Pipelines 4.0 – The future of oil pipelines
Table of Contents

Addressing the Challenges 3
Drive Train Analytics 4
Pump Analytics 6
Connectivity as a Service 7
Smart Pumping 8
Digital Fleet Management 9
Tank Farm Optimization 10
Visualization and Control 11
Pipeline Integrity Monitoring 13
Strategic Partnering 14
Digitalization underpins these solutions

We believe that industrial digitalization – Pipelines 4.0 – is foundational to each of the solution opportunities above in three ways:

- It generates the “digital twin”, which enables design, engineering, commissioning and ongoing optimization in cyber space, saving money and reducing the risk of operational disruption.
- It lowers barriers to exploitation of off-site technical resources, e.g., remote support and outsourcing.
- It creates a business and operational environment that has greater ability to attract and retain top technical talent.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Digitalization Solutions</th>
<th>Outlining the Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Reduce the risk of “abnormal” events</td>
<td>Through the rest of this document we share ideas for how digitalization can be employed across a number of key application areas to achieve better short- and long-term outcomes.</td>
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<td>Uptime</td>
<td>Reduce operational failure modes</td>
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<td>Workforce Attrition</td>
<td>Exploit remote operations</td>
<td></td>
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<tr>
<td>Environmental Stewardship</td>
<td>Reduce environmental failure modes</td>
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<td>Energy Efficiency</td>
<td>Maximize component and system efficiency</td>
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<tr>
<td>Cost Competition</td>
<td>Reduce all failure modes</td>
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<td></td>
<td>Virtually expose and eliminate safety threats</td>
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<td></td>
<td>Employ predictive maintenance</td>
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<td></td>
<td>Enable remote diagnostics and troubleshooting</td>
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<td>Reduce energy consumption</td>
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<td>Increase process visibility and control</td>
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<td>Reduce waste across OPEX, CAPEX and MRO</td>
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Drive Train Analytics

Drive Train Analytics (DTA) provides the capability to derive valuable insights from "big data" for motors, variable frequency drives and gearboxes. DTA integrates advanced data analytics, machine learning, human expertise, and cloud capabilities to enable condition monitoring of a pipeline’s many drive trains. Its three main benefits are:

1. Condition monitoring, to 1) proactively alert operators to growing potential for a fault or trip in a drive train that could enable them to address the specific issue before one occurs, preventing a production disruption, and 2) reactively provide immediate expert access to fault information to expedite system troubleshooting and restoration.

2. Condition-based maintenance, to help operators optimize maintenance more to drive train needs than to schedules, potentially saving unnecessary labor and parts expenses. It also enables needed maintenance to be conducted in planned operational windows, reducing unplanned maintenance that can disrupt production.

3. Asset optimization, to enable operators to use performance analytics of individual or entire fleets of drive trains, either site-specific or across multiple sites, in ways that can provide insights and decision support to improve their function, such as using less energy, or offering guidance in developing new drive train specifications.

Drive Train Analytics (DTA) works by pushing a highly-secured stream of continuous drive train operational, environmental, and status data to a cloud-based server, database, and storage platform.
Because pipelines are considered critical energy infrastructure by the U.S. Department of Homeland Security, cybersecurity is of paramount importance. Siemens Drive Train Analytics – the drive train analytics model Siemens developed for its installed base – safeguards customer drive data with the highly-secure Siemens MindSphere operating system. Data at rest is stored in highly-secured infrastructures provided by leading cloud data center partners. These partner providers typically employ more sophisticated, defense-in-depth approaches than what might be found protecting the local, on-premise data storage of many oil and gas companies. In all cases, you continue to own the data. It is kept separate and secure from other users and can be freely retrieved and moved at any time, just as if it were on-site.

**Monitoring drive train conditions in real-time, 24x7**

By using drive train analytics, you will gain the ability to conduct real-time condition monitoring of connected drive train assets.

Engineers and technicians can drill down into historical and real-time data for a specific drive train operating in any process unit of any station that is connected to the DTA platform.

