Digital Blowout Preventer with the PI System

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Resources: Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.

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COMPANY PROFILE

- Shell is an innovation-driven global group of energy and petrochemical companies
- We are active in more than 70 countries
- Worldwide, we employ 93,000 full-time employees
- Our fuel retail network has around 43,000 service stations
- On average, we produce 3 million barrels of oil equivalent per day (crude oil and natural gas).
- In 2015, we:
  - generated earnings* of $3.8 billion
  - had $28.9 billion of capital investment
  - spent $1.1 billion on R&D
- Royal Dutch Shell plc is a UK company, with its headquarters in the Netherlands
- We are listed on the stock exchanges of Amsterdam, London and New York

*On a current cost of supplies basis attributable to Royal Dutch Shell plc shareholders
Source: 2015 Annual Report and Form 20-F

Company Profile

Accenture is a leading global professional services company, providing a broad range of services and solutions in strategy, consulting, digital, technology and operations. Combining unmatched experience and specialized skills across more than 40 industries and all business functions – underpinned by the world's largest delivery network – Accenture works at the intersection of business and technology to help clients improve their performance and create sustainable value for their stakeholders. With more than 394,000 people serving clients in more than 120 countries, Accenture drives innovation to improve the way the world works and lives. Visit us at www.accenture.com.

Agenda

Business Case

- Domain
- Business Approach
- Case for Change

Solution Overview

- Data
- Displays

Methodology

- Data Engineering

Digital BOP at Shell

COMPANY and GOAL

Shell provides well delivery support and wanted to improve the **reliability of blowout preventers** in their drilling contractor fleet.

CHALLENGE

Manual data reporting provided an incomplete understanding of BOP health and usage.

- Pressures and Temperatures available only via daily readings.
- Usage information limited to best-guess based on time.
- Failures not detected until they exhibited functional symptoms.

SOLUTION

Using the PI System as a data engineering toolkit, Shell implemented a BOP monitoring application.

- Three custom dashboards
- PI Coresight™ screens for ad-hoc trending
- Significant data processing to derive information from data

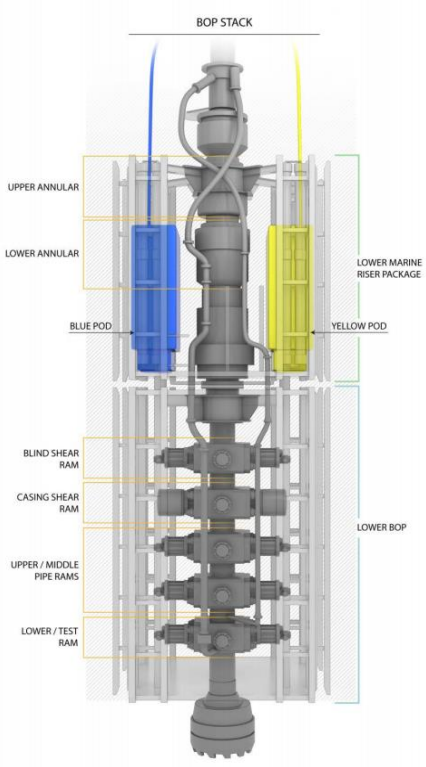
RESULTS

First instance of onshore detection of a control fluid leak in the industry.

- Onshore monitoring of regulatory testing
- Collection of previously unavailable usage information
- Organizational awareness of BOP health

Business Case

What is a Subsea Blowout Preventer (BOP)



- **Pressure Control Safety Equipment**
- **Used for Deepwater Drilling and Completion**
- **Installed on the Subsea Wellhead**
- **Operational Uses (Well Control)**
- **Emergency Uses (Shear and Seal)**

[1]U.S. Chemical Safety and Hazard Investigation Board, 2010, *Investigation Report-Explosion and Fire at the Macondo Well,* **2**, http://www.csb.gov/assets/1/7/Vol_2_Final_Version.pdf, Retrieved on: January 11, 2017.

