Optimizing Drilling and Production Operations with Advanced Functionality of the PI System

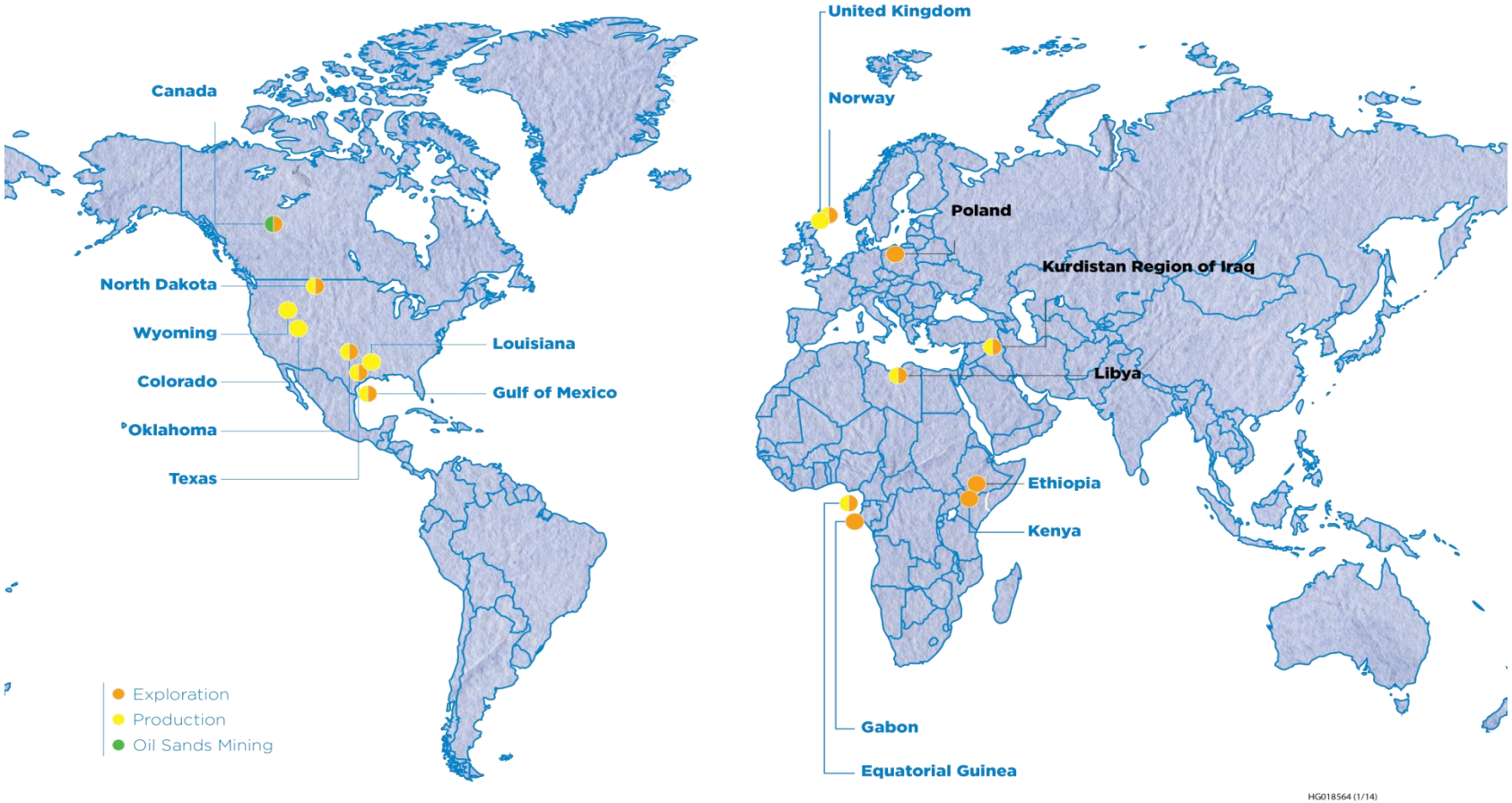
Presented by **Ken Startz – Marathon Oil Company**

Marathon Oil

Marathon Oil – A global E & P Company

- Established in 1887
- Market Cap: ~ $26 billion (as of 7/26/13)
- Revenues: $15.7 billion
- Net Income: $1.6 billion
- Capital Expenditures*: $5.1 billion
- Net Liquid Hydrocarbon Sales: 282,000 BPD
- Net Natural Gas Sales: 902 million CFD
- Net Synthetic Crude Oil Sales: 47,000 BPD
- Net Proved Liquid Hydrocarbon, Natural Gas and Synthetic Crude Oil Reserves: 2.0 billion BOE
- Employees: ~3,400
- Headquartered in Houston, Texas

*Excludes acquisitions and includes accruals. Unless otherwise stated, financial and operating statistics noted are as of 12/31/12



The Journey of the PI System at Marathon Oil

Tactical "Historian"

Strategic Infrastructure

1987 – PI System selected in Refining as standard real-time data "historian"

1988 – My First PI System Install – Robinson, Ill Refinery

2005-2006 – PI System selected as integration and applications infrastructure in Upstream for Equatorial Guinea

2006-2010 – PI System Installed in Norway to Integrate and enable remote monitoring and collaboration; Droshky Gulf of Mexico

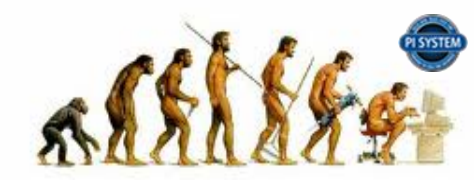
2012 – PI System used for remote Drilling monitoring and optimization

Separation of Marathon into Marathon Petroleum (Downstream) & Marathon Oil (Upstream) 2011

Business Challenges for 2014

- Develop infrastructure for high frequency data needed for Drilling.
- Leverage PI System investment in the new unconventional resource plays.
- Transfer knowledge to newer professionals (Great Crew change Skill Builder Phase).
- Provide easy self-service visualization for engineers.
- Deliver mobility solutions for Operators on iPad.

Agenda

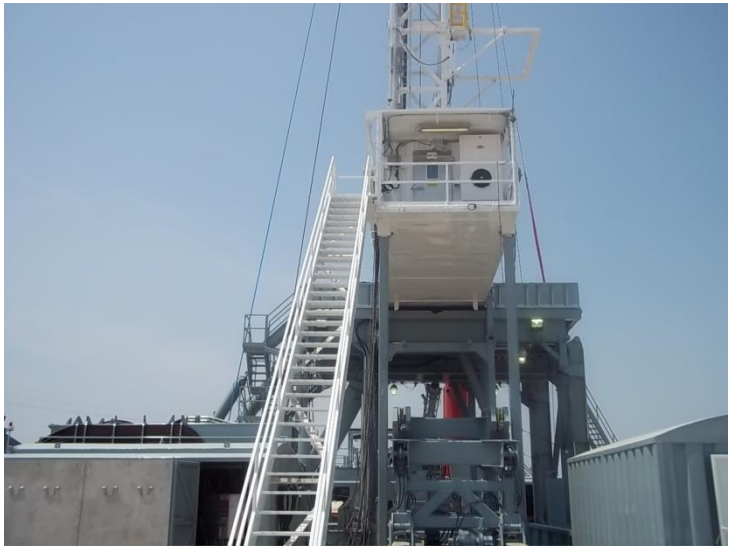


- Illustrative Case Studies
  - Maradrill ™ – Onshore Remote Drilling Monitoring and Optimization

MaraDrill™ Background

- Land-based drilling rigs in Eagle Ford and Bakken.
- Primarily oil.
- Horizontal wells.
- Factory drilling.
- Rigs operated by Helmerich & Payne (H & P).
- Data extracted from OMRON Control System and aggregated with 3rd party vendor data, using PI Interface for OPC HDA.
- POC started January 2011.