In all cases, whenever an out-of-limit variance occurs in the operating parameters of any drive train component, the event is logged and its data immediately analyzed for any role in any broader pattern of anomalous behavior in the drive train. At the same time, alerts of drive train component faults can be sent to operations and maintenance staff, whether they are onsite or remote, via their preferred contact channels – email, text, or voice call. That’s in addition to providing them with decision support of the appropriate response, which can be set with pre-determined business rules and escalation paths.

With Siemens Drive Train Analytics, your personnel can choose to immediately escalate issues for expert 24x7 support from Siemens operations centers. This rapid response model can help compress the MTTR cycle for your drive trains to a fraction of what it may have been before. That’s because both pipeline staff and the remote experts can view the same fault data simultaneously, while the latter can also quickly access and push to the onsite staff the relevant documentation they need to troubleshoot and fix the problem. This can be especially valuable for resolving issues that may be unfamiliar due to their infrequency.

Recently, for example, a major power customer deployed Siemens Drive Train Analytics at one of its largest U.S. plants. When a drive unexpectedly tripped, the rapid response model was triggered and the drive was back in production about 85 percent faster than the company’s prior troubleshooting approach, which would have taken many hours longer. The customer determined that bringing the drive back online more quickly helped them avoid $120,000 in costs.
Siemens and a strategic pump OEM (name withheld to maintain confidentiality) have teamed up to integrate pump and drive train analytics, and create a comprehensive approach to oil pipeline heavy equipment monitoring. This new approach will integrate the technologies with the objective of creating a complete pump/drive train analytics capability at pump stations.

Through refinement on one or more pilot projects, Siemens and our OEM partner can apply this approach on multiple pumping assets and offer many of the same capabilities as drive train analytics, including predictive analytics, improved diagnostics and troubleshooting, efficiency optimization, and performance monitoring and visualization.

As this approach develops it will naturally expand in its ability to pull in more data from the machines, enabling additional conclusions and stronger insights into system performance and health.

Our vision is an integrated analytical capability that considers information about the entirety of the pump train to optimize total pumping performance.
Connectivity as a Service

Pipelines face several unique challenges in adopting IIoT:

- Limited available bandwidth out of remote sites
- Limited abilities to assess and mitigate risk of disrupting critical SCADA communication
- Lack of existing and/or standard approach for data transmission security
- Limited resources to address challenges

Siemens can help you overcome these obstacles by offering communications hardware and software, connectivity services and cybersecurity consulting. We call this **Secured Connectivity as a Service (SCaaS)**. SCaaS includes:

- Enabling connectivity of components
- Use of edge devices for data processing, securing, and IIoT gateway
- Secure data transmission, including wireless, cellular, satellite and/or other means
- Data warehousing

Siemens “defense in depth” cybersecurity expertise has been developed over decades and is continuously augmented to meet the most rigorous, current national and global standards.

The cybersecurity portfolio for energy companies includes several conceptual steps illustrated as follows:

**Siemens Cybersecurity Offering for Energy**
Energy optimization in a pipeline involves complex, multi-variable equations that must be continuously solved. Factors such as individual pump efficiencies, pump station efficiencies, varying energy costs between stations, and the delicate balancing of the cost/benefit of expensive DRA concentrations must all be considered. Siemens Smart Pumping technology addresses all of these variables to maximize overall energy efficiency in pipeline operations.

Smart Pumping eliminates the need for complex manual spreadsheets or other tools that usually do not effectively consider all of the relevant variables. Our Smart Pumping solution uses both on-premise and cloud-based analytics to optimize energy usage by:

- Using continuous, real-time energy monitoring to optimize the output and overall operating profile for each pump station and across the pipeline
- Considering energy price differential along pipelines, and enabling more focused discussion and negotiations with key utility partners
- Optimizing DRA application
- Providing intelligent analysis for station-to-station load balancing and proper handling of transient operations (batch changes)
- Enabling ratchet penalty avoidance
- Increasing life span of capital equipment by minimizing and/or avoiding pressure surges, mechanical wear, and overheating
- Central tracking and storage of dynamic pump performance profiles and pump station energy price data
Large drives and motors are normally found in operationally-critical applications where extremely high reliability is required. Data from these machines can be used to improve performance and transparency, enabling dramatically improved asset and fleet performance, reduced costs, and improved productivity.