Digital BOP - Case for Action

BOP is a Major Cause of Non-Productive Time (NPT)

- Testing & Certification
- Unplanned Maintenance
- Component Failures
- Stack Pull Decisions

Digital BOP Objectives

- Continuously Understand the BOP Condition

Digital BOP – BOP Reliability Team

Mission statement

The BOP RELIABILITY TEAM supports Shell's deep-water drilling operations globally by increasing BOP reliability through engineering & operations support, and analysis of BOP performance data.

Operations

- Troubleshooting and Maintenance Support
- Regulatory Compliance Support
- Fleet Failure Tracking
- Real-time Operating Center (RTOC)

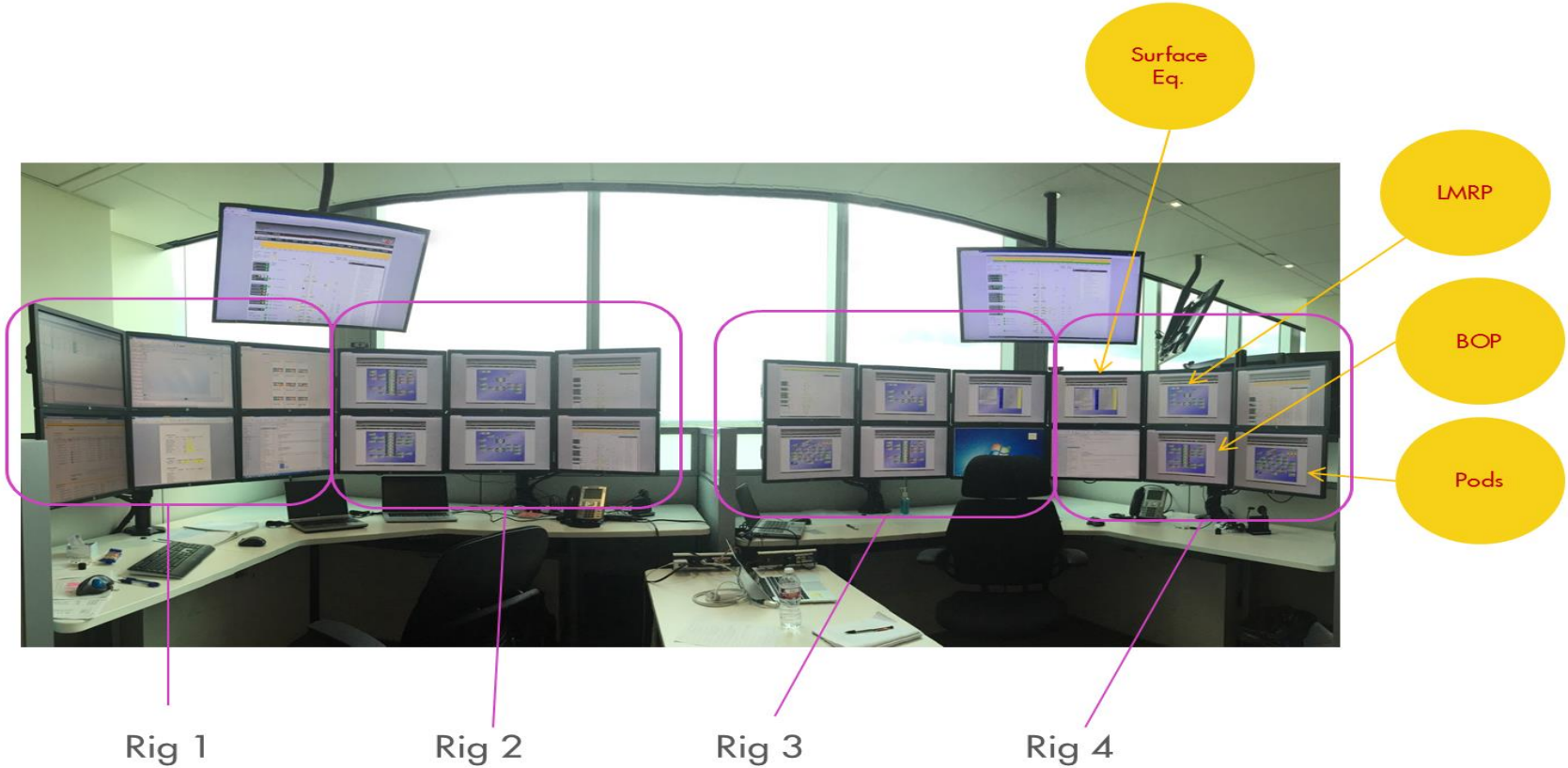
Engineering

- Shear Testing Support
- Accumulator Sizing
- Future Designs / Special Projects

Technology & Data

- Real-time Analytics
- Monitoring Dashboards
- Expert Systems

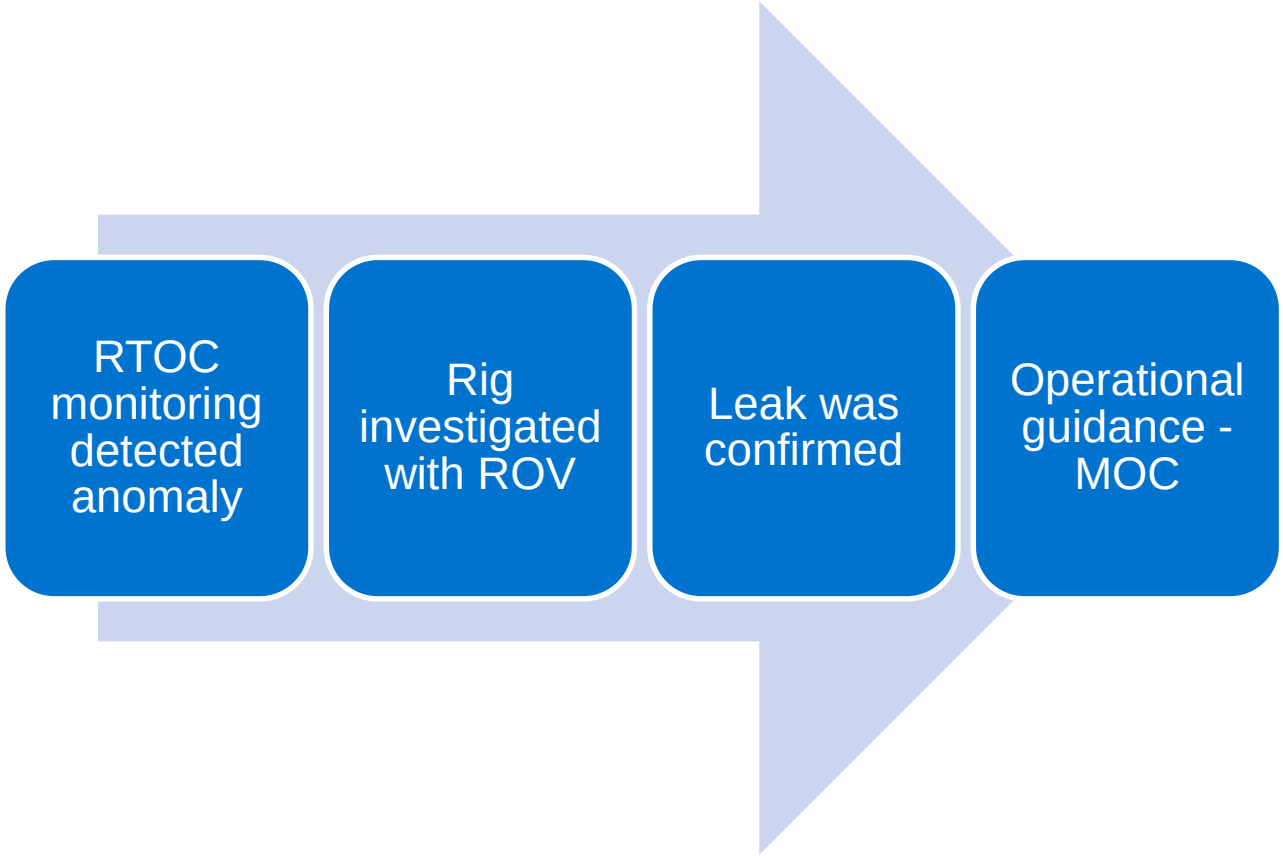
Digital BOP – Real-Time Operating Center (RTOC)



