Digital refinery
Connecting the unconnected assets and processes
In this age of connectivity and mobility that has enhanced user-oriented patterns in every aspect of life, there is an impending need to apply this concept to industries and more specifically to a traditional industry like Oil & Gas. This point of view is an enabler to the direction that will allow connecting the unconnected aspects of refining, leveraging the robust platform of Industrial Internet of Things (IIoT).

**Current scenario and gap**

Present global refineries are all highly instrumented and are process controlled in real time on a millisecond basis. Distributed Control Systems & Programmable Logic Controllers (DCS & PLCs) have evolved in a significant way to cope up with the ever-increasing demands of operational demands. However, there are certain assets and processes in a refinery that are still not being monitored or analyzed on a real-time basis. These assets and processes are not super critical regarding refinery process control or safety or operational bottlenecks and hence not mandatorily monitored through DCS/PLCs. The reason maybe is they are not economically viable to route through DCS/PLC. They are primarily monitored periodically and sometimes through manual intervention only. Analysis of performance history or failure prediction is not possible. Few examples of these type of assets and processes are steam traps, pressure relief valves, corrosion monitoring, catalyst life, liquid carryover in compressors, dosing chemicals, primary supply & distribution, etc.

However, if there is a more cost-effective way of monitoring them on a real-time basis, they can contribute significantly to improving the productivity, efficiency, asset life, process safety and hence the GRM.

**What's new to enable change**

Advancement of technology and Industrial Internet of Things (IIoT) is inspiring new and innovative ways to boost operational efficiency. It has opened up more accessible and more cost-effective channels of monitoring processes. This will enable all those assets and processes to get connected and monitored on a real-time basis in a simpler, cost-effective and easy to implement manner that were hitherto unconnected. This will enable the below possibilities:

- Shift from periodic or manual inspection to realtime monitoring of certain assets and processes
- Enable on-the-edge analysis at your premises or from central locations as per need
- Even for the connected process parameters, this has enabled exposure of critical process operational data with the process licensors like UOP, Bechtel, Linde, KBR who can run performance analysis and optimization models outside the refinery premises and come back with following recommendations
  - Debottlenecking process constraints
  - Failure predictions
  - Yield loss, catalyst life recommendations
  - Spare parts planning

**How it works**

To illustrate with an example of how IIoT enables connecting the unconnected, consider the common Pressure Relief Valve (PRV). The PRV is supposed to discharge excess gas from containers and pipes beyond a set pressure. Over a period, springs in the PRVs suffer from fatigue and their set-points change and the PRVs start leaking gas into the environment at a lesser pressure. This leads to lost products and environmental and safety hazard. PRVs are un-instrumented and also mounted in inaccessible places making manual inspection challenging. Therefore, they are left to be tested only during turnarounds/shutdowns. However, the recent stringent safety regulations have made it mandatory to monitor PRVs electronically. The solution is to add an IIoT differential pressure sensor across the PRV that will monitor the health of the PRV in real time.
This will transmit the real-time information directly to Data Historians or to IIoT Platforms—without having to be connected to the DCS or PLC. Any malfunctioning PRVs will be detected immediately on real time and can be actioned upon without having to wait for months for the next shutdown. Imagine this happening for all the thousands of PRVs in a refinery. Studies have shown that real-time monitoring of all PRVs in a refinery can potentially lead to additional ~20% savings in operating costs.

Another example can be the steam traps. Steam traps are currently monitored monthly. So any steam trap failure will wait for about 20 to 30 days before it gets replaced. The impact is condensate held up in steam lines or steam passing to condensate header; both scenarios lead to inefficient heat transfer and process operation. An IIoT enabled acoustic sensor can be mounted on the steam trap. Once a steam trap fails, it will emit sound greater than the desired decibel. The IIoT sensor can send the information directly to the data historian for realtime monitoring and analysis—enabling instant action and replacement of the steam trap as soon as it fails, instead of waiting for the next inspection after 30 days.