Our Digital Fleet Management approach addresses two kinds of data:

- **Static data**, such as drawings, performance curves, configuration and BoM, component traceability, and spare parts inventories
- **Dynamic data**, such as operating status, alarms, current and prescriptive maintenance plans

We make this data available at the click of a mouse, accessible securely by authorized parties. The data will drive regular conversations about equipment status and health, as well as potential improvements.

Ready availability of this real time and configuration data allow the assets’ risk profiles to be understood and managed appropriately in a planned and predictable manner. All of this simplifies collaboration between operation sites, central corporate technical experts, and external (e.g., Siemens) experts.

**Recapping the benefits of Digital Fleet Management:**

- **Drive Train Analytics**
  - Improve consistency of operational set-up parameters
  - Enable control and tracking of firmware and software
  - Provide centralized storage of drawings and documents
  - Maintain digital “issue log” and equipment history that is available globally, including lessons learned
  - Obtain information on product and related updates
  - Obtain information on availability of spare parts: at a warehouse, from other sites, or from Siemens; create consignment potential

- **Performance Management**
  - Obtain real-time, fleet-wide operating performance information and health status remotely using Siemens Drive Train Analytics
  - Allow for performance trending and comparison between similar equipment
  - Obtain preventive and predictive / prescriptive maintenance information
  - Expedite unplanned issue resolution and minimize any technical or operational support delay
  - Allow rapid remote diagnostic and troubleshooting for faults, trips and alarms
  - Enable optimization of the equipment based on fleet wide experience

- **Configuration Management**
  - Obtain information on product and related updates
  - Obtain information on availability of spare parts: at a warehouse, from other sites, or from Siemens; create consignment potential

- **Smart Pumping**
  - Obtain information on product and related updates
  - Obtain information on availability of spare parts: at a warehouse, from other sites, or from Siemens; create consignment potential

- **Digital Fleet Management**
  - Obtain real-time, fleet-wide operating performance information and health status remotely using Siemens Drive Train Analytics
  - Allow for performance trending and comparison between similar equipment
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  - Enable optimization of the equipment based on fleet wide experience

- **Tank Farm Optimization**
  - Obtain real-time, fleet-wide operating performance information and health status remotely using Siemens Drive Train Analytics
  - Allow for performance trending and comparison between similar equipment
  - Obtain preventive and predictive / prescriptive maintenance information
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  - Allow rapid remote diagnostic and troubleshooting for faults, trips and alarms
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- **Visualization and Control**
  - Obtain real-time, fleet-wide operating performance information and health status remotely using Siemens Drive Train Analytics
  - Allow for performance trending and comparison between similar equipment
  - Obtain preventive and predictive / prescriptive maintenance information
  - Expedite unplanned issue resolution and minimize any technical or operational support delay
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  - Enable optimization of the equipment based on fleet wide experience

- **Pipeline Integrity Monitoring**
  - Obtain real-time, fleet-wide operating performance information and health status remotely using Siemens Drive Train Analytics
  - Allow for performance trending and comparison between similar equipment
  - Obtain preventive and predictive / prescriptive maintenance information
  - Expedite unplanned issue resolution and minimize any technical or operational support delay
  - Allow rapid remote diagnostic and troubleshooting for faults, trips and alarms
  - Enable optimization of the equipment based on fleet wide experience
Tank Farm Optimization

Effective tank farm management is critical to product availability and is a significant influencer of reliability, environmental compliance and operating expense.

Siemens tank farm optimization program offers an automation and digitalization master plan for your tank farm, including concept definition, basic and detailed design and support through execution. Cloud-based data processing and optimization of operations (e.g., tank inventories and loading/unloading procedures), as well as cybersecurity, physical security and safety of operations are built in to the system. And, you also benefit from complete lifecycle services, such as obsolescence and spare parts management and predictive, preventive and corrective maintenance.

The Siemens Terminal Management System (TMS), for example, is a modular system for managing loading schedules, tank status, product inventory, order management, reporting and traceability, and security access control.
Visualization and Control

COMOS

Today, it is possible to use Siemens COMOS software to build and maintain a life-like digital model of a pump station or other unit operation. At design time, this model keeps all engineering disciplines involved in a project synchronized, even though they may be working from many locations. Each discipline has direct access to the most current specifications for every piece of equipment in the manufacturing environment, eliminating typical project error/rework cycles.

