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# EMEA USERS CONFERENCE

BERLIN, GERMANY • SEPT 26-29, 2016



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# TransCanada | CPG Real-time Intelligent Maintenance and Operations

Presented by **Brendan Bell, Ionut Buse**



# Agenda

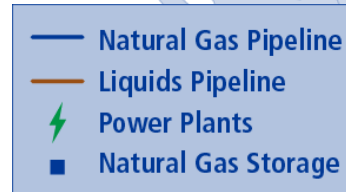


## One of the Largest Natural Gas Transmission Companies in the U.S.

- ~31,000 miles (50,000 km)
- Serves ~10% of U.S. demand

## Connected to High-Demand Markets

- LDC demand
- Electric Power Generation
- Growing LNG Market



# Business Challenges



**Availability**

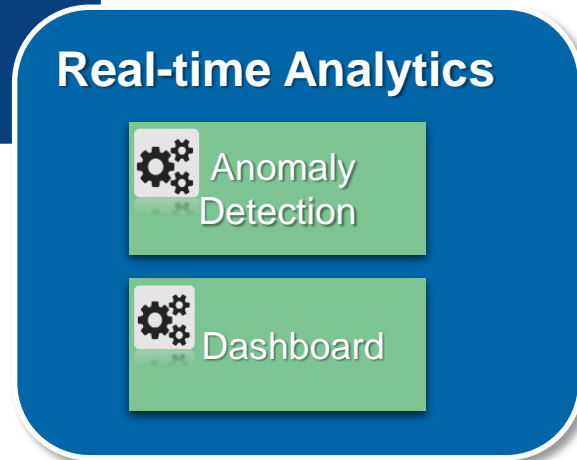
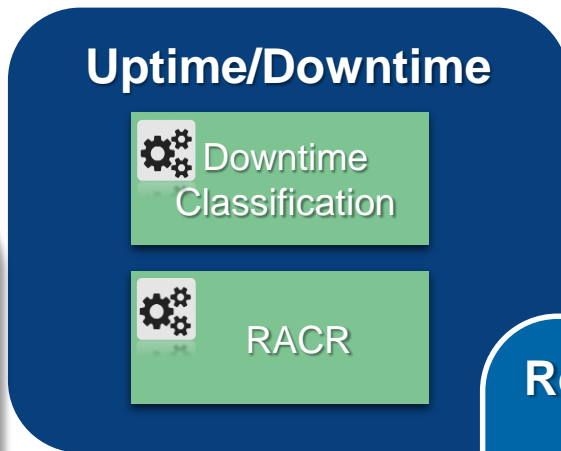
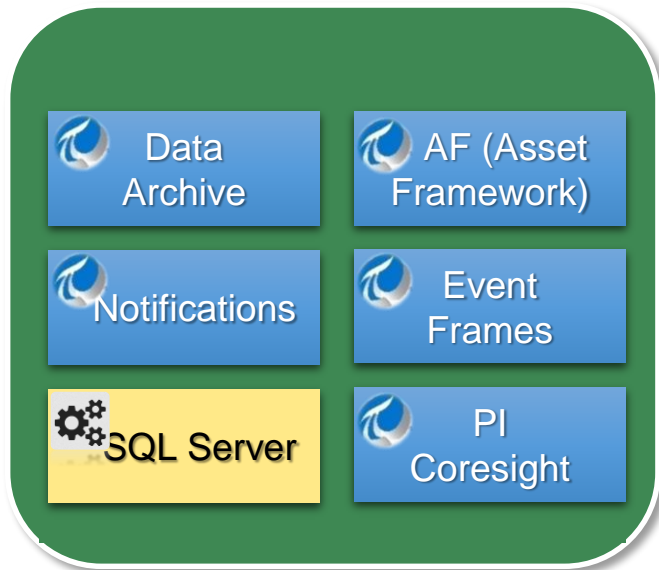


