



Using Drilling Data Analytics to Drive Performance Efficiencies

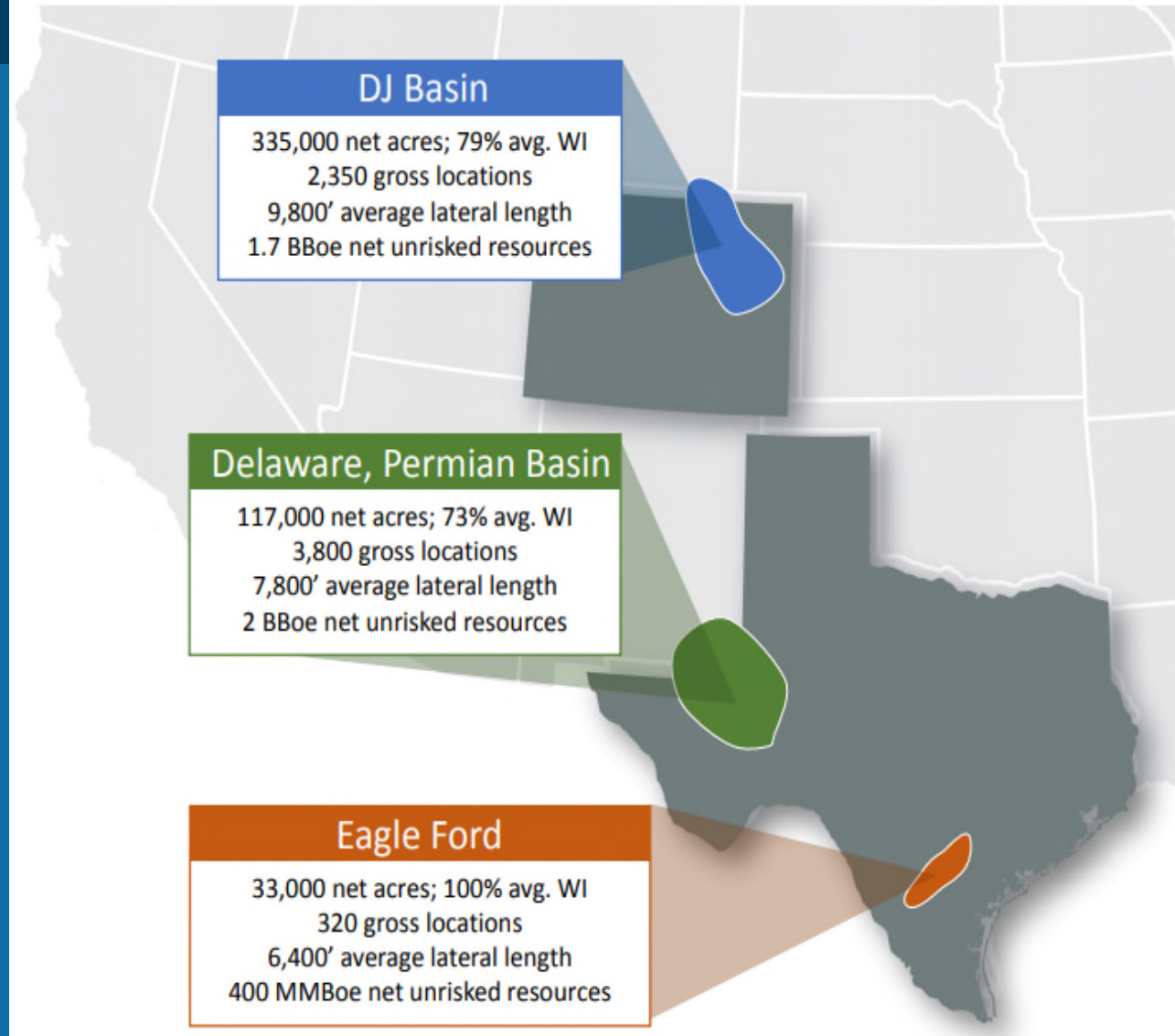
Daniel Burch – Engineering Supervisor Onshore Drilling
Digitalization and Automation in the Oil and Gas Industry
Tel Aviv, Israel - June 18, 2018



