EMPOWER YOUR ANALYTICS WITH OPERATIONAL DATA

# PI System Use Cases and Experience Sharing

*Ann Moore – Industry Principal*

*October 1, 2019*

Organiser

Co-host

# Digital transformation is hard

**60%**
of digital initiatives fail

-Cisco

**53%**
of a data scientist's time is spent cleaning data, not analyzing it.

-Crowdflower

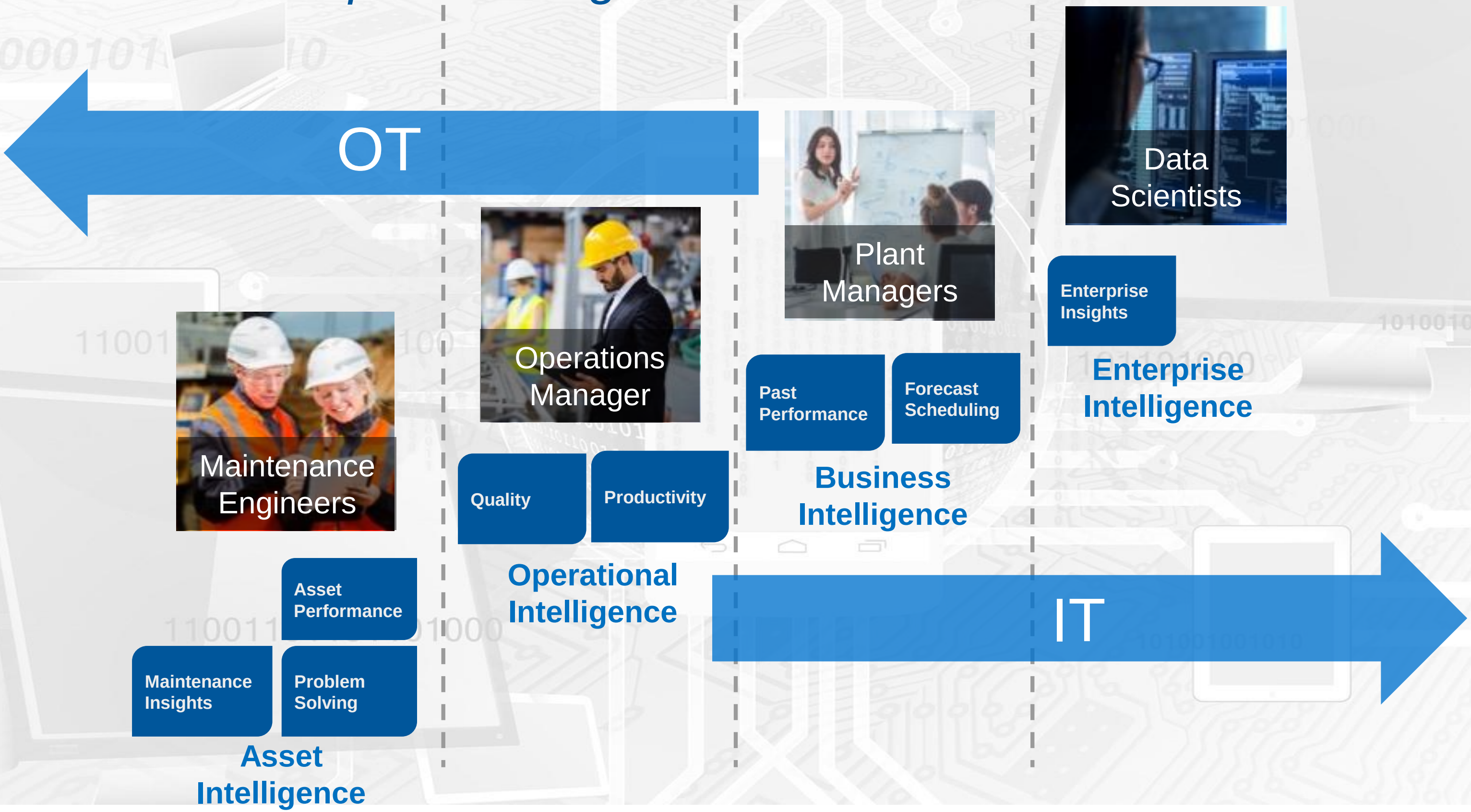
**17%**
of companies feel they effectively collect, manage and analyze OT data