Digital BOP – Opportunities

Remote Certification	Failure Detection	Organizational Awareness	Reliability Statistics	Operational Guidance
Reduce trips offshore	Leaks	Drilling Superintendents	Cycle counts	Function selection
Lower cost for third-party surveyors	Seal failures	BOP Operations Team	Pressure exposure	Maintenance
	Regulator failures	Regulatory	Temperature exposure	Testing Exceptions
	Valve failures		Time subsea	

Digital BOP – Leak Detected

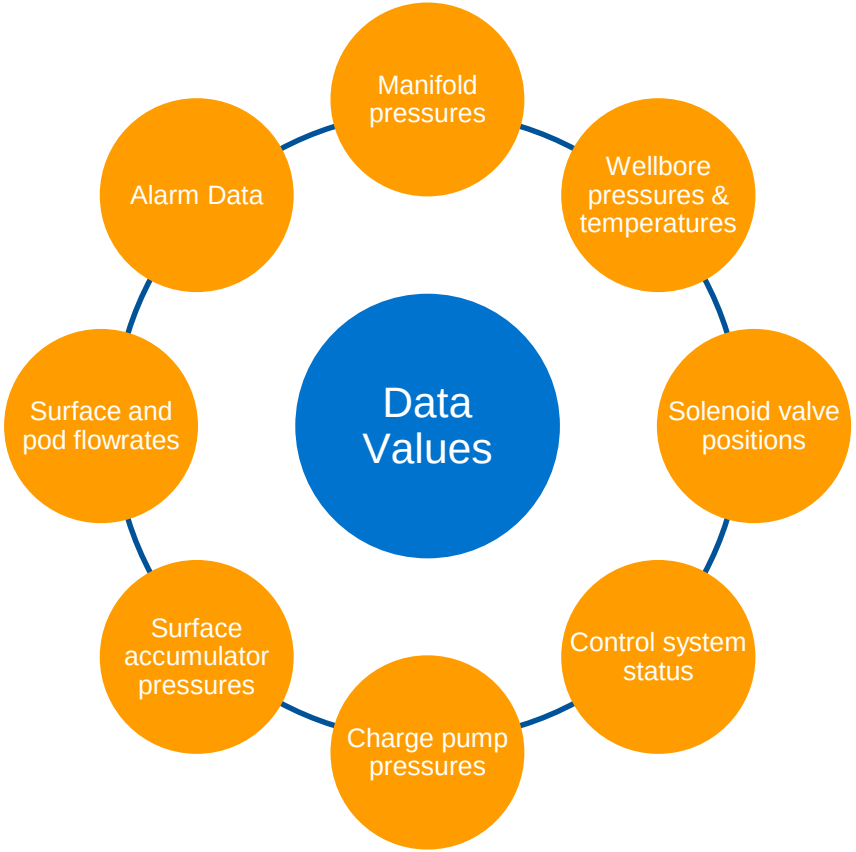


Solution Overview

Digital BOP – Available Data

Digital BOP uses available data from equipment and sensors to improve BOP performance and reliability.
Data sources include:

- **150 individual values**
- **2 redundant electronic modules**
- **2 redundant control pods**
- **20 surface readings**