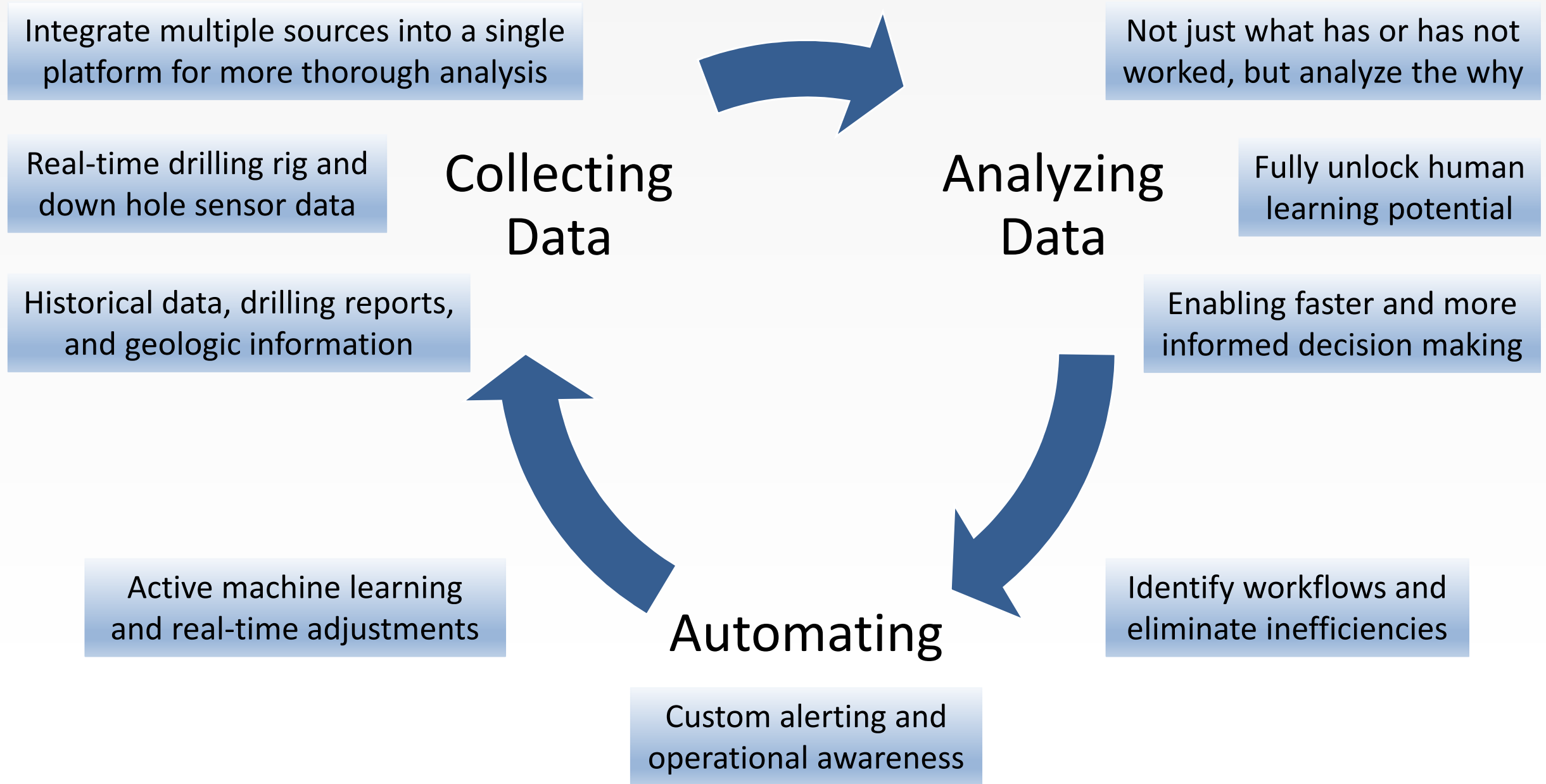
U.S. Onshore Operations

Current Drilling Activity

- **9 Operated U.S. Onshore Drilling Rigs**
 - 2 DJ Basin Rigs
 - 6 Delaware Basin Rigs
 - 1 Eagle Ford Rig
- **Leveraging shared learnings between basins**
- **Long laterals and multi-well pads**
- **Multiple horizon targeting**
- **Advanced drilling precision through geo-steering**
 - Delivering wells within 15 feet target window across 10,000 feet horizontal lateral in the Delaware Basin
 - Integration of region mapping, 3D seismic and real-time measurements driving results



Drilling Data Analytics Overview



Drilling Data Analytics Accomplishments

➤ In-house Data Management

- Created a platform for real-time drilling data ingestion to allow for proprietary solutions