**Reliability**



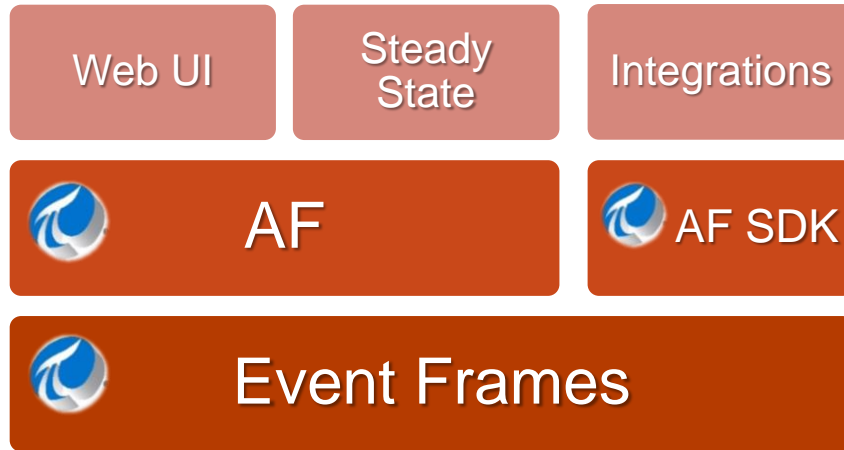
**Growth**

# Solution Overview

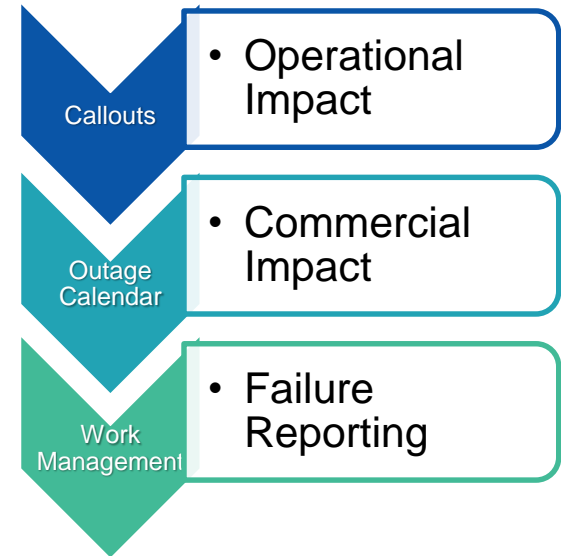


# Solution Elements – Downtime Analysis

## Downtime Classification



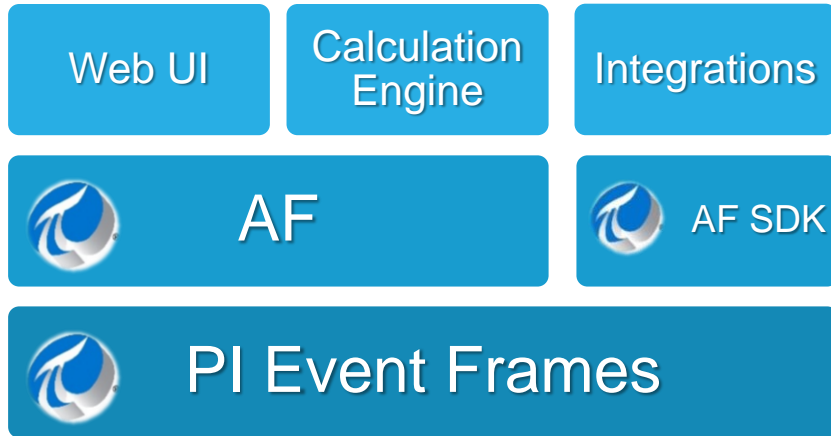
## External Systems



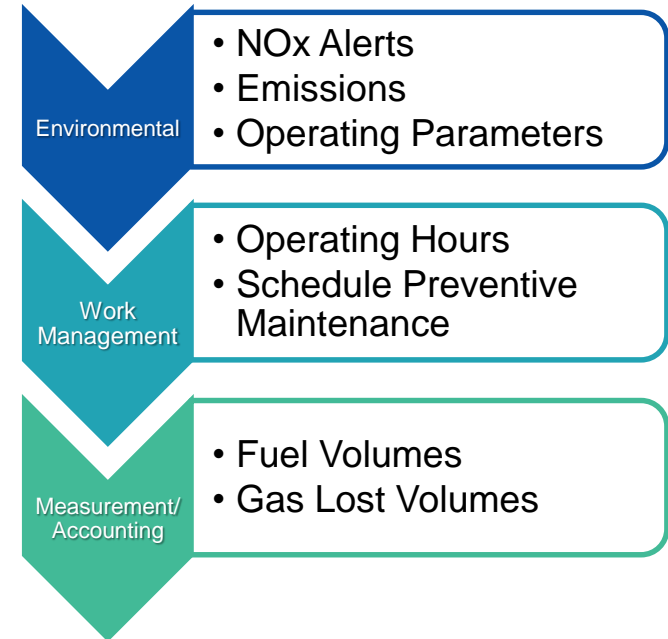


# Solution Elements – Uptime Analysis

## Runtime Reporting (RACR)

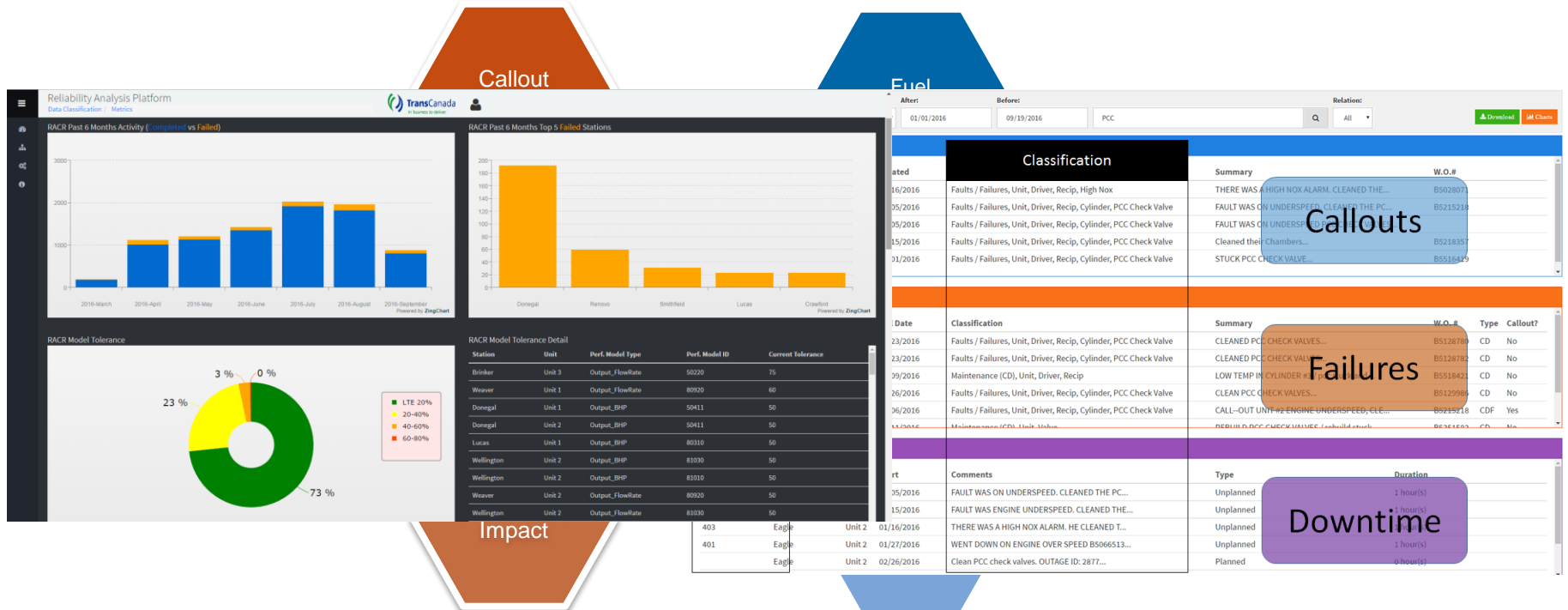


## External Systems

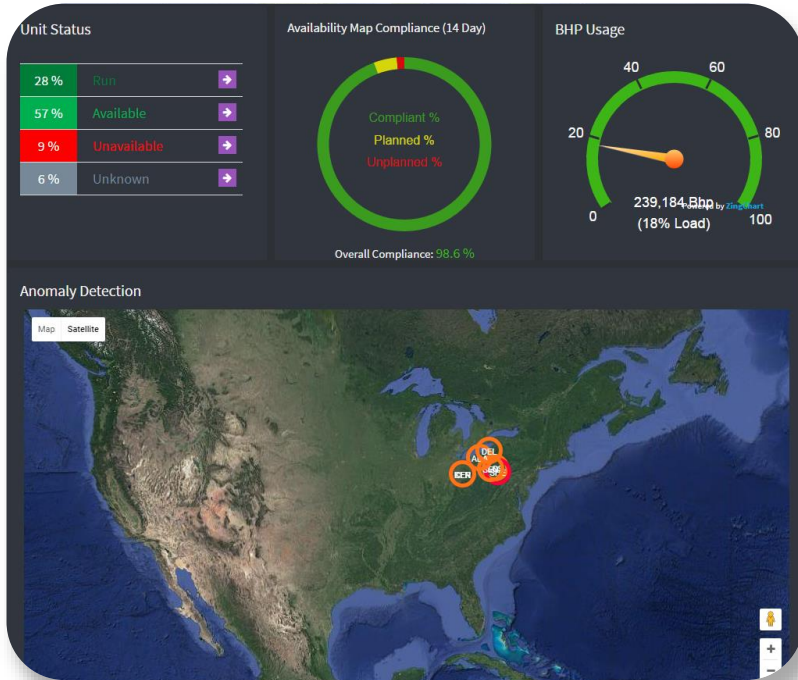




# Solution Elements – Uptime/Downtime Analysis



# Real-time Analytics



CPG

North

East

Central

South

Active Anomalies

Past 3 days

Reports

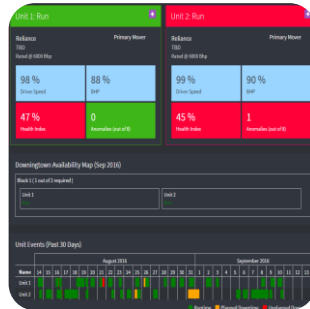
Found 11 active anomalies

Region	Tier	Monitoring Module	Duration	Status	Slope	Bayes
East	1	Compression\Shenandoah\Unit02\Driver\Shaft Vibration	34.1 hour(s)	Pending Acknowledgement	Flat	Not Trained
East	1	Compression\Lost River\Unit12\Gas Compressor\Bearing Temperatures	0.5 hour(s)	Pending Acknowledgement	Flat	Not Trained