Digital BOP – Custom Dashboards

Current state of valves and preventers

Valve state history bar chart

Headline readback pressures

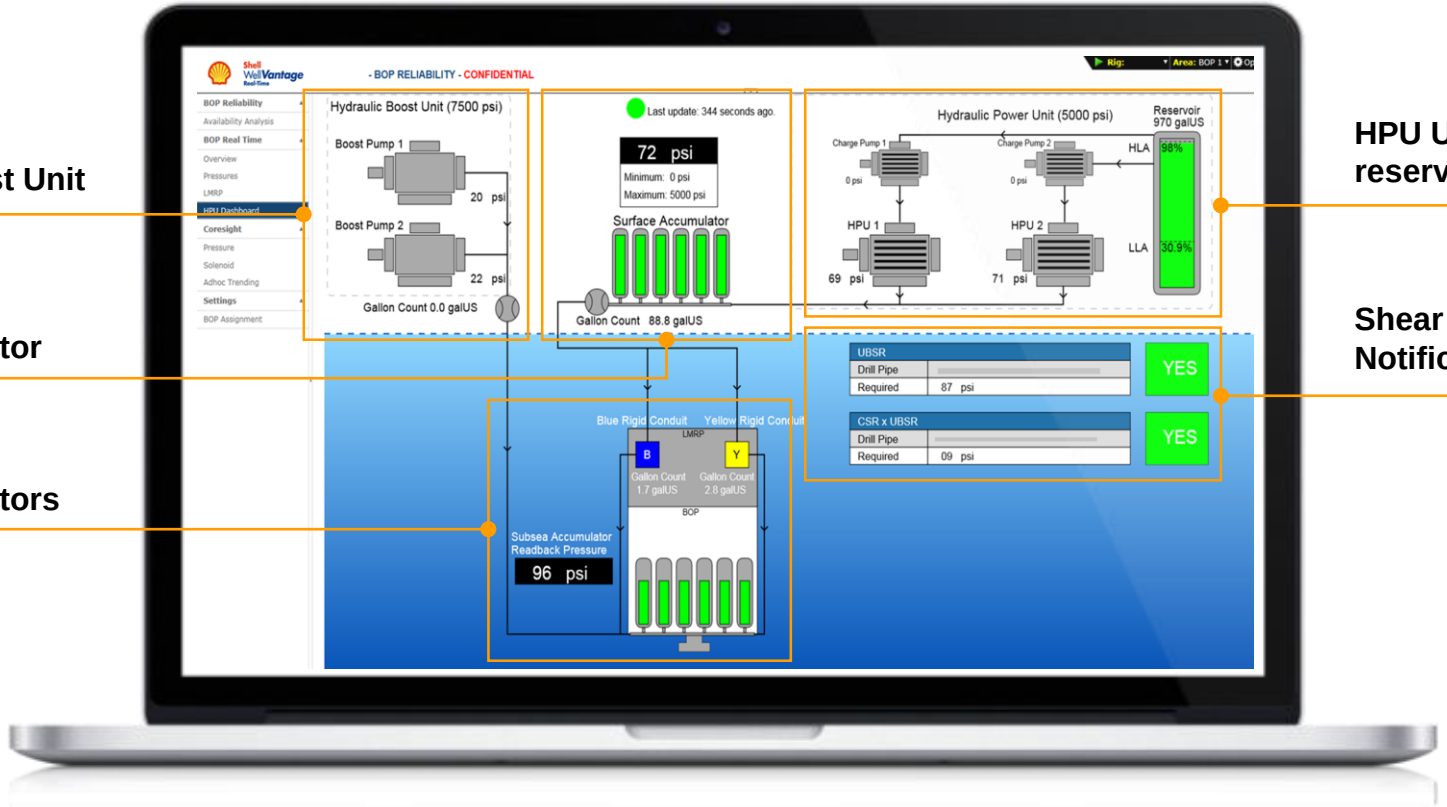
* Note: Dashboard image does not represent actual readings.

Digital BOP – Custom Dashboards

HPU Boost Unit

Surface Accumulator

Subsea Accumulators



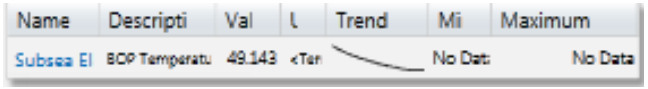
HPU Unit and reservoir

Shear Pressure Notifications

* Note: Dashboard image does not represent actual readings.