MaraDrill™ Doghouse



Common Drilling Data Tags

Engineering Units

ROP = Rate of Penetration – Ft / Hr

WOB = Weight on Bit – K Pounds

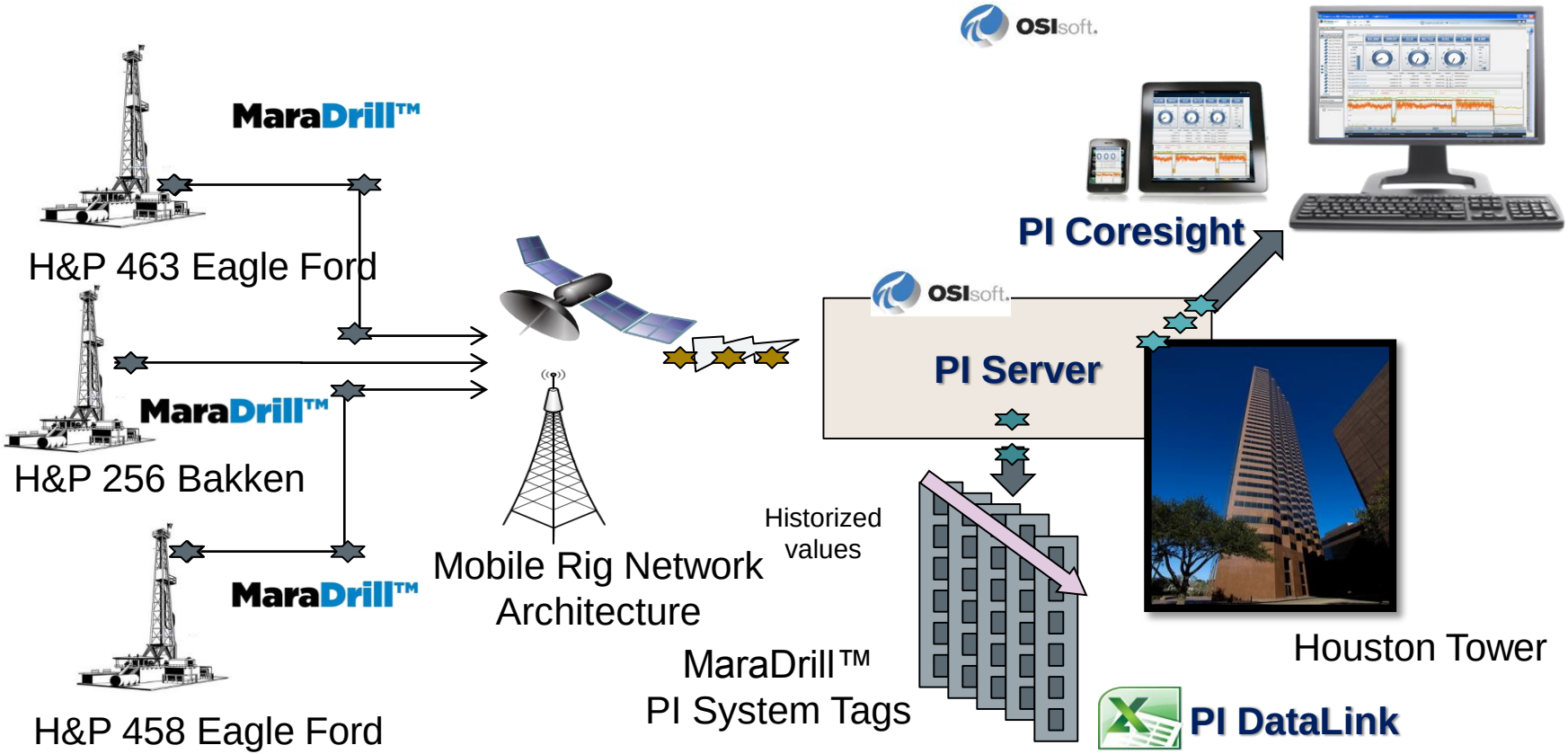
RPM = Revolutions per Minute – RPM

Mud Flow Rate – GPM

Torque – kFt*Lbs

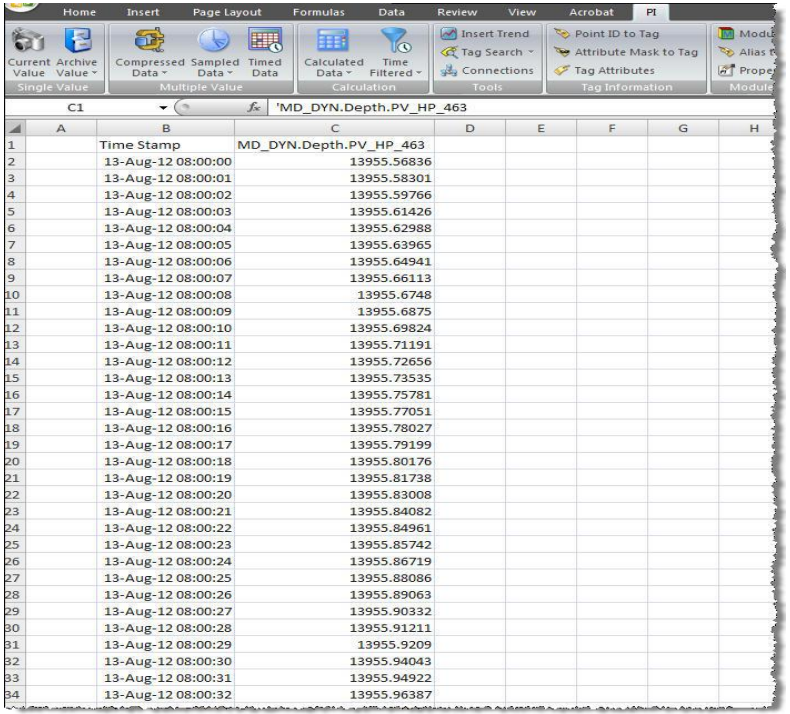
Need 1 second time stamp resolution!