East	2	Compression\Loudoun\Unit02\Driver\Casing Vibration	4.6 hour(s)	Pending Acknowledgement	Flat	Not Trained
North	1	Compression\Delmont\Unit01\Driver\Exhaust Temperature	33.9 hour(s)	Pending Acknowledgement	Flat	Not Trained
Central	1	Compression\Seneca\Unit05\Driver\Lube System	6.4 hour(s)	Pending Acknowledgement	Flat	Not Trained
North	1	Compression\Adaline\Unit01\Driver\Cooling & Lubrication	18.9 hour(s)	Pending Acknowledgement	Flat	Not Trained
East	1	Compression\Lost River\Unit12\Gas Compressor\Discharge Temperature	0.8 hour(s)	Pending Acknowledgement	Flat	Not Configured
Central	2	Compression\Ceredo\Unit03\Driver\Exhaust Temperature	63.2 hour(s)	Pending Acknowledgement	Flat	Not Trained

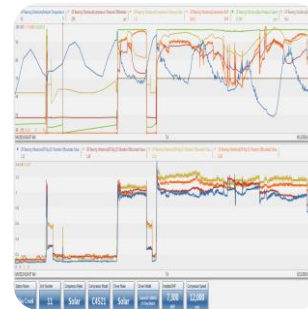
# Real-time Analytics – Process



Executive Dashboards  
Visibility  
Situational awareness



Drill into the Problem  
Multiple layers  
of information



Data Analysis  
Ad-hoc trending  
Model training



Take Action, Track  