-Forresters

# Extending the Value of Operations Data

*From asset to enterprise intelligence*



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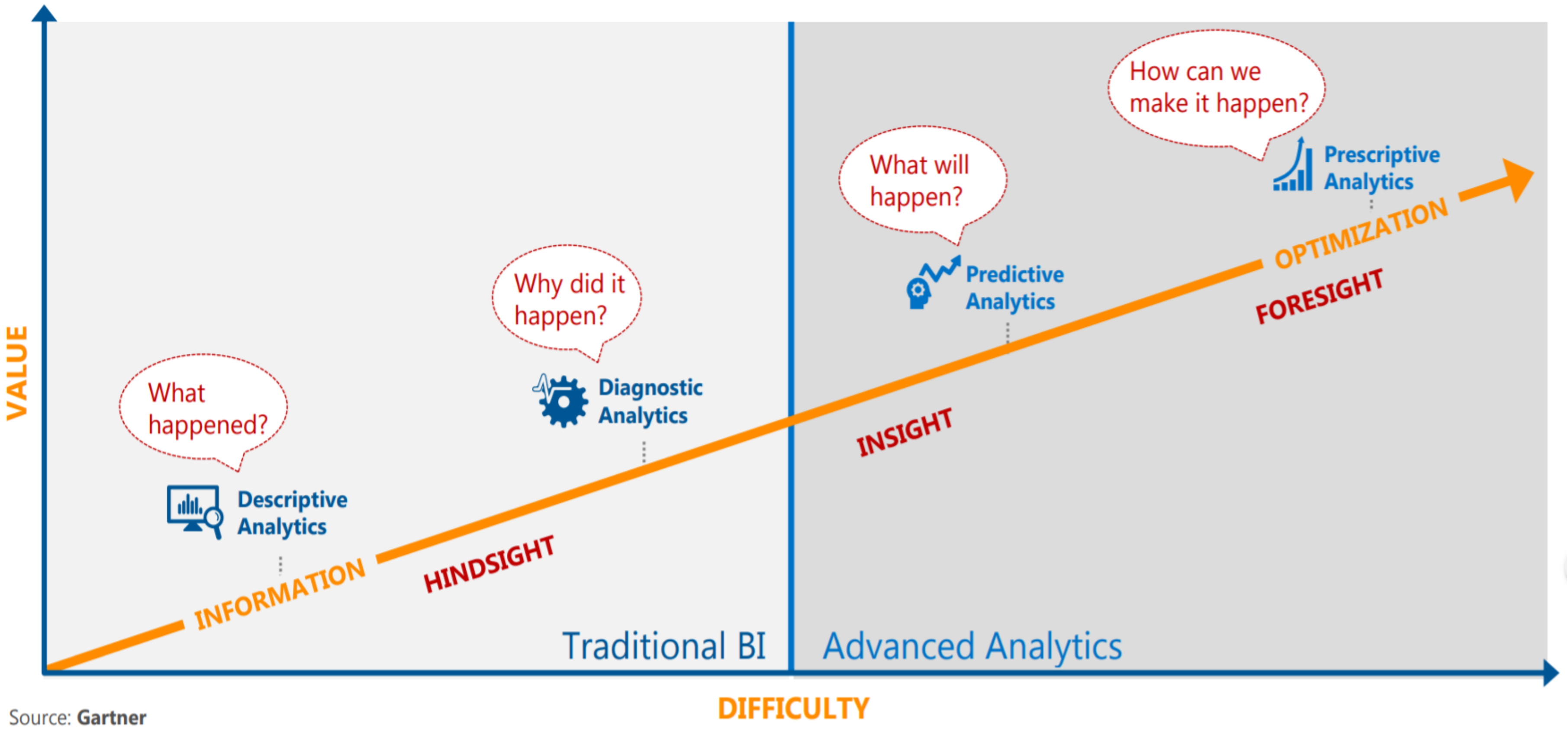
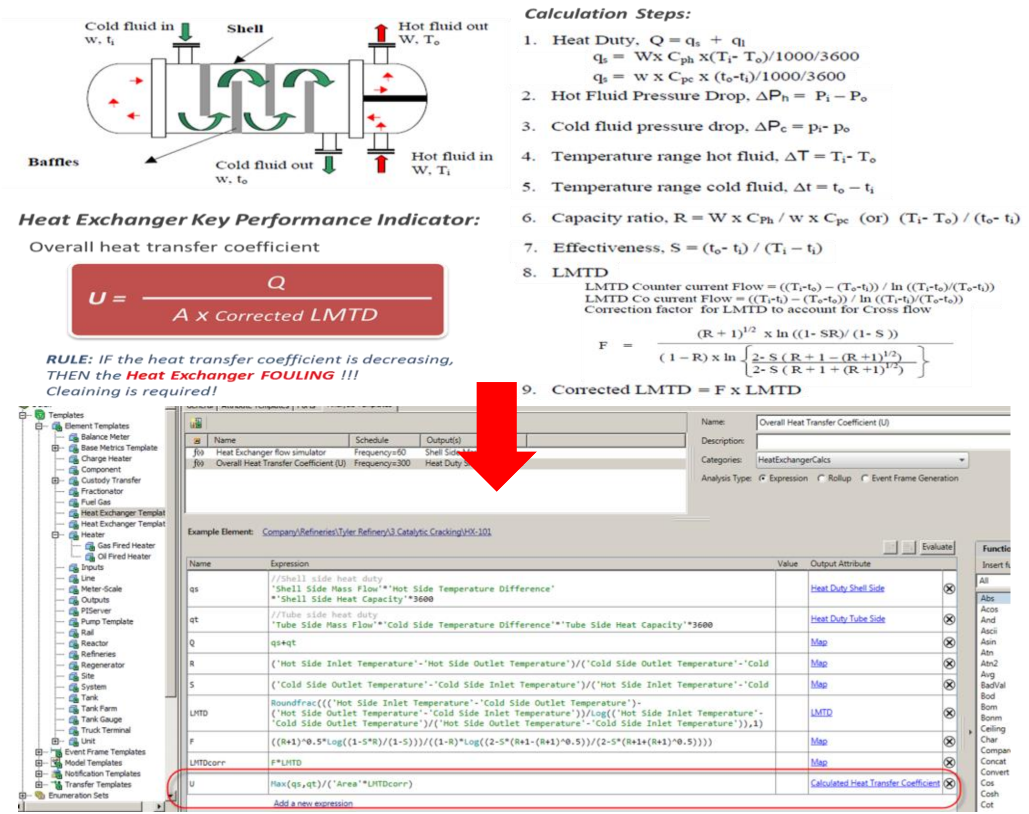
# Analytical Layers for Intelligent Operations