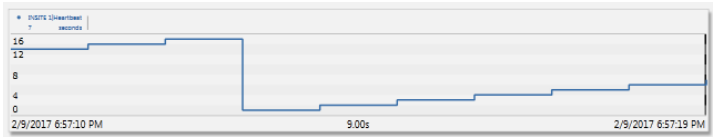
Digital BOP – PI Coresight Dashboards

- BOP 1
  - BOP Control Accumulator
  - BOP Controls
    - BOP Control Panels
    - BOP Controls Stack Mounted
    - Control Pod - Blue
      - Shear Seal Valves
      - Solenoid Valves
      - SPM Valves
      - Subsea Electronic Modules (SEMs)
    - Control Pod - Yellow
    - Reels Hoses & Cables
  - BOP Controls Emergency
  - BOP Stack
    - Acoustic Stab
    - Casing Shear Ram
    - Choke Connector
    - Kill Connector
    - LMRP Connector
    - Lower Annular Preventer
    - Lower Blind Shear Ram
    - Lower Pipe Ram
    - Middle Pipe Ram
    - Mud Boost Valve
    - Stack Choke and Kill System
      - Choke and Kill Valves



Pressure Trend Display

Valve State Display



Adhoc Trending

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Methodology

Digital BOP – Data Engineering

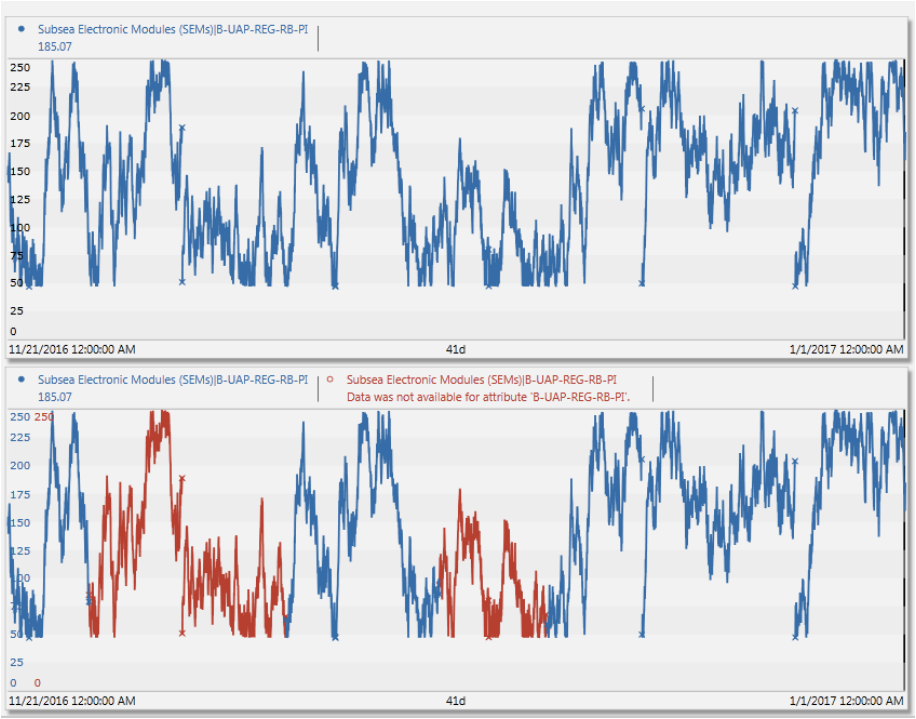
Data engineering is the multi-disciplinary practice of **engineering** computing systems and algorithms to derive **information** from **data**.