& Document

Active Alarms	Alerts	Reports
1 Found 1 active alarms		
For Monitoring Module	Duration	Status
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained
Compressor/Drumming/Unit/001/Compressor Service	1.6 hours	Strong Not Trained



Acknowledgement Comments			
Time	Assigned to	Action	Comment
Sep 13, 2016 8:37:31 AM	Buddy Childers	Assigned	Bearing 02 Temp A & Bearing 03 Temp A, values criss-crossed suddenly



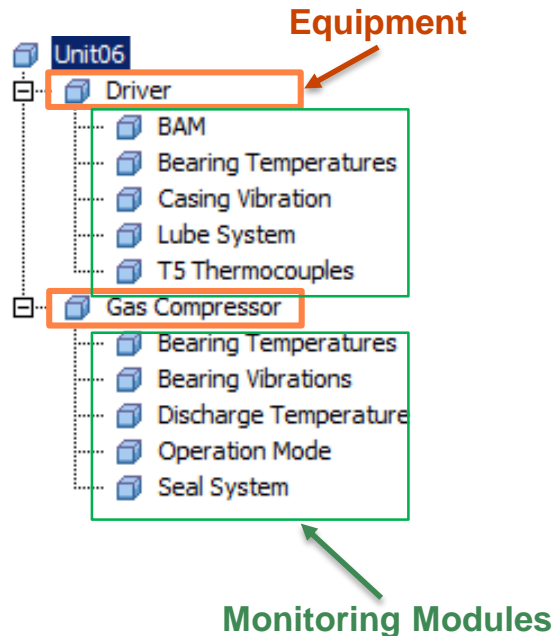
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# Real-time Analytics – Monitoring Strategy

## Modular Approach



## Anomaly Detection

### Statistical Analysis

- Univariate: SQC
- Multivariate: Bayesian Network
- Train 'Normal' models based on historical data

### Key Performance Indicators

- Calculate nominals based on performance curves

## Notification Strategy

### First Level

- Anomaly based on historical normal behavior
- Prioritized list on executive dashboard
- Reliability Analyst starts investigation