COMOS Walkinside uses the design engineering data to generate 3D, virtual-reality models of the entire station. One interesting advantage of this is a unique and immersive training experience with intuitive, game-like navigation. This is a particularly valuable learning mode for the next generation, technical workforce. Such immersive training can create high skill levels, even before the physical station or unit is taken into operation.

COMOS speeds up and simplifies the commissioning process. Once the new or re-engineered station or unit is finalized virtually, it can be passed to the Automation Designer where control loops, safety interlocks, etc. can be developed and tested against a range of processing conditions, all without ever touching the physical equipment.
## Visualization and Control

**XHQ**

<table>
<thead>
<tr>
<th>Short Term</th>
<th>Drive Train Analytics</th>
<th>Pump Analytics</th>
<th>Connectivity as a Service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mid Term</strong></td>
<td>Smart Pumping</td>
<td>Digital Fleet Management</td>
<td>Tank Farm Optimization</td>
</tr>
<tr>
<td><strong>Long Term</strong></td>
<td>Visualization and Control</td>
<td>Pipeline Integrity Monitoring</td>
<td>Strategic Partnering</td>
</tr>
</tbody>
</table>

XHQ Operations Intelligence software provides visibility that overarches operational and business systems such as ERP, MES, production databases, process historians, and more. Our customers in refining and chemical processing have used this software to create real-time dashboards that support complex operations.

XHQ aggregates, relates and presents operational and business data in a dashboard to support real-time performance management and decision making. The results are dramatic improvements in process visibility and control, leading to increases in efficiency, reduction of downtime, and improved predictivity of operational results.

XHQ can display information around process and production, as well as around specific assets, like maintenance plans/history and performance information. In-depth analysis capabilities, like data trending and historian functions, allow users to chart the performance of their overall process and its components in order to optimize them. You can also summarize operations and aggregate pipeline data with intelligent drill-down to detailed dashboards to facilitate root-cause analysis.

### Pipeline Utilization and Optimization
- Scheduling
- Pump optimization
- Asset maintenance and reliability
- Energy-efficient management

### Crude Supply Tracking
- Reporting and monitoring of upstream crude supply
- Monitoring crude delivery constraints

### Pipeline Safety and Integrity Monitoring
- Support risk reduction decision making
- Leak detection monitoring
- Environmental issues
- Alarm monitoring
Pipeline Integrity Monitoring

Siemens is developing new advanced technologies for improving the monitoring of a pipeline’s physical integrity. Some of these technologies have their roots in the sophisticated health care imaging, 3D scanning and visualization, and power/energy technologies found in the broader Siemens portfolio. Siemens has recognized the potential to combine and leverage these technologies towards an improved and less-costly approach to assessment of pipeline health.

Customer benefits include process optimization, maximized efficiency, increased pipeline security and integrity, reduced OPEX, improved personnel safety, and environmental stewardship. These technologies can be deployed across the your pipeline network as they are developed and eventually implemented into standard operating procedures for monitoring pipeline health and identifying compromised assets.
Strategic Partnering

In addition to the real digitalization benefits of improved productivity, efficiency, and uptime the resulting transparency of asset performance described in prior sections of this document has the potential to improve the strategic value of your suppliers (like Siemens). We see this as creating a platform to further engage us in your success by working interactively with you to enhance asset performance, optimize CAPEX/OPEX spend, and reduce unplanned disruptions.

Getting closer to your KPIs through more regular interaction opens up the possibility of new types of flexible payment and financing models such as:

- Performance and/or availability guarantees
- Pay-for-performance buying models
- Leasing models and/or other means for deferred CAPEX
- "X-as-a-service" buying/delivery models (pumping, speed/torque, etc.)

Such innovations – which have long been discussed across industry – are enabled by digitalization. In the end, these new business models with key suppliers will encourage a continued, interactive dialog between organizations to optimize the productivity of the pipeline in the most desirable economic manner.
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