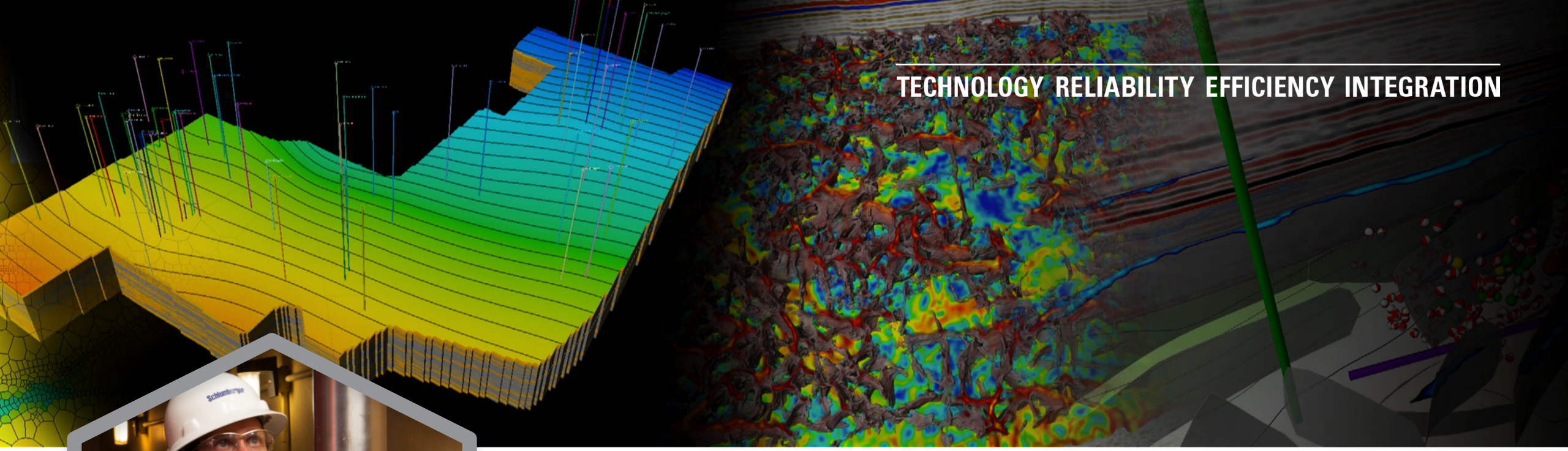
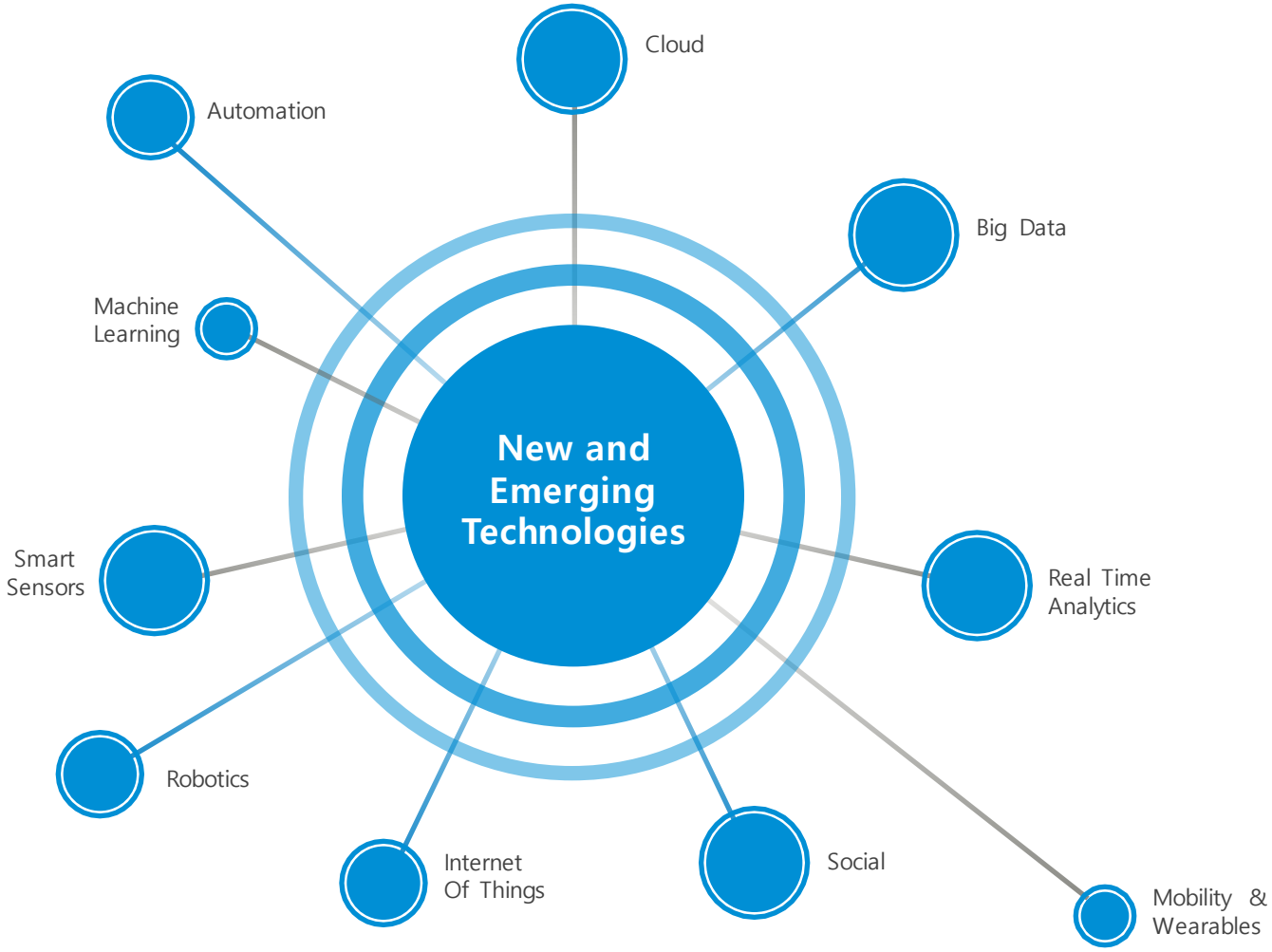


