($/ Yr Savings)

• Monitoring – Need Automated Calculation Of Equipment, Unit, And Site KPI’s
Summary

- IIoT transforms how plant is run and maintained
  - More proactive
  - Less reactive

- IIoT transforms how personnel work
  - Less time spent collecting data
  - More time to act on the new information

- The standards and technologies are already in place
  - You can start today
  - Some plants have already taken the first few steps
Thank You!