➤ KPI Reporting

- Developed automated daily data analytics reports and dashboards to replace manually exporting and manipulating data
 - Algorithms to quantify and study drilling vs non-drilling times to understand best practices

➤ Analytics Software

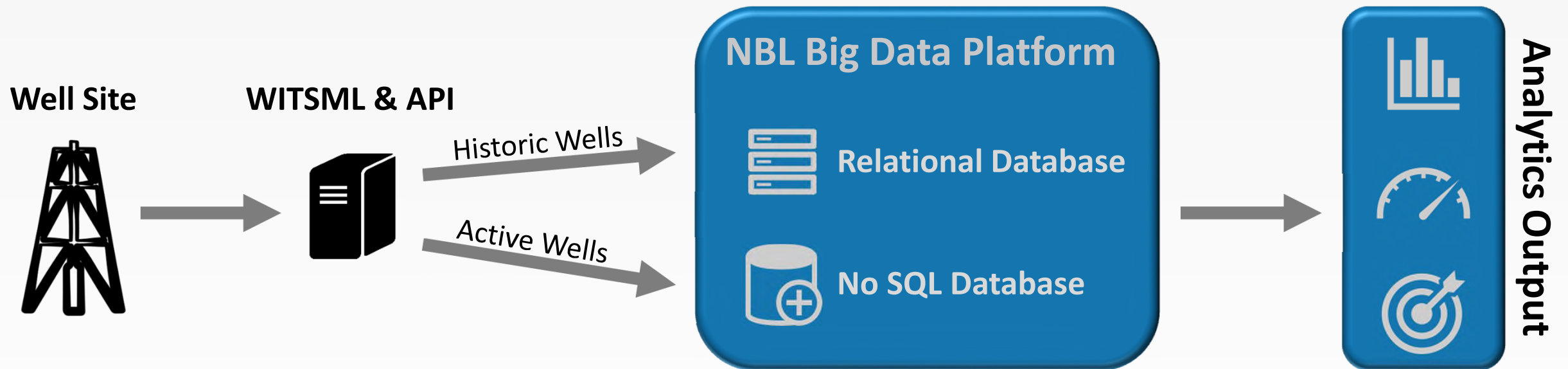
- Selected Mobilize as a tool to enhance drilling team's data analytics capabilities and real-time optimization
 - Engineering analysis time reduced from days to hours
 - Increased optimization capabilities leading to drilling time performance gains

➤ Industry Partnerships

- BHGE Optima Solutions project combining advanced data science and machine learning with industry expertise
- Evaluated and tested available active learning and automation technologies