Revolutionizing Oil & Gas Prognostics and Health Management

Neil Eklund, Ph.D.
Chief Data Scientist
PHM Society Conference – October 2016

Schlumberger

“Big Data” Meets “Internet of Things”



Across all industry sectors, companies see enormous opportunity arising from these new technologies.

Reacting faster and more intelligently by analyzing data streams generated from connected sensors and devices.

Analytics is Revolutionizing Industries

What It Is

"… a process of inspecting, cleaning, transforming, and modeling data with the goal of suggesting conclusions, and supporting decision making."

Common types of analytics:

- Business analytics
- Web analytics
- Social network analytics
- Equipment analytics
- Talent analytics

Why is it relevant

- Productivity in a time of slow growth
- Ability to scale with consistency during growth
- Competitive differentiation on outcomes in complex domains hard to model using conventional methods

Who's Doing It

Business Analytics

IBM, SAP, SAS, Disney, amazon.com, VISA, MGM

Social Network Analytics

facebook, IBM, SAS, LinkedIn

Equipment Analytics

GE, SIEMENS, Honeywell, IBM, GM, John Deere, Boeing, verizon

Why Now

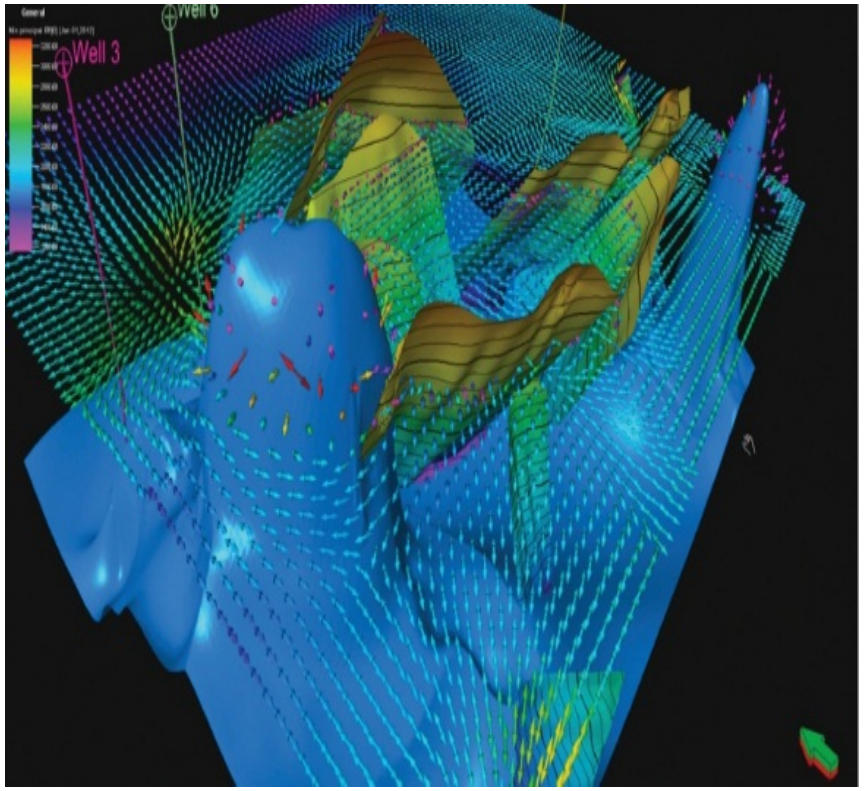
- Powerful open-source tools
- 'Thin Margin' industries
- Mobile, low cost sensing
- Data driven decision making reaching 'C suite'

From Satya Nadella's memo at Microsoft:

"We will be more effective in predicting and understanding what our customers need and more nimble in adjusting to information we get from the market." And as part of that "each engineering group will have Data and Applied Science resources that will focus on measurable outcomes for our products and predictive analysis of market trends, which will allow us to innovate more effectively."

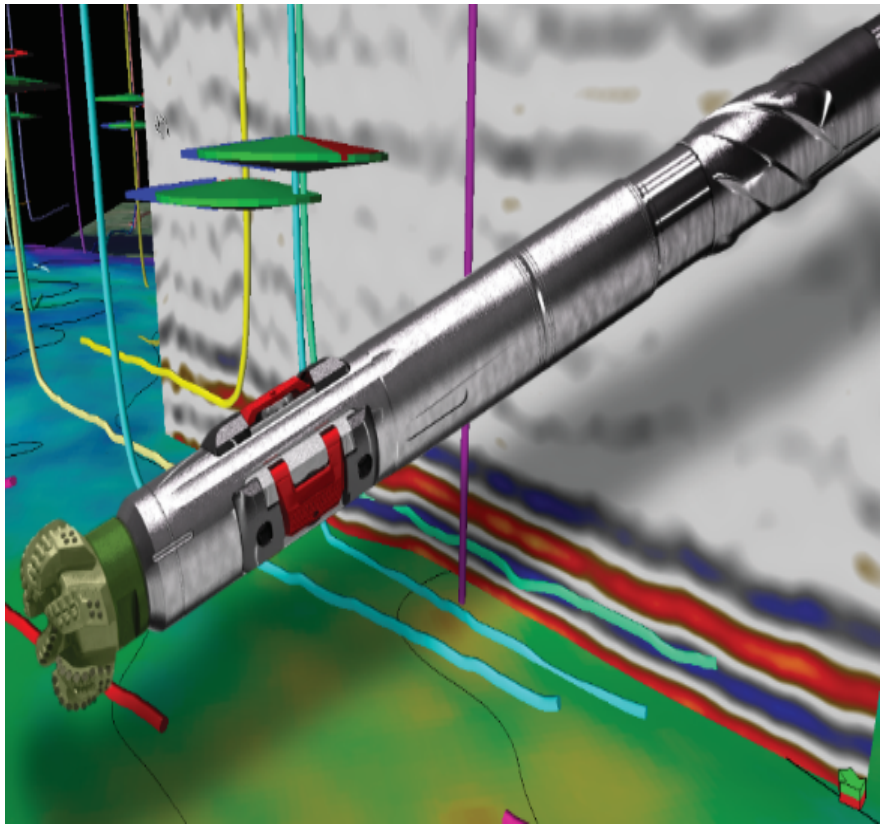
Exploration and Development

- Combining data from multiple sources, such as weather patterns and ice flows from NOAA and historic production records can provide insight toward operational processes, such as the impact of storms on rigs.
- Combining enterprise data, including financials and back-office operational detail, with real-time production data can deliver new insights to customers.
- Create competitive intelligence fusing sources such as geospatial data, news feeds, and other syndicated information sources.