### Second Level

- Email/text notification based on rate of change and time to failure
- Immediate action

# Real-time Analytics – Technology

## Back-end

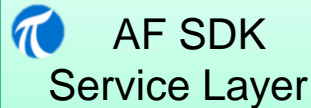
### Asset Framework

- Data Model
- Data Integration
- One Version of the Truth
- Element Templates
- Highly Scalable
- Complex Calculations
- Custom Plug-ins

### Notifications

- Notification Templates
- Multiple Levels

## Middle Layer



## Presentation Layer

### AngularJS

- HTML5
- Expressive, Data-driven Dashboards
- Highly Accessible
- Fast Implementation

### PI Coresight

- Ad-hoc Data Analysis
- Information Sharing
- Templates based on Related Assets

# Equipment Health

Combine **multiple** pieces of **information** for a **complete** picture of **equipment health**

## Availability

### Downtime

- ✓ Event Frames
- ✓ Downtime classification
- ✓ Planned vs. unplanned
- Maintenance data

## Performance

### Runtime

- ✓ Event Frames
- ✓ RACR
- ✓ Horse power usage
- Efficiency

## Quality

### Anomaly Detection

- ✓ Sensor data behavior based on historical normal
- Oil analysis
- Equipment analysis reports

## Health Index

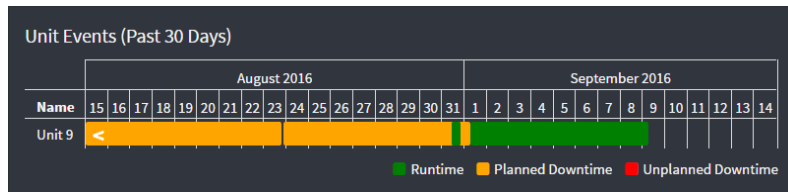
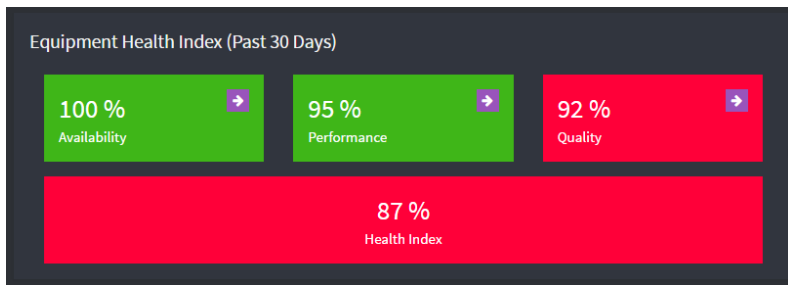
- ✓ **Currently Implemented**
- Future



# Equipment Health

## Information at our Fingertips

- Centralized
- Visible
- Highly accessible



Health Index - Availability Details (Past 30 Days)

Downtime

Unplanned Downtime (0) Planned Downtime (2)

Start	End	Hours	Description
Jul 05, 2016 7:34 AM	Aug 23, 2016 10:34 PM	208.1	7/5/2016 to 9/2/2016: Sending motor off site for repairs
Aug 24, 2016 1:10 AM	Sep 01, 2016 10:25 AM	201.3	7/5/2016 to 9/1/2016: Sending motor off site for repairs

Health Index - Performance Details (Past 30 Days)