In-House Data Management

Rig Data Ingestion

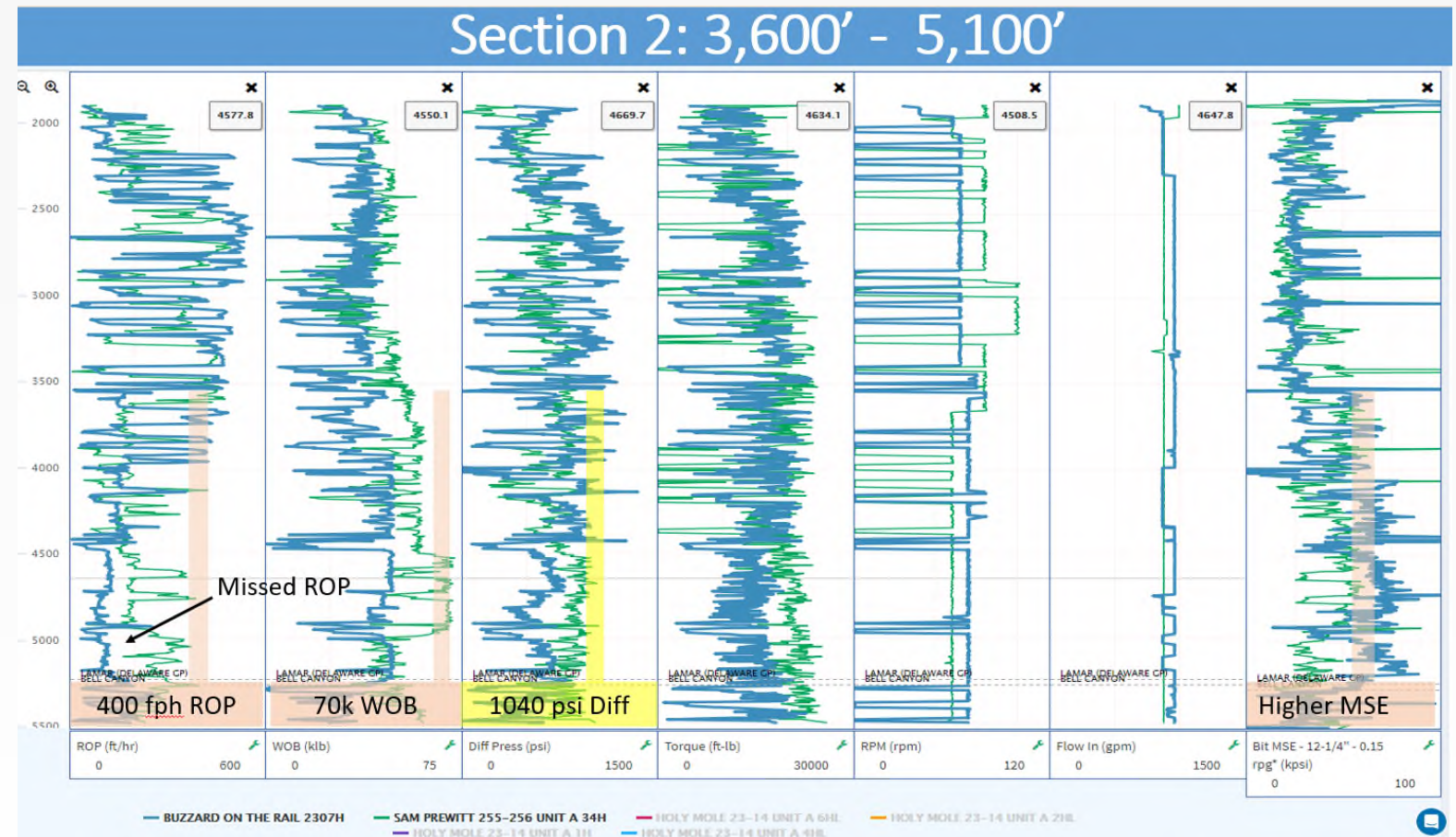


- Currently actively ingesting data from **9 rigs** (6 Permian, 1 Eagle Ford, 2 DJ)
- Daily data volumes around **84,000 records a minute**, or **121,000,000 records a day**
- 472 historical wells loaded
 - **1,110,000,000 records of depth indexed data**
 - **6,890,000,000 records of time indexed data**

Analytics Software Tool

User Friendly Interface Allows Drilling Team To Easily Manipulate Views To Dig Into Real-Time Data

- Multi-well analysis for real-time optimization in the field
- Streamlines post run analysis
- Enables fine tuned drilling parameter roadmaps from the office



Additional features: Rig-state algorithms to capture connection times & tripping speeds, customizable dashboards & automated report distributions, rig-to-rig & crew-crew comparisons, plus much more

Drilling Performance Improvements

Drilling Capabilities as a Competitive Advantage

➤ Real-Time Drilling Data Integration Enables Rapid Design Optimization

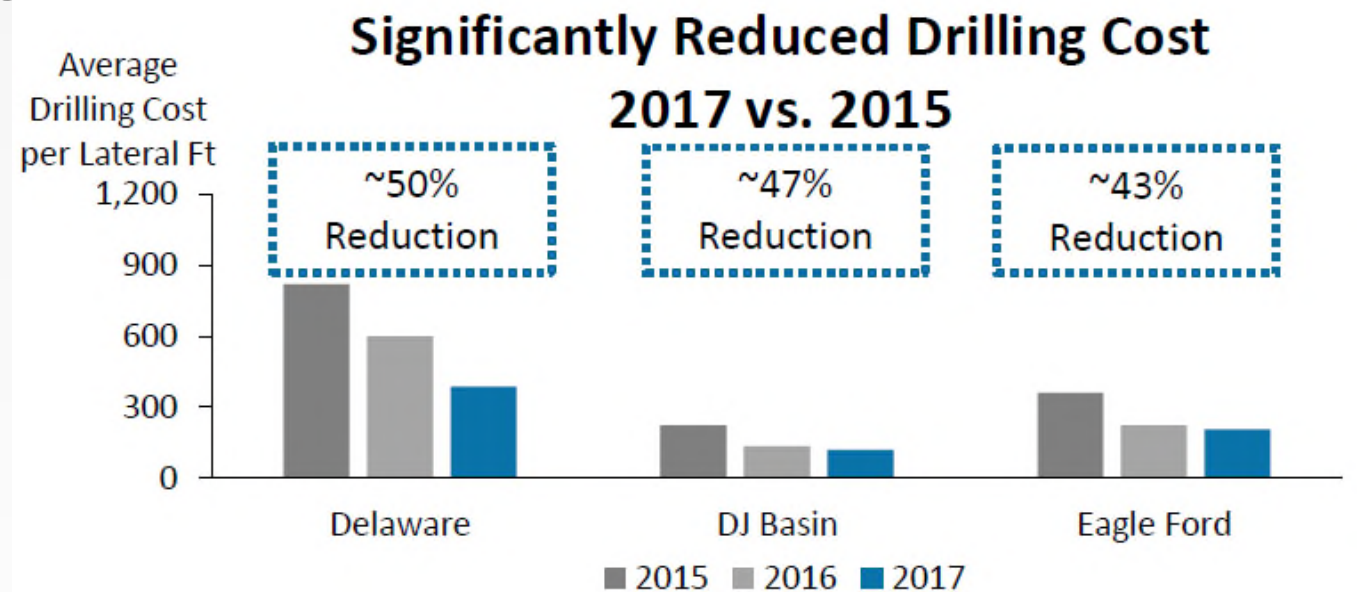
- Leveraging predictive analytics to improve drilling efficiencies and reduce down time
- Physics-based approach supplements empirical data