Data Workflow



MaraDrill™ – Data Acquisition: PI DataLink

- **Collect MaraDrill™ data from OSIsoft. PI DataLink**



	A	B	C	D	E	F	G	H
1		Time Stamp	MD_DYN.Depth.PV_HP_463					
2		13-Aug-12 08:00:00	13955.56836					
3		13-Aug-12 08:00:01	13955.58301					
4		13-Aug-12 08:00:02	13955.59766					
5		13-Aug-12 08:00:03	13955.61426					
6		13-Aug-12 08:00:04	13955.62988					
7		13-Aug-12 08:00:05	13955.63965					
8		13-Aug-12 08:00:06	13955.64941					
9		13-Aug-12 08:00:07	13955.66113					
10		13-Aug-12 08:00:08	13955.6748					
11		13-Aug-12 08:00:09	13955.6875					
12		13-Aug-12 08:00:10	13955.69824					
13		13-Aug-12 08:00:11	13955.71191					
14		13-Aug-12 08:00:12	13955.72656					
15		13-Aug-12 08:00:13	13955.73535					
16		13-Aug-12 08:00:14	13955.75781					
17		13-Aug-12 08:00:15	13955.77051					
18		13-Aug-12 08:00:16	13955.78027					
19		13-Aug-12 08:00:17	13955.79199					
20		13-Aug-12 08:00:18	13955.80176					
21		13-Aug-12 08:00:19	13955.81738					
22		13-Aug-12 08:00:20	13955.83008					
23		13-Aug-12 08:00:21	13955.84082					
24		13-Aug-12 08:00:22	13955.84961					
25		13-Aug-12 08:00:23	13955.85742					
26		13-Aug-12 08:00:24	13955.86719					
27		13-Aug-12 08:00:25	13955.88086					
28		13-Aug-12 08:00:26	13955.89063					
29		13-Aug-12 08:00:27	13955.90332					
30		13-Aug-12 08:00:28	13955.91211					
31		13-Aug-12 08:00:29	13955.9209					
32		13-Aug-12 08:00:30	13955.94043					
33		13-Aug-12 08:00:31	13955.94922					
34		13-Aug-12 08:00:32	13955.96387					

- **Functions that retrieve single value**
  - Current value
  - Value at a specific time
  - Tag attributes

- **Functions that retrieve series of values**
  - Evenly spaced (sampled) data
  - Compressed (archived) data
  - Sampled data for a user-specified array of timestamps

Pre-MaraDrill™ vs. MaraDrill™ Technology

- **Pre-MaraDrill™**

Data	Real-Time Parameters						Manually entered Parametes						
TimeStamp	Depth	ROP	W_b	rotary RPM	Torque	Q	MW	μ	m	D_p	D_b	n	D_n
6/27/2012 11:09:50	297.8	384.35	14942.4472	223	2060	807	8.33	1.999	0.00	5.0	13.50	4	
6/27/2012 11:10:00	299	391.89	11464.4946	223	2060	807	8.33	1.999	0.00	5.0	13.50	4	
6/27/2012 11:10:10	300.3	500.47	11657.6955	223	2175	807	8.33	1.999	0.00	5.0	13.50	4	
6/27/2012 11:10:20	301.2	327.73	11013.6402	223	3067	807	8.33	1.999	0.00	5.0	13.50	4	
6/27/2012 11:10:30	301.9	327.73	14427.185	223	3456	807	8.33	1.999	0.00	5.0	13.50	4	
6/27/2012 11:10:40	301.9	327.73	0	223	3403	807	8.33	1.999	0.00	5.0	13.50	4	

Pason Data Calculator Spreadsheet

- **MaraDrill™ Technology**

OSIsoft. PI Server

PI DataLink

Intermediary Application

PI JDBC 2010 Provider

Spotfire

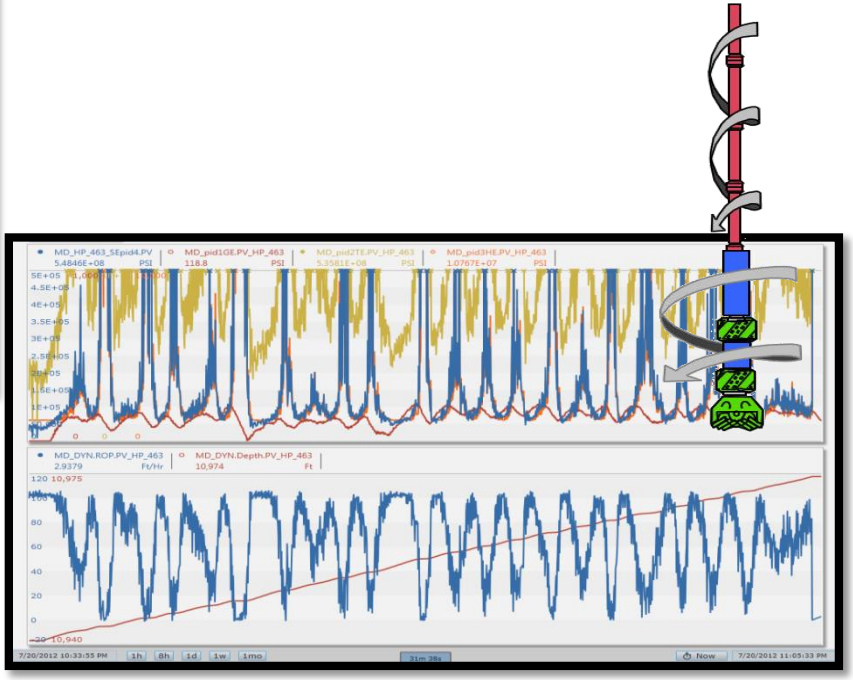
Tool for Advanced Analytics

PI Coresight – Stick-Slip Identification: H&P 463

"Perfect" drilling

Stick-slip: Non-uniform rotation of the bit/BHA

- Sticking phase → bit stops
- Slipping phase → bit "breaks" free
- Drillstring torsional oscillations



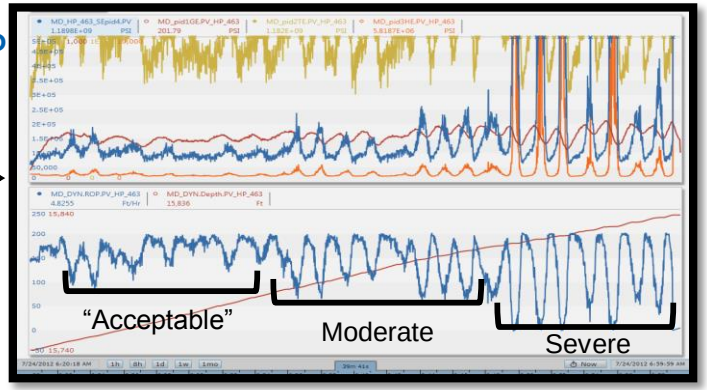
Stick-slip

Real-Time Optimization PI Coresight

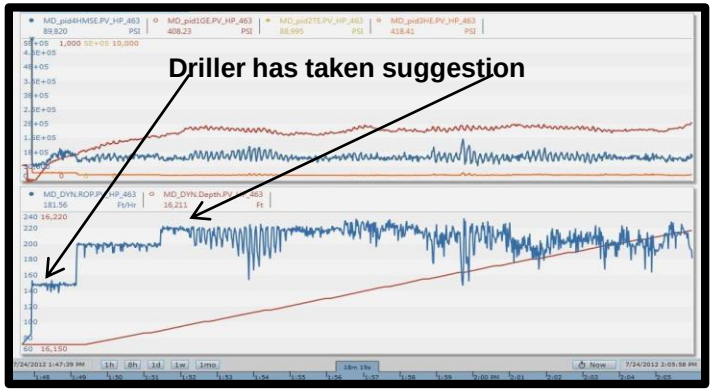
Stick-Slip Identification …few stands later… Stick-Slip Mitigation