Source: **Gartner**

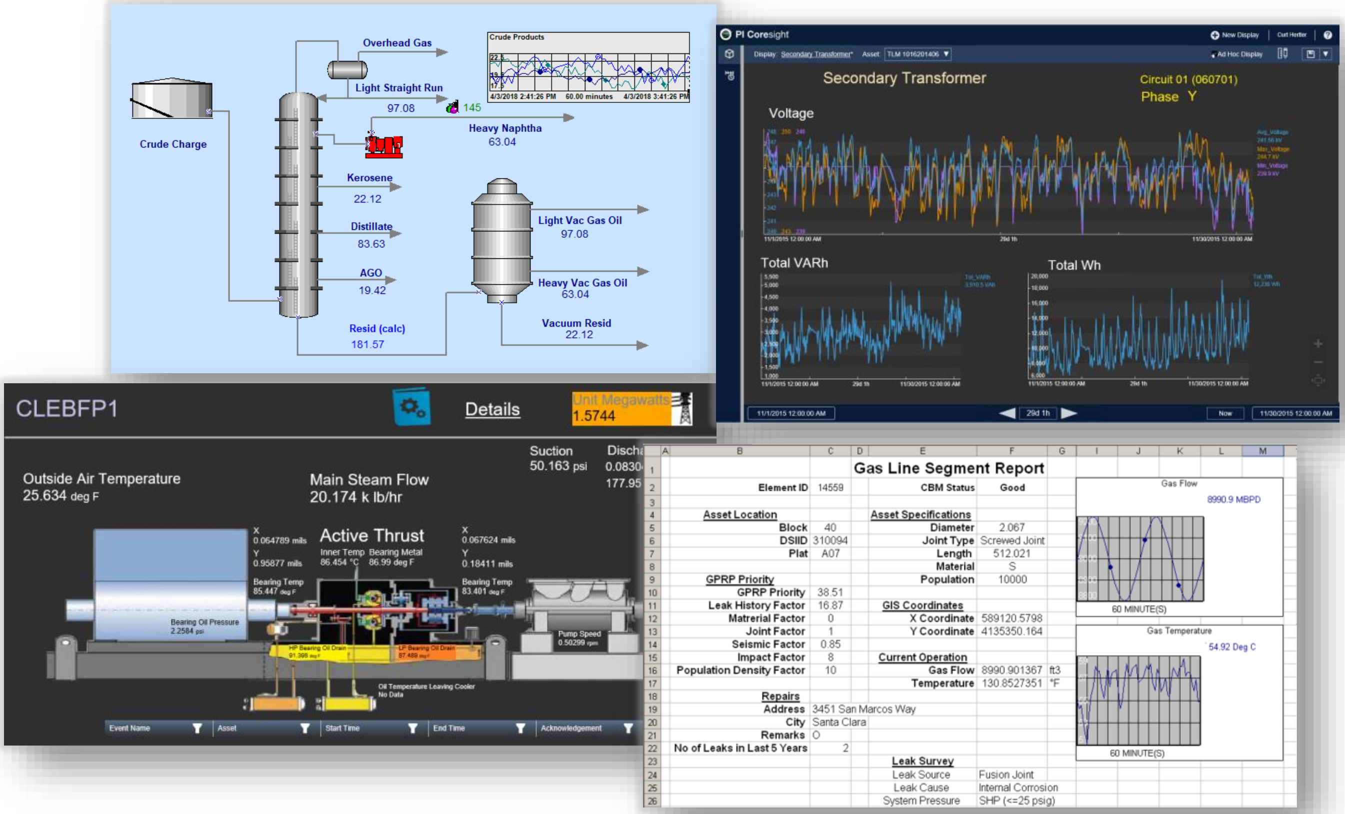
# Descriptive Analytics – *PI AF Analytics*

- <u>Configurable calculations</u> using math, statistical, and time-based functions providing appropriate aggregation
- <u>Backfill calculations</u> for validation and operationalization of predictive models
- <u>Future data support</u>, adding relevance to prediction and forecasting results
- <u>Notification</u> for proactive response



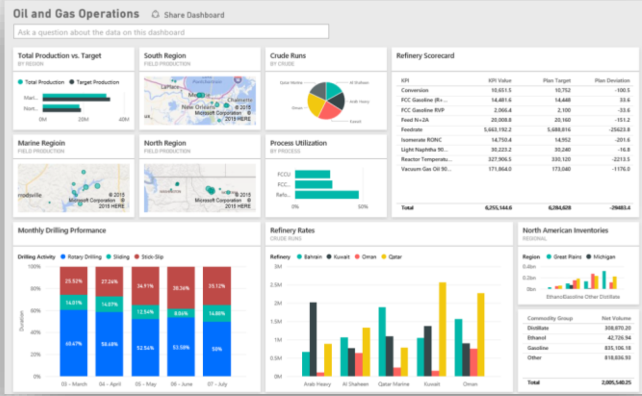
# Diagnostic Analytics – *Trending and Event Awareness*

- Access to real-time events with intuitive tools suited to Operations
- Supports ad hoc, self-service investigation on all platforms, desktop, web, mobility
- Complete suite of development tools