➤ Realizing Significant Drilling Efficiencies

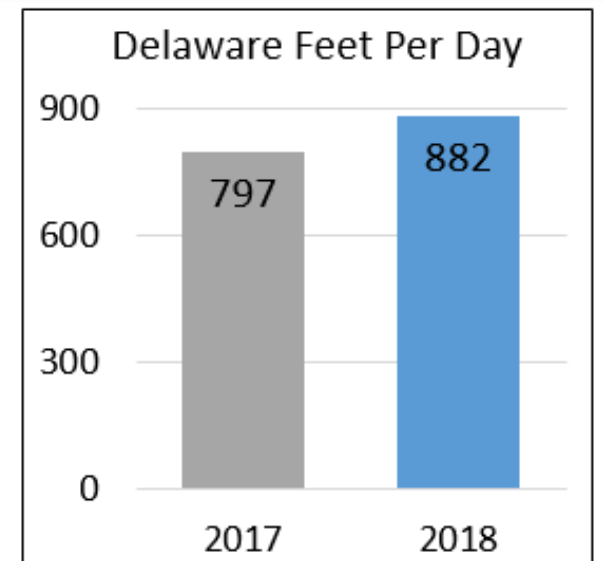
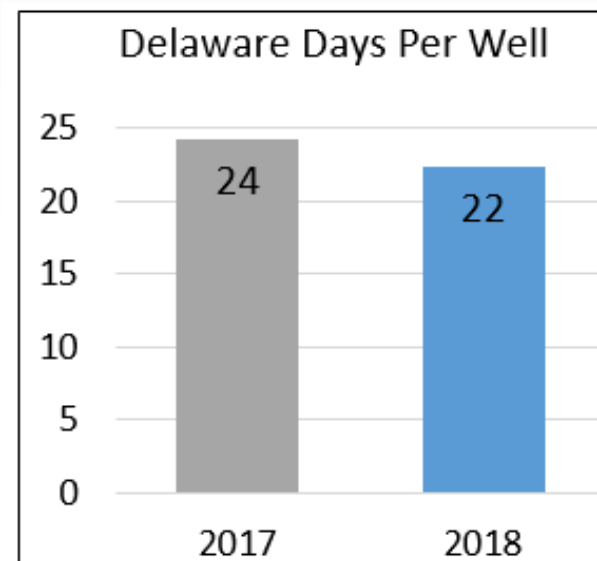
- Reduced Delaware Basin drill time for 10,000 ft lateral wells by 7 days versus beginning of 2017 (25% improvement)

➤ Lowering Non-Productive Time <12%

- Minimizing downhole tool failures and rig equipment downtime



Performance Improvements Continue Into 2018



Industry Trend Towards Automation

The Industry Is Moving Towards Implementing Active Machine Learning and Automation

Technologies Noble Energy Has Evaluated or Is Evaluating

- H&P “Back-to-Drilling” & NOV/Precision Drilling “NOVOS”
 - Connection automation: Auto disengage & engage bit
- Pason “DAS” (Drilling Advisory System)
 - Automated drilling parameter optimization
- Pason “Event Detection”
 - Pit gain/loss adaptive alarms
- Motive (directional drilling automation)