40% Sustained Increase in Rate of Penetration

Avg. ROP for stand is **144 ft/hr**



Avg. ROP for stand is **201 ft/hr**



MarathonOil

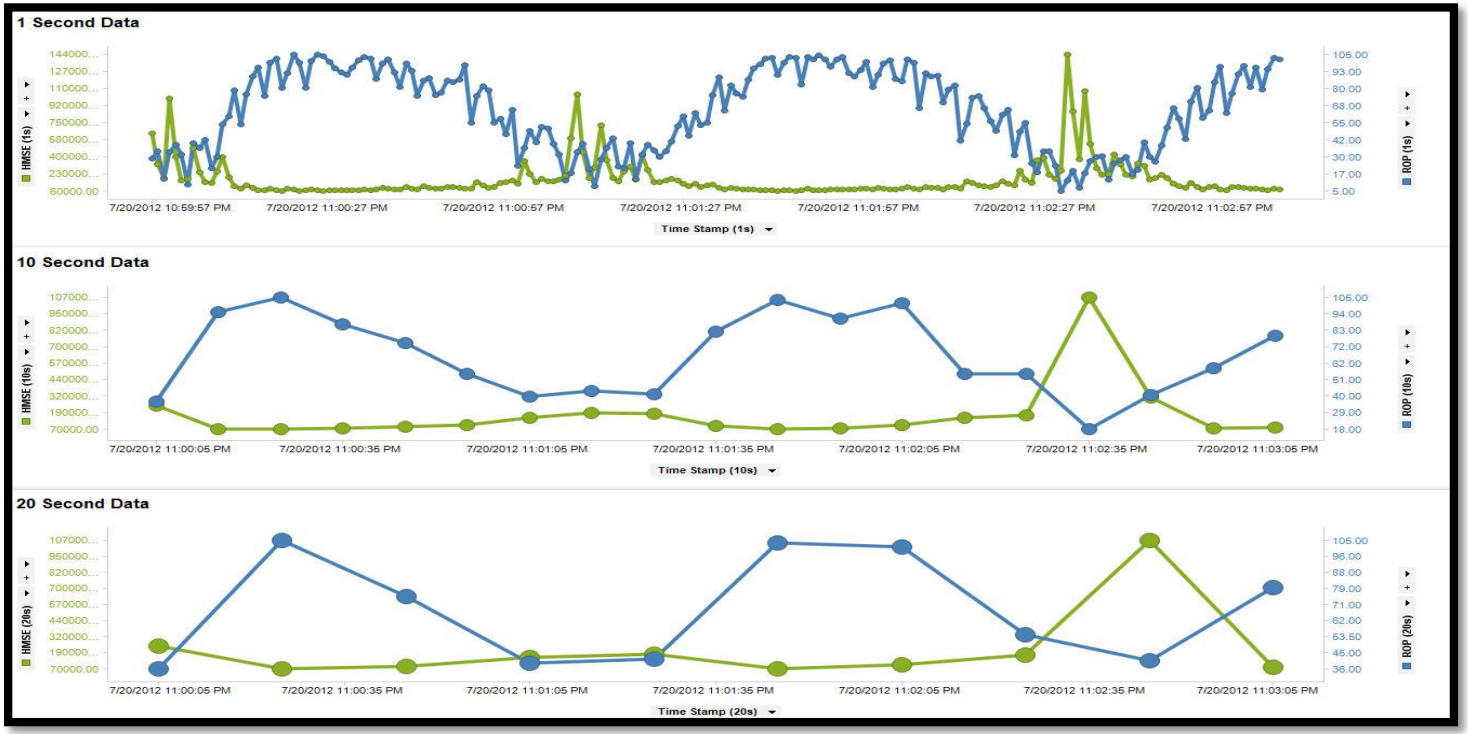
PI Coresight/SpotFire – Stick-Slip Analyses

- **Importance of 1 second data**

MaraDrill™

Other vendors

Rig Display



PI Coresight - Stick-Slip

Stick-Slip is Expensive

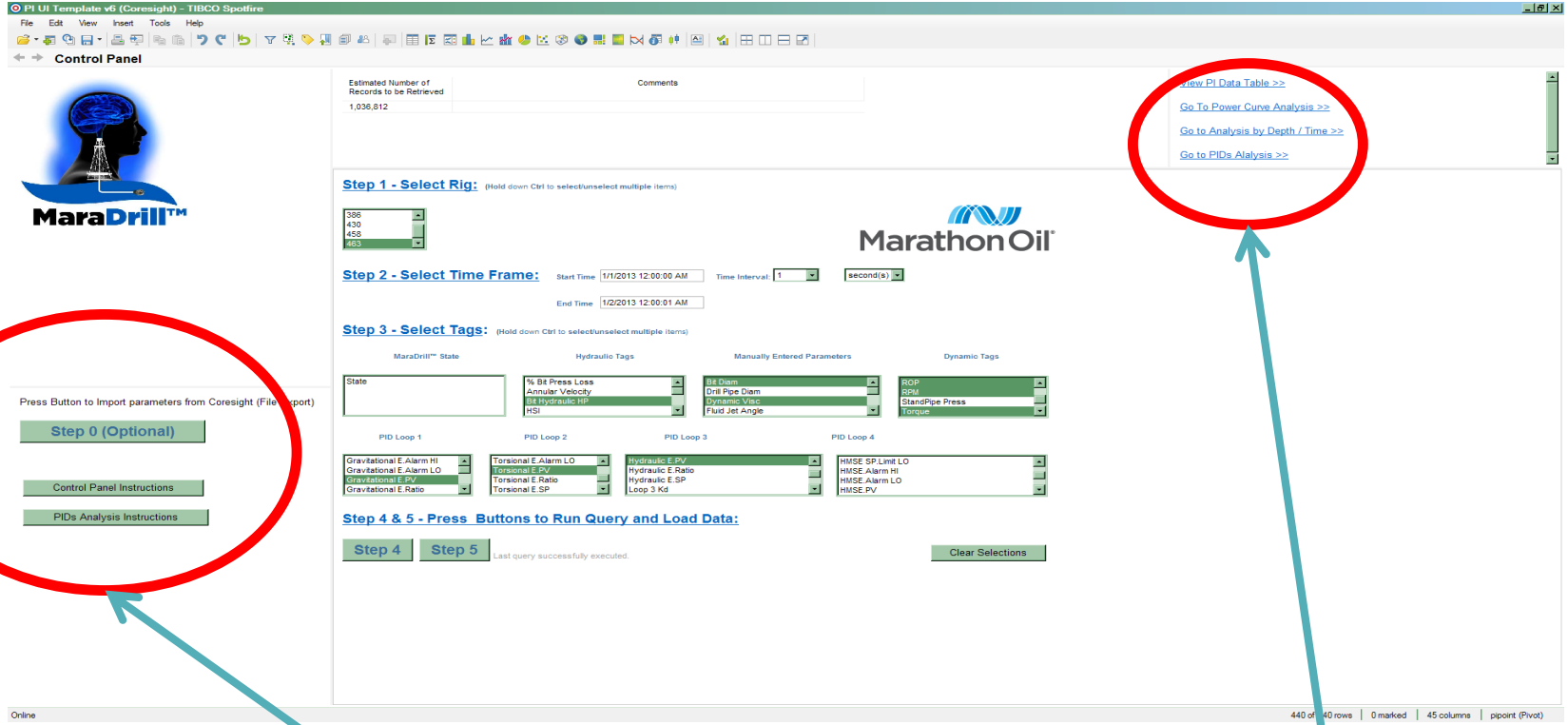
- Increased bit cost due to number of runs, repair/replacement charges
- Increased hourly cost due to motor usage
- Increased drilling time due to accelerated dulling (low ROP)
- Increased trip time due to number of runs
- Increased costs associated with downhole tool damage (MWD, LWD)