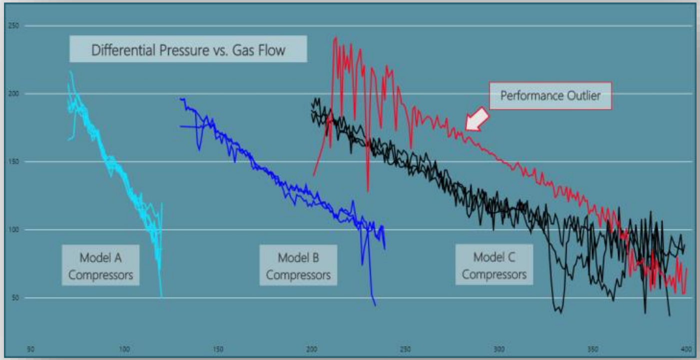
# Diagnostic Analytics – *Multidimensional Visualization*

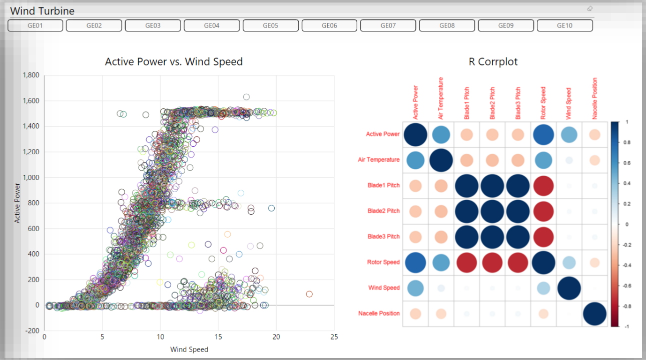
**Business Analysis**
*Product inventories*