Drilling and Completions

- Use big data to anticipate and avoid interruptions to drilling. Identifying conditions or anomalies that would impact drilling can save millions in labor and equipment costs.
- Real-time information returned from supervisory control and data acquisition systems on field assets can be used to look for opportunities that maximize asset performance and optimize production.



Production and Operations

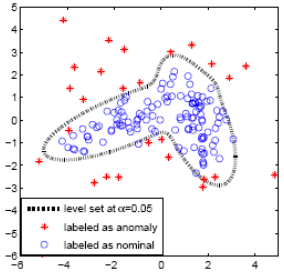
- Integrate seismic, drilling, and production data to provide business intelligence to reservoir engineers.
- Identify sub-par production zones, and shift assets to more productive regions.
- Understand how asset life is affected by variables such as pressure, temperature, volume, shock, and vibration to prevent failure and associated downtime.
- Integrate well and tool maintenance data with supply chain information to optimize scheduling of shop floor maintenance.

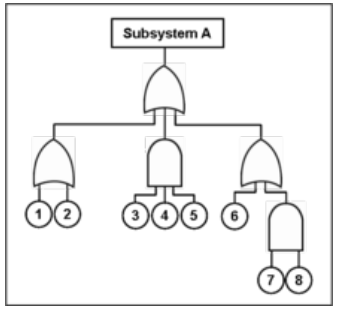
Prognostics and Health Management (PHM)

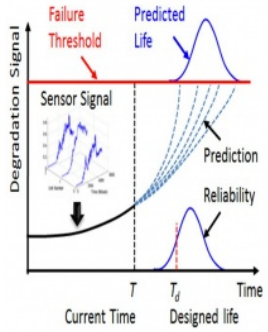
PHM is a comprehensive system of data collection, reasoning methods, diagnostics, remaining life estimation, maintenance optimization, and asset management designed to improve reliability, reduce life cycle costs, and enhance safety.

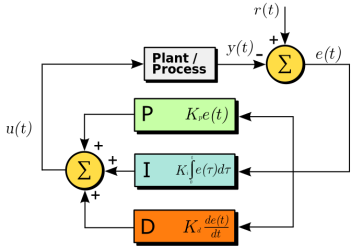
Remote Monitoring & Diagnostics | **Prognostics** | **Control & Optimization**

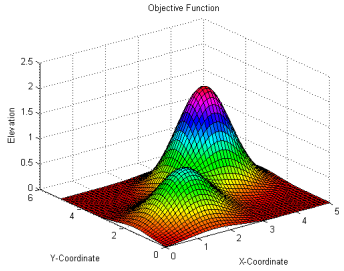
Data Acquisition	Anomaly Detection	Diagnostics	Prognostics	Fault Accommodation	Optimization	Feedback & Learning