PI Coresight View with XML Data Export

Enables integration with WellView data

Enables integration with Spotfire visualization

Custom Spotfire Interface



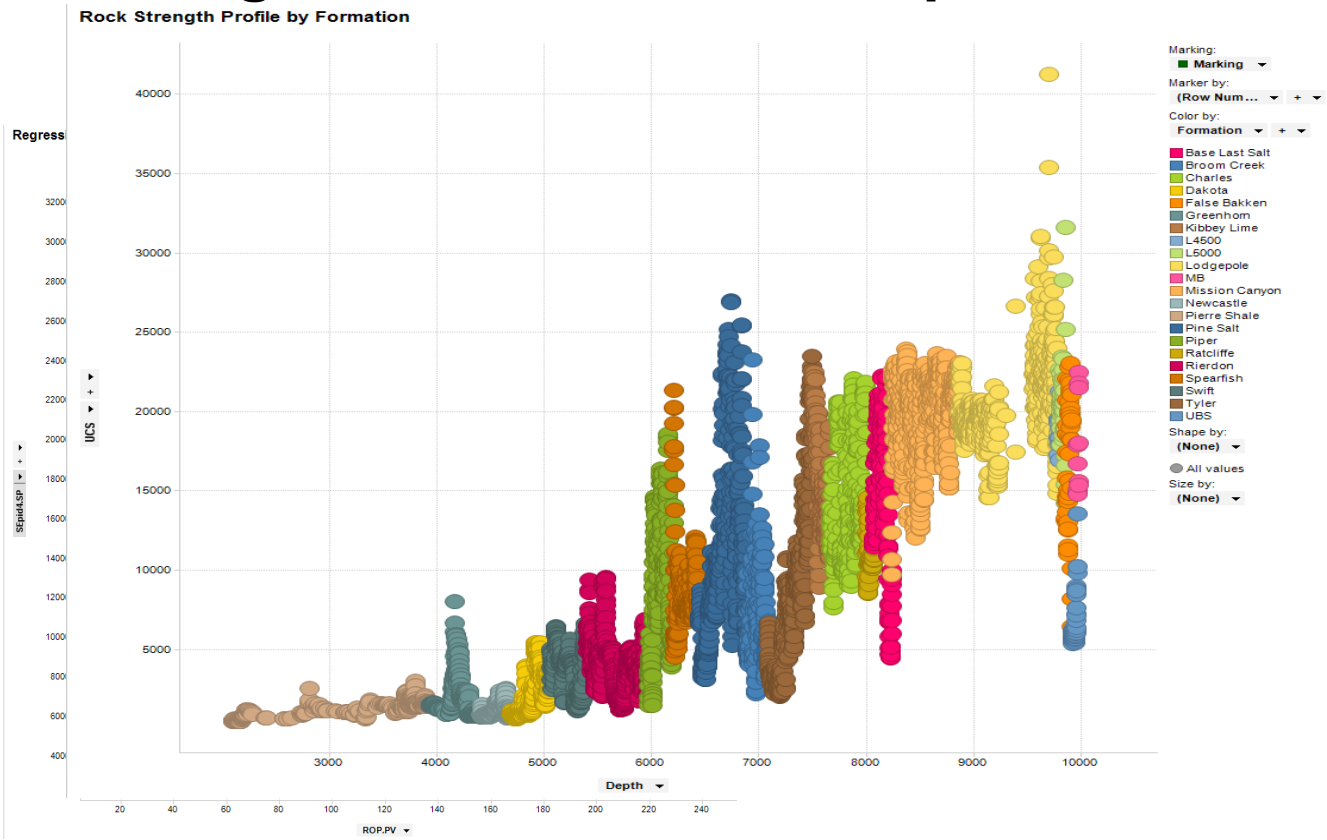
Enables integration with PI System data from PI Coresight

Guided analytics

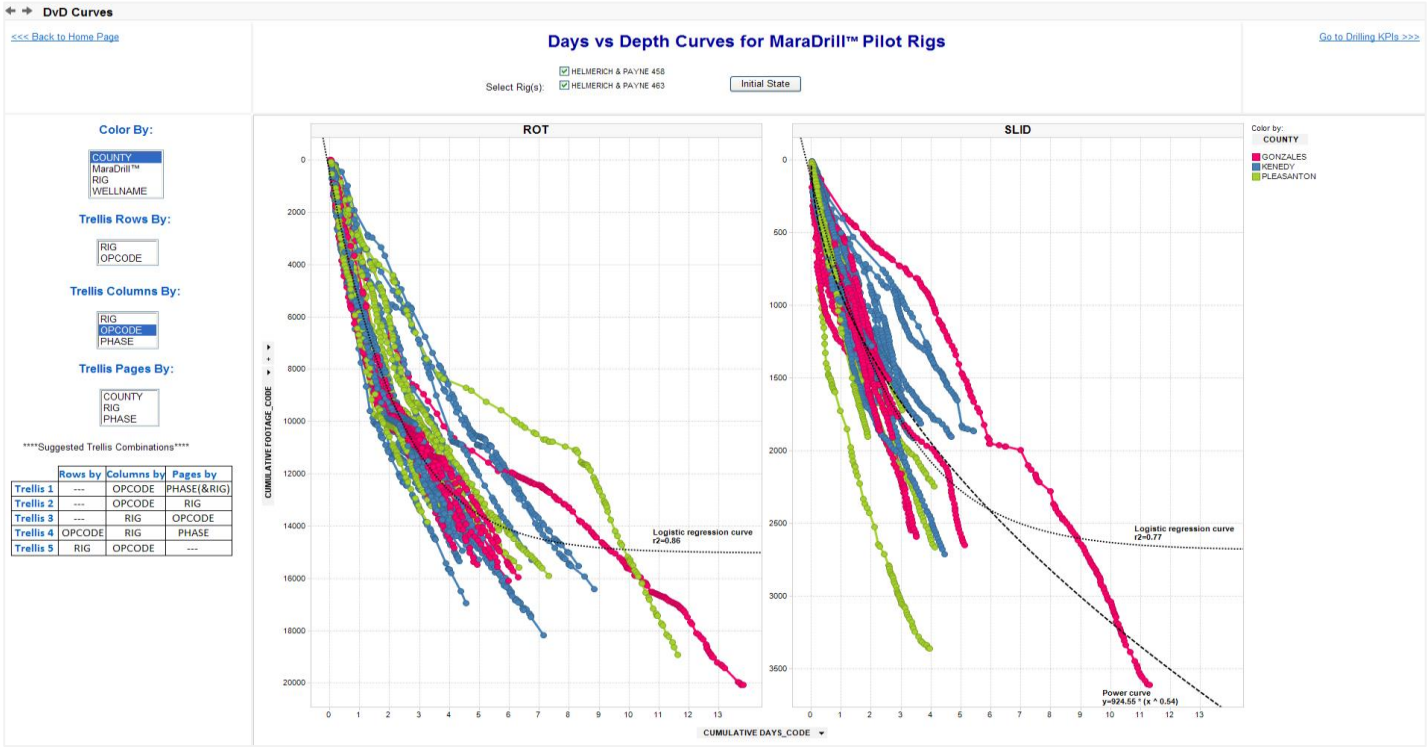
Guided Analysis – Time Based or Depth Based