Runtime

Details

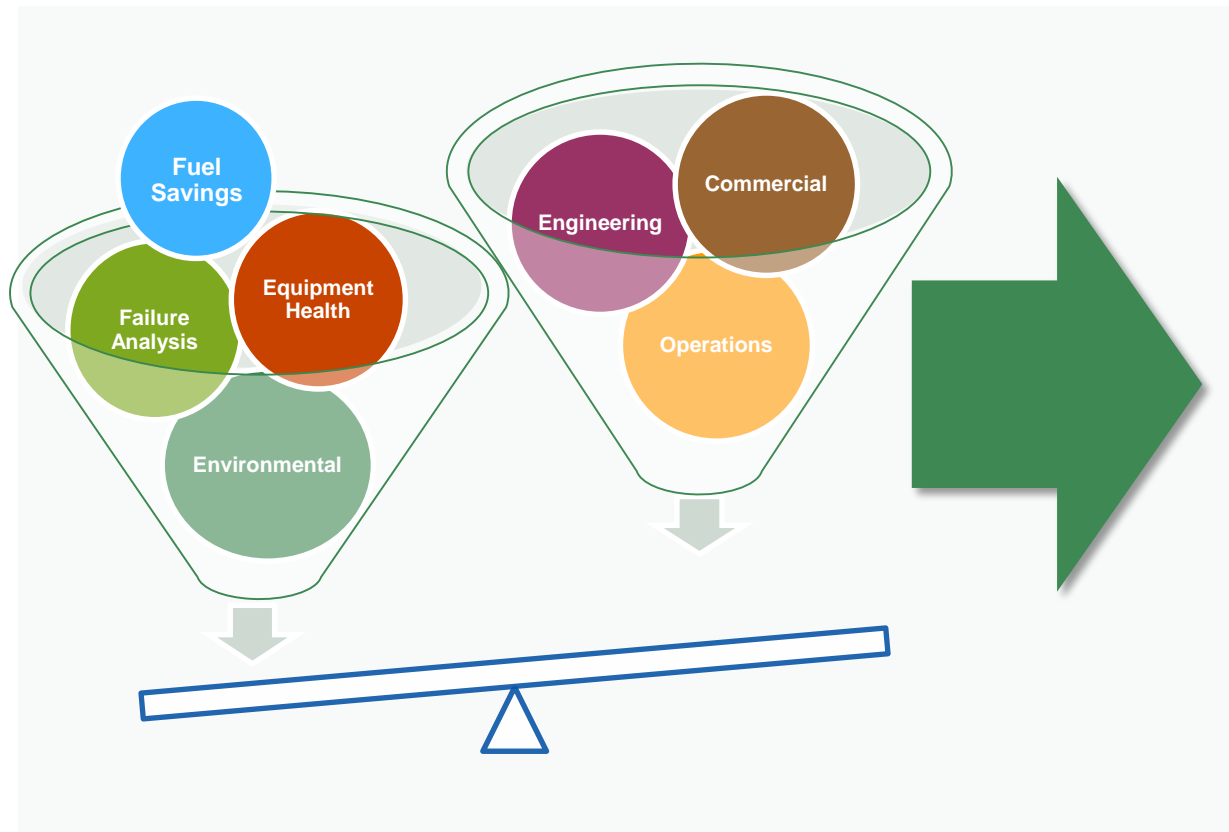
Start	End	Hours	Avg BHP	Avg BHP %
Aug 31, 2016 2:07 PM	Aug 31, 2016 2:08 PM	0.0	2,127	53 %
Aug 31, 2016 2:18 PM	Aug 31, 2016 3:45 PM	1.5	3,336	83 %
Sep 01, 2016 10:27 AM	Sep 09, 2016 10:00 AM	191.6	3,786	95 %

Health Index - Quality Details (Past 30 Days)

Monitoring Module	Occurrences	Duration
Driver\Bearing Temperatures	1 time(s) 09/01 12:21 PM - 09/01 2:06 PM Total duration: 1.8 hour(s)	1.8 hour(s)
Driver\Bearing Vibrations	0 time(s)	0.0 hour(s)
Driver\Shaft Vibration	1 time(s)	117.8 hour(s)
Driver\Winding Temperatures	0 time(s)	0.0 hour(s)
Gas Compressor\Bearing Temperatures	1 time(s)	79.5 hour(s)
Gas Compressor\Casing Vibration	2 time(s)	143.7 hour(s)
Gas Compressor\Discharge Temperature	0 time(s)	0.0 hour(s)



# Intelligent Operations

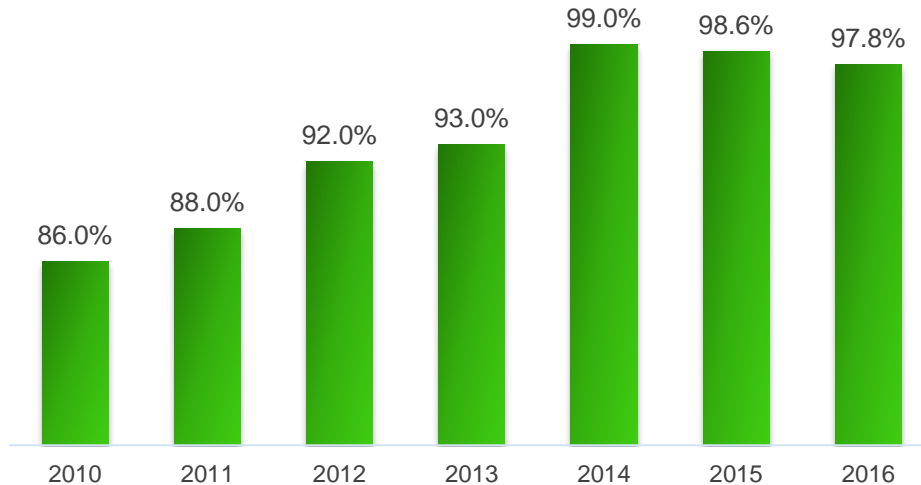


## Better Operational Decision Making

- Regulatory compliance
- Exceed customer expectations
- Minimize unplanned outages
- Optimize asset efficiency
- Optimize organizational efficiency