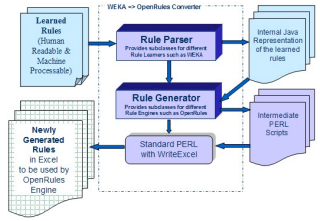






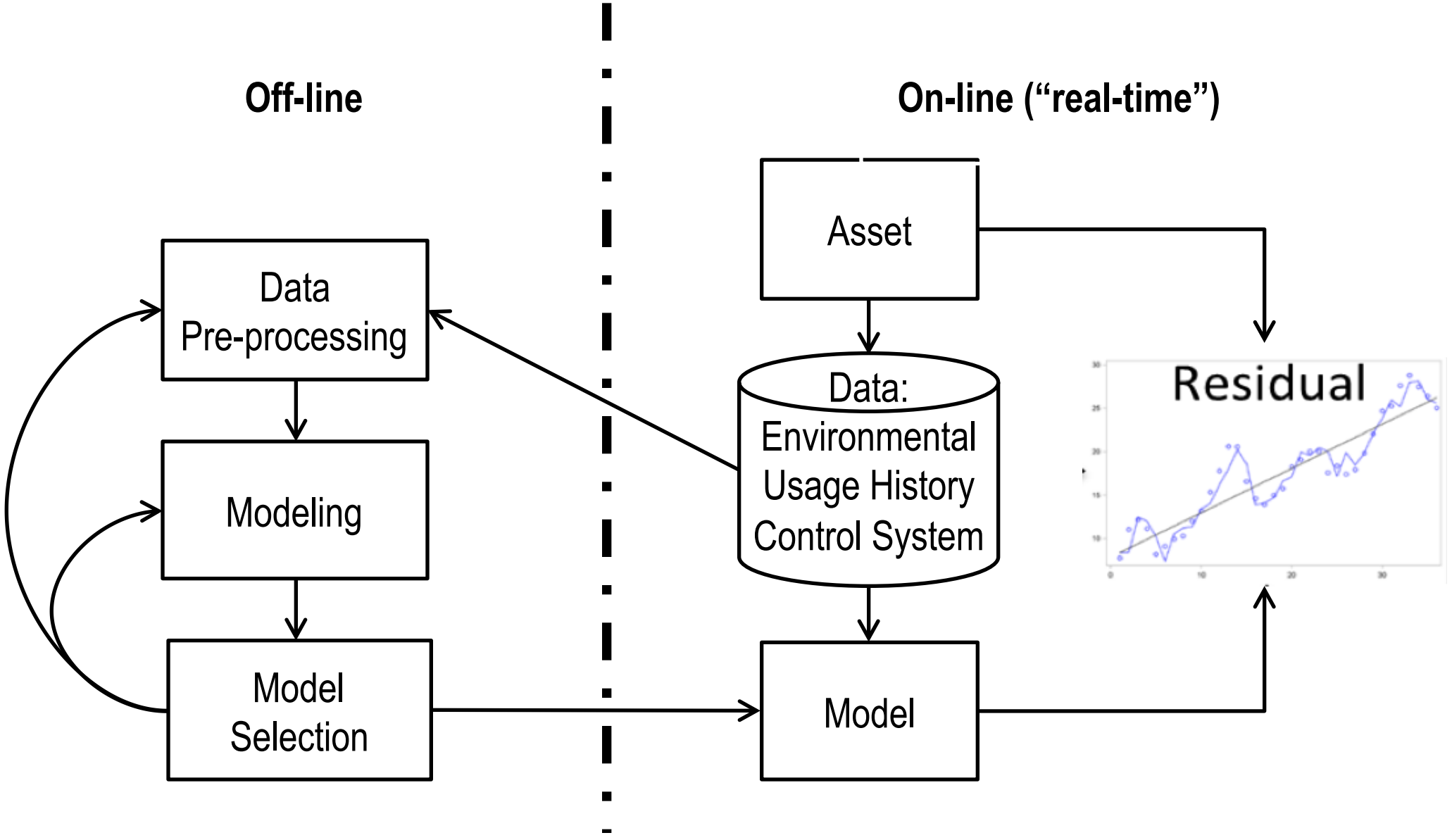






PHM = Intelligent Systems + Intelligent Management

Data-Driven PHM



Impact of PHM at Schlumberger

Predictive analytics system (combined with other measures) for fracturing pump power-end components monitored at Regional Support Centers:

- nearly **$8MM** savings in materials and supplies *since September 2015*

Predictive analytics enabled the development of a Pump Asset Care Program that uses Reliability centered maintenance (RCM):

- **$30MM** accumulated total savings* over a three-year period
- increased asset availability by **8%**

RCM for blenders and hydraulic fracturing pumps along with a comprehensive staff training program:

- approximately **$9MM** savings *over a nine-month period*
- reduced blender-related nonproductive time (NPT) by **64%**

Source: Schlumberger Q2-2016 Earnings Release

* Expected results once fully implemented