 Disciplines	 Considerations	 Principles	 Examples
Systems Integration	Scales well?	Modularity	Active BOP
Data Quality	User needs?	Immutability	Unit Scaling
Data Processing	Future-proofing?	Conformity	Valve States
Data Modeling	Technical debt?	Fit-for-Purpose	AF Hierarchy
	Support?	Rawness	Data Outages

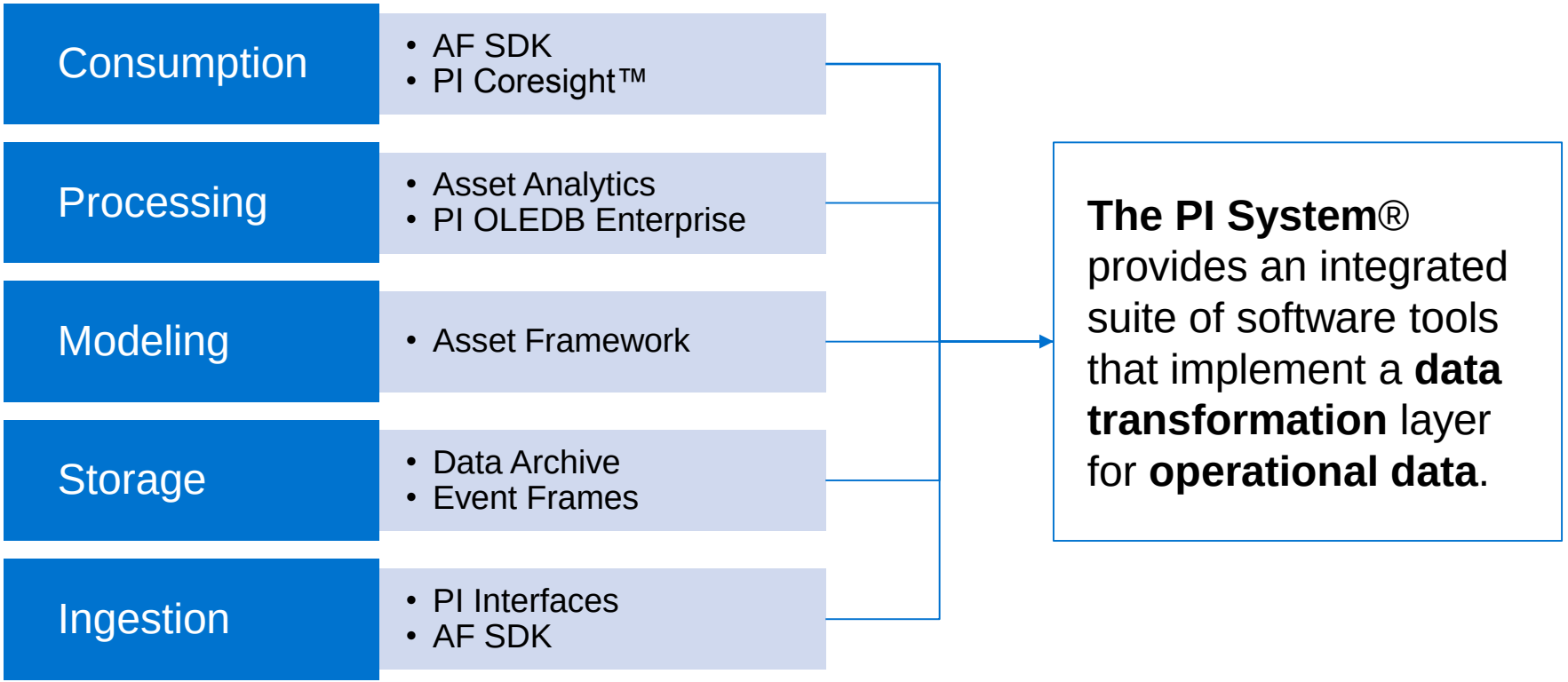
Digital BOP – Data Engineering Example

"Active" BOP

- Each rig has 2 BOP's
- Only one BOP is connected to the control system at a time
- Data must be segregated by connected, or "active", BOP
- Use cases:
  - Cycle counting
  - Failure detection



Digital BOP – Data Engineering for Time-series Data



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Danke

Merci

Gracias

Thank You

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