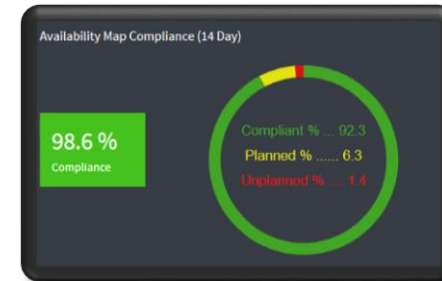
# Results - Compression Availability Compliance

## Availability Compliance by Year



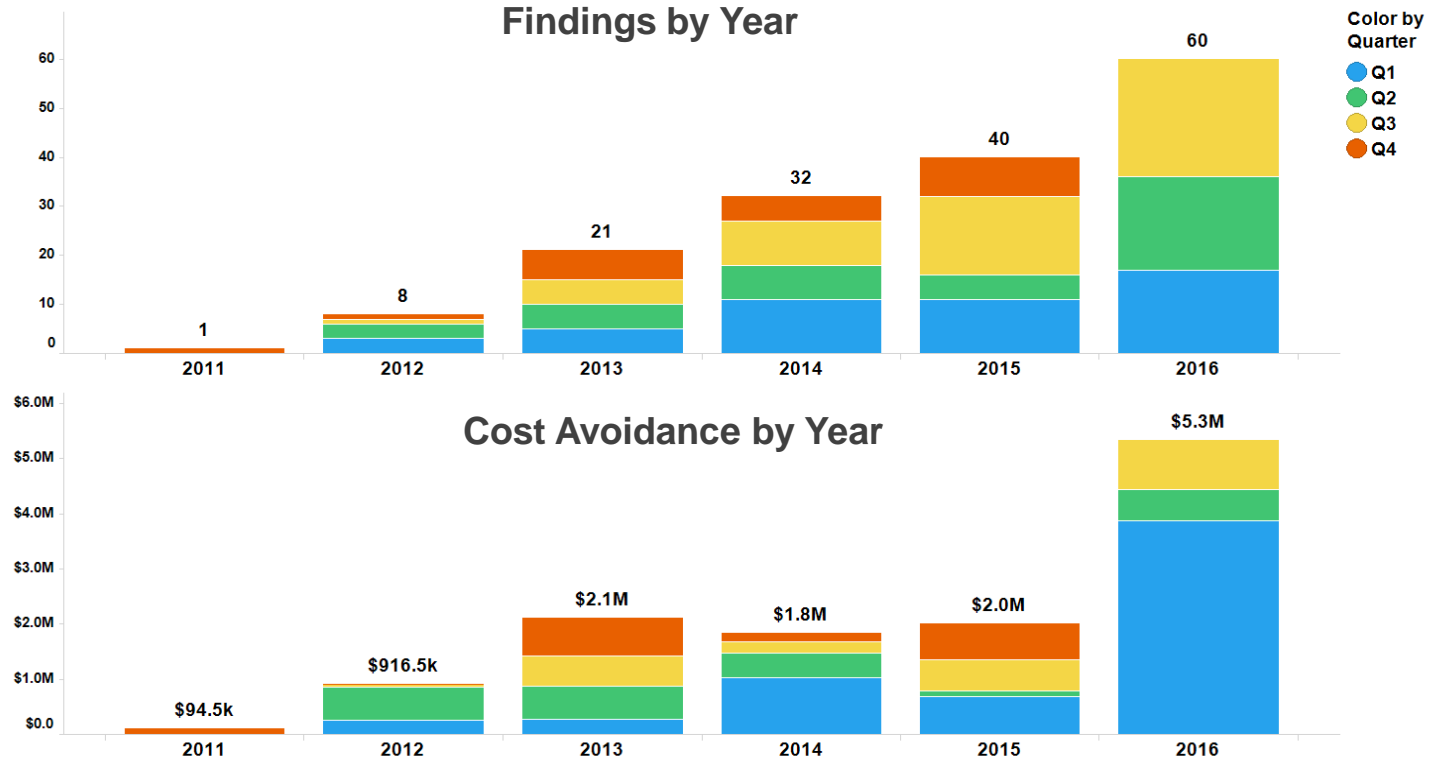
## Visibility

- Real-time dashboard

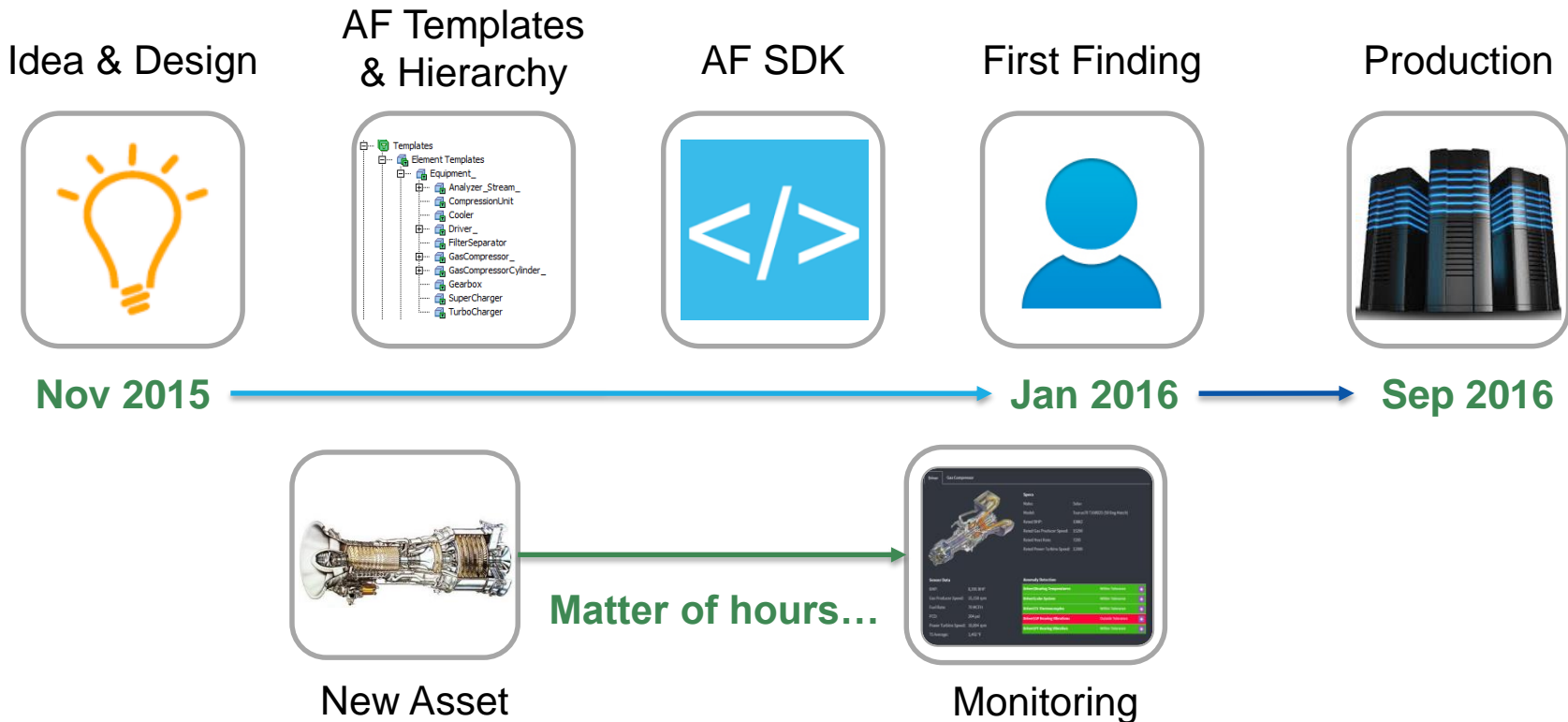


- Monthly scorecard reporting to president

# Results – Anomaly Detection



# Results - Implementation Time & Scalability



# Summary

## COMPANY and GOAL

- TransCanada manages over 3M BHP and 31,000 miles of natural gas pipe
- Goal to safely and reliably deliver gas in a manner that exceeds customer expectations



## CHALLENGE

- Challenge has been to ensure assets are available and reliable
- Accommodating large growth
- Commercial impact of unplanned outages
- Communicating fleet health and availability
- Expansion of asset fleet by 1M BHP

## SOLUTION

- Suite of tools built on PI System infrastructure enabling Real Time Anomaly detection, Uptime/Downtime analysis
- Uptime/downtime analysis tools
- Feature-rich real-time dashboard
- Full context of asset health

## RESULTS

- Intelligent maintenance and operations
- Anomaly findings up 50% over 2015 - \$5.3M YTD
- Asset health at our fingertips
- New assets under monitoring during commissioning



# Contact Information

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## Questions

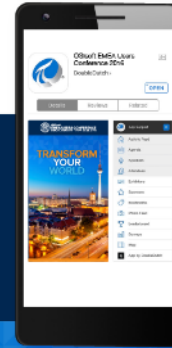
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State your **name & company**

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado



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