**Dashboards**
*Collaboration*

**Asset Performance**
*Benchmarking*

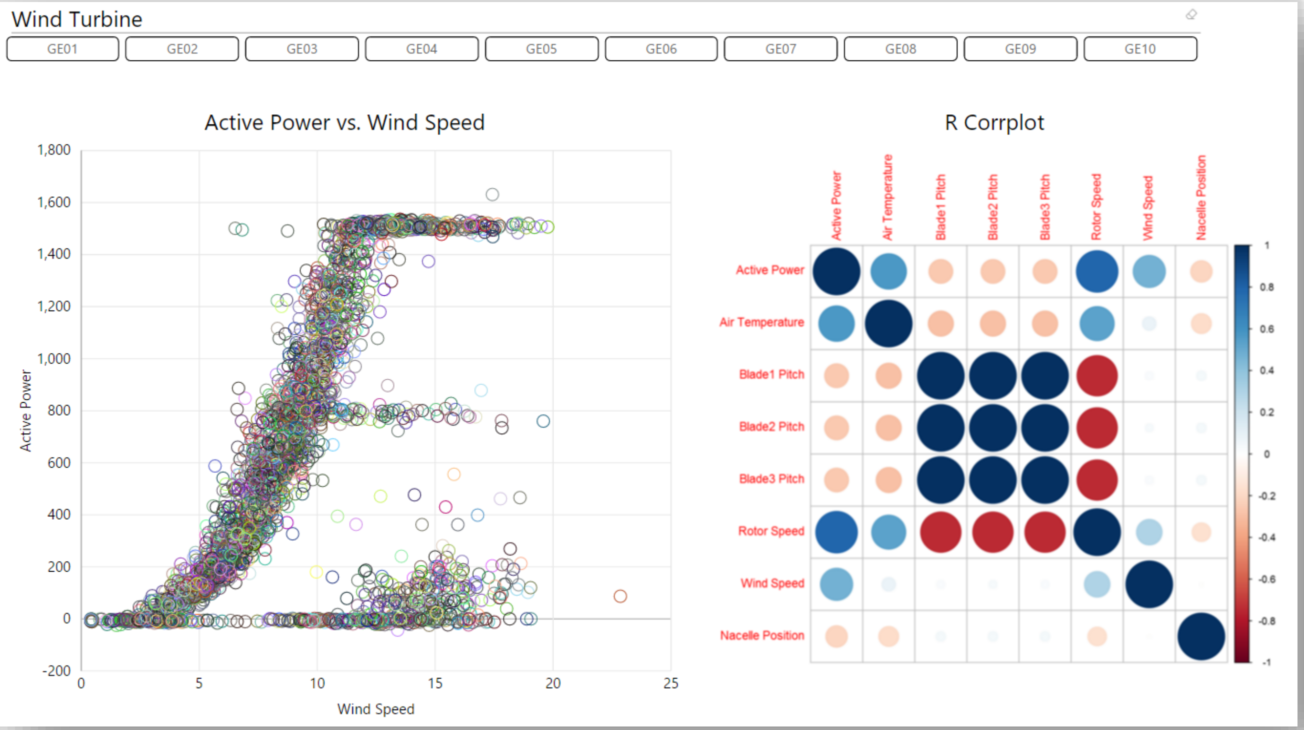



**Analytics**
*Measurement Correlation*

# Diagnostic Analytics – *Cross Correlation Statistics*

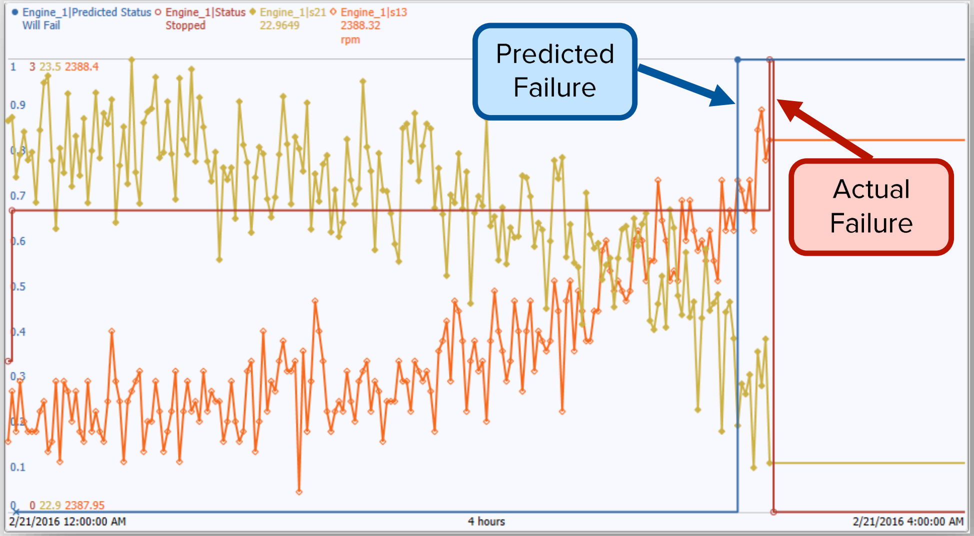
- Understand wind turbine operating characteristics
- Identify data to be used for predictive model training
- R "corrplot" to identify correlated variables



# Predictive Analytics - *Asset Failure*

Complex systems; descriptive equations are too numerous and interrelated

- Create an operationalized model to reduce unplanned downtime for 100 engines



# Predictive Analytics - *Asset Failure*

Complex systems; descriptive equations are too numerous and interrelated

- Create an operationalized model to reduce unplanned downtime for 100 engines
- PI Integrator for BA used to extract data for 2,300 sensors leading up to engine failures
- Developed a statistical model using R for predicting failure
- Tested and operationalized using PI Analytics for all engines