Post-Well Science Using MaraDrill™ Data in SpotFire

Modeling the rock strength & predicting ROP's on subsequent wells in the area to improve logistics and planning

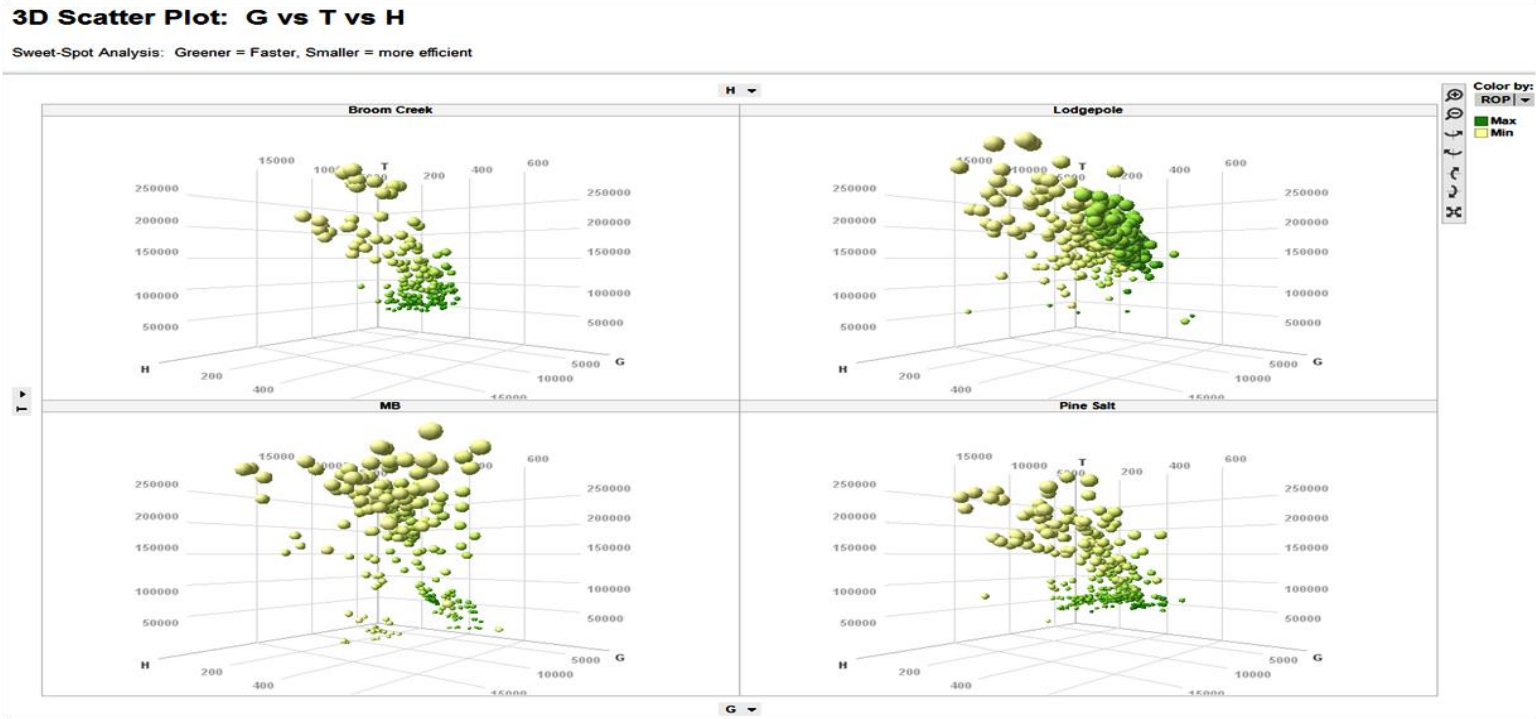


Days vs Depth Curves for MaraDrill™ Rigs
Black = MD, Teal = No MD



Post-Well Science Using MaraDrill™ Data in SpotFire

Formation Sweet-Spot Analysis

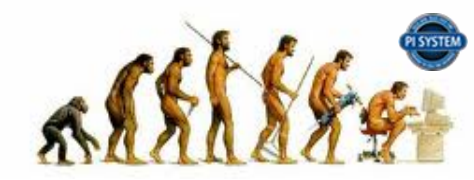


MaraDrill™ Benefits

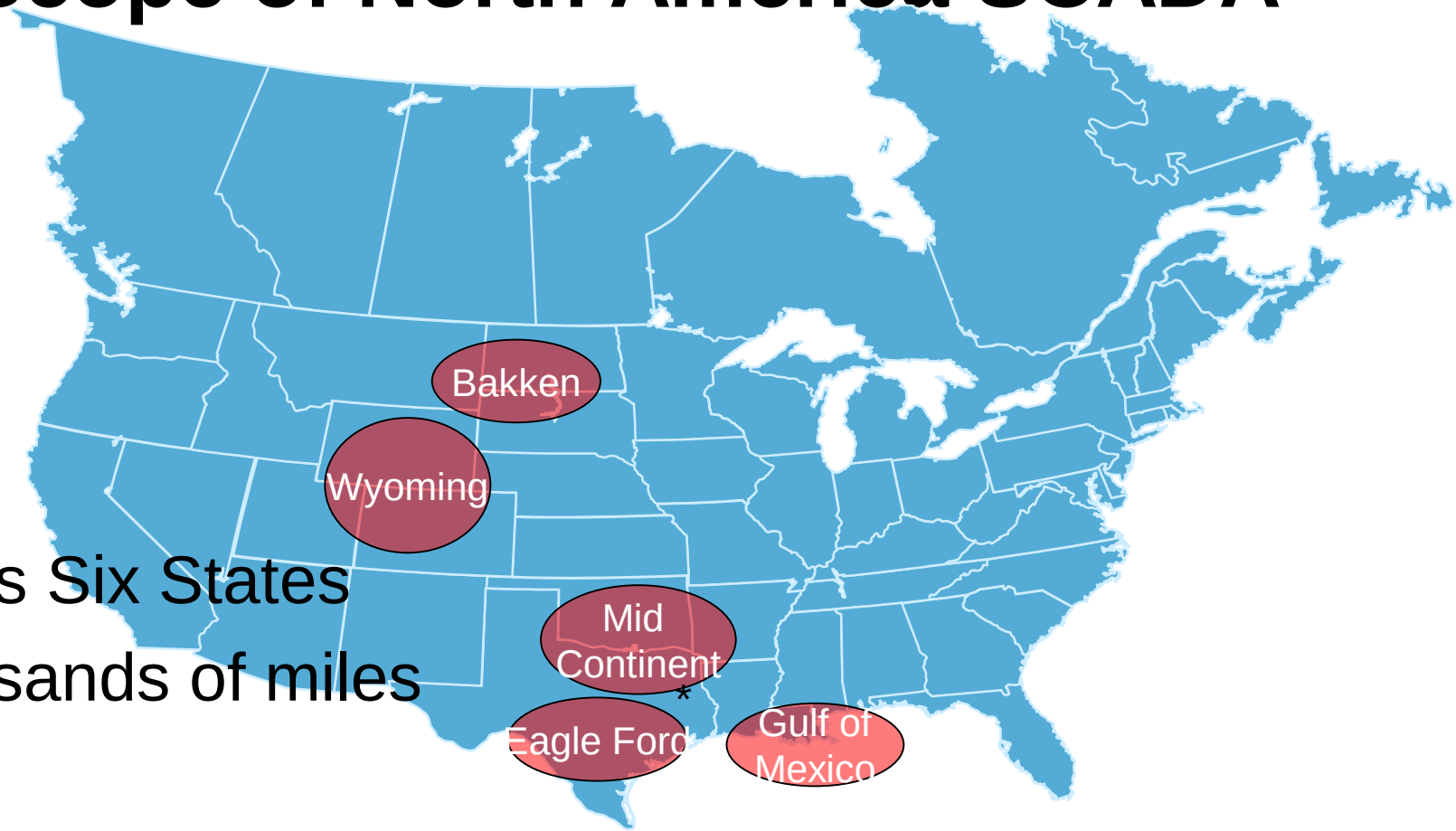
- May replace third party real-time data aggregation software.
- Accessible real-time data at the rig and to remote employees, enabling more efficient decision making.
- Consistent and easy-to-access data. More eyes on the data.
- Drilling time and capital well cost savings:
  - Potential $ 1 MM / rig / yr for every 5% reduction in drill time.
- Reduced vibration and damage to downhole tools
- Continuous optimization onsite and retrospective post-well analysis