It is imperative to ensure effective collaboration between the organization and the new solutions provider to achieve success in transition.

Typical architecture in case of a steam trap is shown as below:

The high-level steam trap-IIoT architecture

- **Field Data**
  - Steam trap
  - Wireless acoustic transmitters
  - View real time data and alerts
  - Field mobile device

- **Running edge platform**
  - Edge device

- **Connectors**
  - Routers & embedded connectors

- **Cloud**
  - Data historian
  - Web API
  - Or
  - Web API

- **Chart**
  - Capacity
  - 1.21 TB
  - 0 1 2
The fundamental architecture for a connected solution involves:

**Site area:** Retrofitting equipment with appropriate IIoT sensors, connecting distributed equipment and pushing the data out through a communication gateway to the data historian or IIoT platform

**Security:** Ensuring data security between the sensor and the receiver platform

### Unlocking hidden value

A long list of such assets and processes can benefit from the above solution. Some examples:

#### Solution overview

<table>
<thead>
<tr>
<th>Field</th>
<th>Control room</th>
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<tbody>
<tr>
<td>Compressor liquid carryover detection</td>
<td>IIoT moisture analyzer or gas composition analyzer</td>
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<tr>
<td>Replacement for corrosion coupon</td>
<td>IIoT ultrasonic sensors on the equipment’s surface for thickness monitoring</td>
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<tr>
<td>Blockages and obstructions in equipment</td>
<td>IIoT sensors send acoustic waves down the pipeline and analyze the pattern of reflected waves.</td>
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<tr>
<td>Optimization of chemical dosage</td>
<td>IIoT enabled flow metering system will help monitor operating parameters</td>
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<tr>
<td>Leak detection (under surface leaks and gas leaks)</td>
<td>IIoT thermal imaging sensor and computer vision techniques to automate the monitoring and alerting process</td>
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<tr>
<td>Primary supply and distribution visibility</td>
<td>IIoT enabled edge devices to push the data from terminal tank farms, pumping stations, berth operations, vessels, pipeline operation and intermediate tank farms (across supply &amp; distribution) to data historian and/or into analytics platform directly</td>
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<tr>
<td>Desalter filter efficiency</td>
<td>IIoT enabled differential pressure sensor will help monitor operating parameters</td>
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**Receiving system:** The data from the sensor can come directly to the data historian or IIoT platform. The historian will store data, perform analysis—corrective/advanced/predictive/prescriptive, enable KPI dashboards, visualization and mobile messaging/access to enable corrective action in real time.

Connect to the data historian and/or into analytics platform directly without connecting to DCS/PLC.
Facing the challenges

To implement the above and make it a reality, a refinery may face several challenges. There could be interoperability issues, inability to identify right business cases, lack of technological maturity and a dearth of the required technical skills. However, these are not intractable challenges. A majority of them can be quickly addressed. Wipro’s digital frameworks and tools help organizations identify the right opportunities, mitigate challenges, and architect solutions with a contextual roadmap.

About the authors

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Arnab Sarkar leads a global team of domain and technology professionals in the areas of Manufacturing Execution System. Over a period of 22 years, Arnab has had extensive experience in Greenfield Refinery Implementation & Commissioning, Plant Maintenance in Refineries, IT enablement of Brownfield & Greenfield Plants across roles of go-to-market, solution design, delivery and project management of large complex programs.

In his role as a practitioner, he has successfully built centres of excellence with domain capability to win and deliver multiple projects globally from consulting, end-to-end implementation, integration, run & maintain of MES applications for refineries mainly in the areas of asset reliability & integrity, planning & scheduling, data reconciliation and yield accounting, operations management, performance management and real time systems. In his current role he is responsible for advising clients on IT enablement of manufacturing plants, creating innovative solutions and developing competencies that can provide the right technology enablement in a challenging industry environment.

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