Agenda

- Illustrative Case Studies
  - MaraProd ™ – Production Operations by Exception



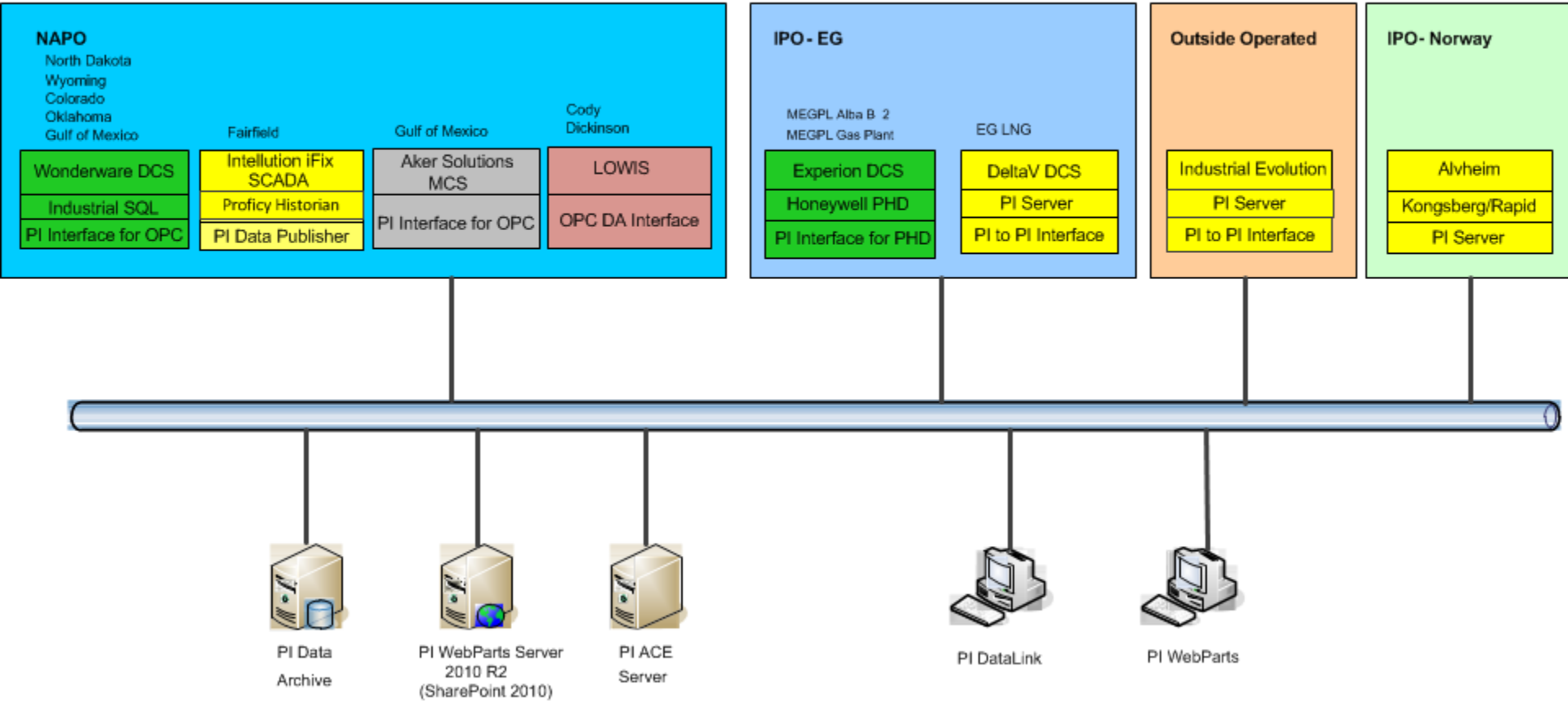
Scope of North America SCADA



Spans Six States

Thousands of miles

Marathon Oil Company Real-Time Architecture for Global Production Operations



MaraProd™ Background

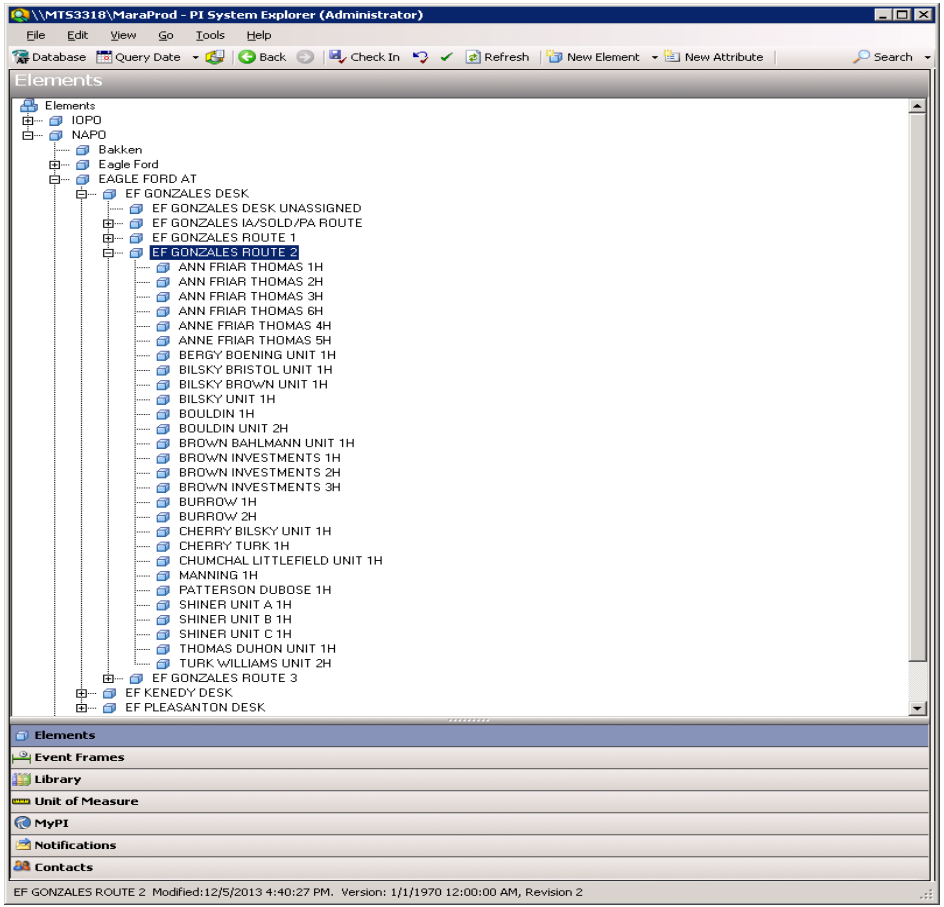
- Will cover 5,200+ Automated Wells in U.S.
- Enables Production by Exception Mindset
- Pilot (Jan 2014) for Eagle Ford Asset
- Initially released on iOS Devices. Programs written by Marathon developers.
- Geospatially enabled.
- Both Well Surveillance and Calculations based on PI AF V 2.5.

MaraProd™ Data Tags

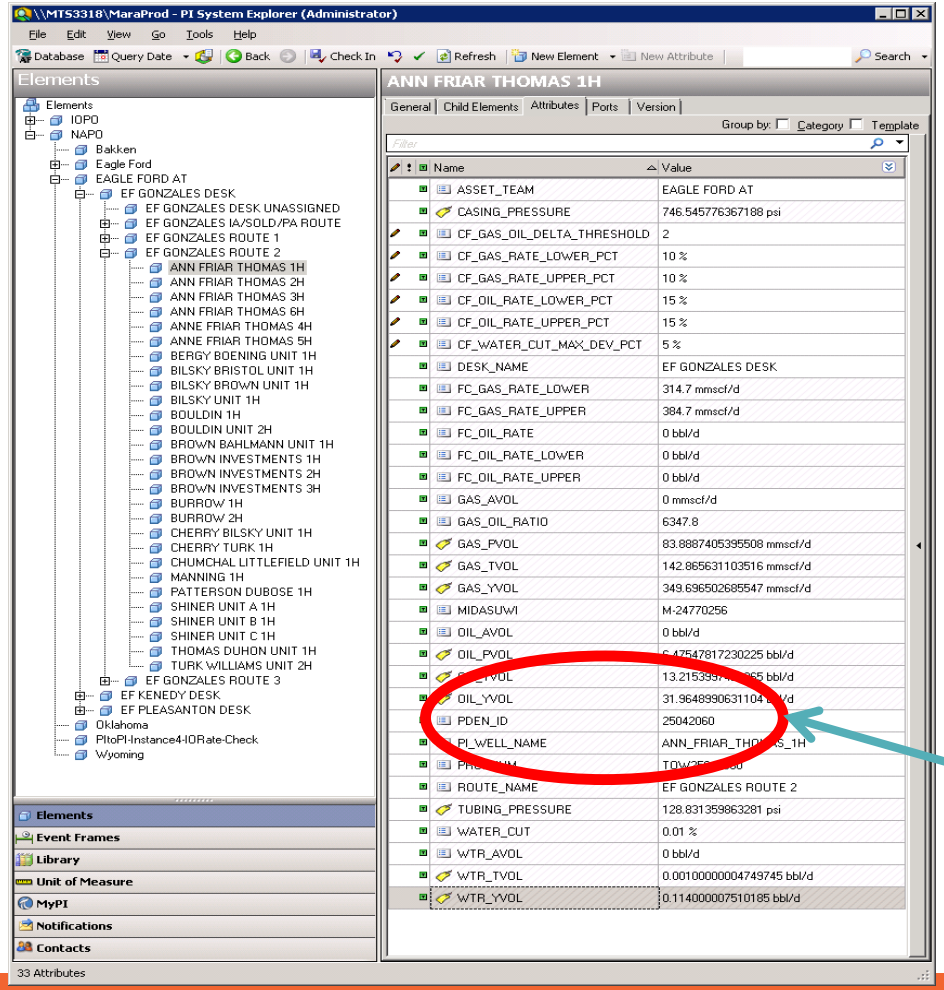
TBG_PRESS	Tubing Pressure
CSG_PRESS	Casing Pressure

YVOL	OIL
TVOL	GAS
PVOL	WATER

Drill Down by Asset Team, Field Office, and Well Elements



Attributes for each Well in Eagle Ford



Standard 11 Data Tags pulled for every well on the route.

PDEN ID is the well header ID from TOW.

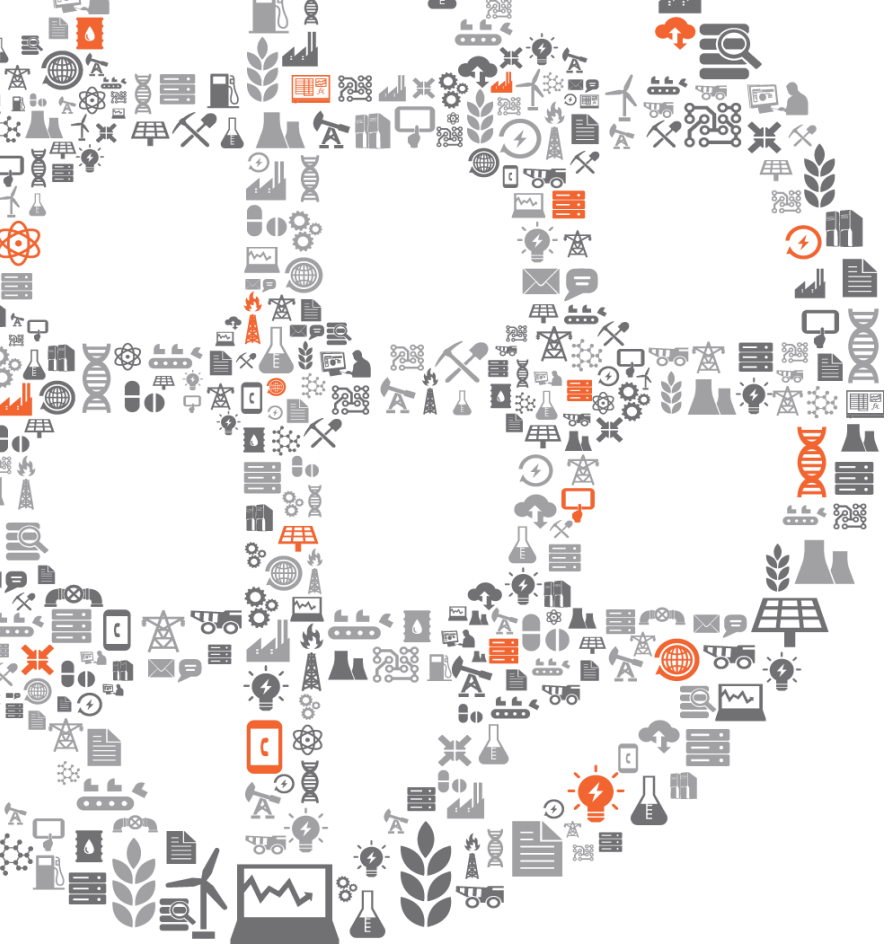
Summary

1. Use and value of the PI System has evolved over the last 25 years…and has become strategic to our information infrastructure

2. Significant benefits in model integration and SME enablement

3. PI System combined with PI Coresight has value in Drilling!

4. PI AF has huge value in enabling standard Production Ops queries.



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THANK YOU

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