R MATLAB python

```
+('s11'-(47.51488))/0.2701003*0.3090913+('s12'-(521.4901))/0.7517117*-0.3049236+('s13'-
(2388.09))/0.07484883*0.2845465+('s14'-(8143.502))/19.7965*0.04163657+('s15'-
(8.438634))/0.03782789*0.2868222+('s17'-(393.0714))/1.561964*0.2685557+('s2'-
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(553.4522))/0.8983562*-0.2995252+('s8'-(2388.091))/0.07388822*0.2847322+('s9'-
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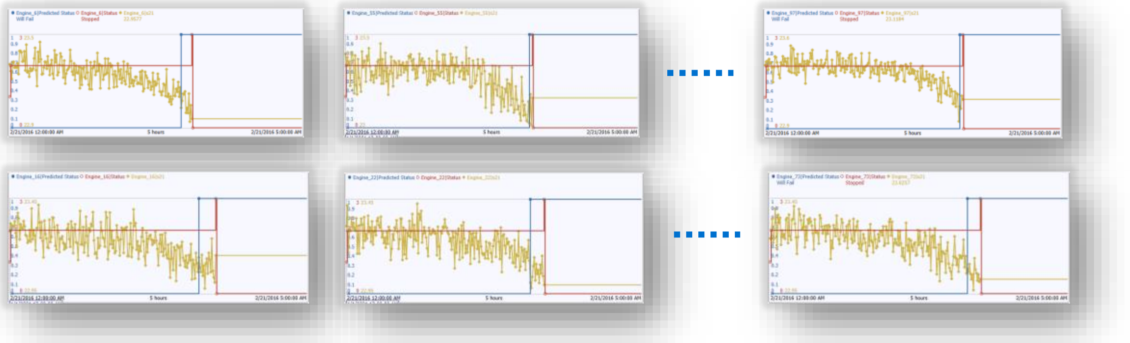
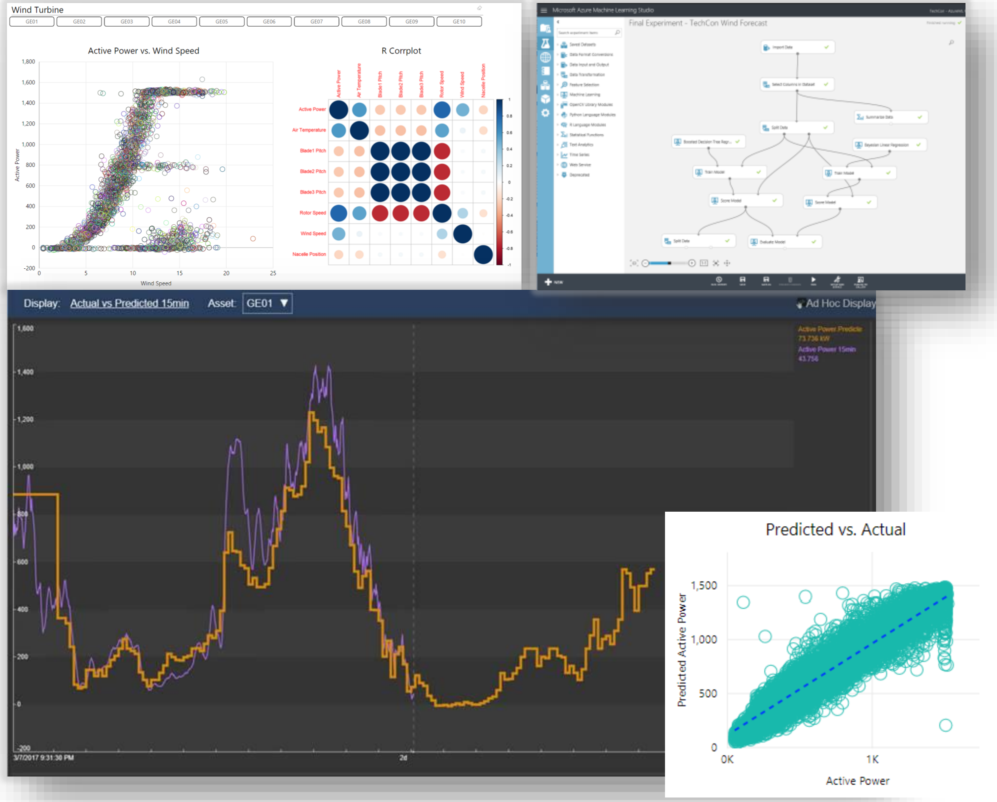


*All Engines*

# Predictive Analytics - *Forecasting*

Outline a process for operationalizing a forecasting model using the PI Infrastructure

- Prepare data for forecasting model development
  - ***PI Integrator for BA (Business Analytics)***
  - ***Event Frames and PI Event Views***
  - ***Power BI***
- Train model and deploy a forecasting web service
  - ***Machine Learning***
- Integrate real-time forecasts into PI System
  - ***PI Future Data***
- Validate model performance
  - ***AF Analytics Backfill/Recalculate***
  - ***Power BI***

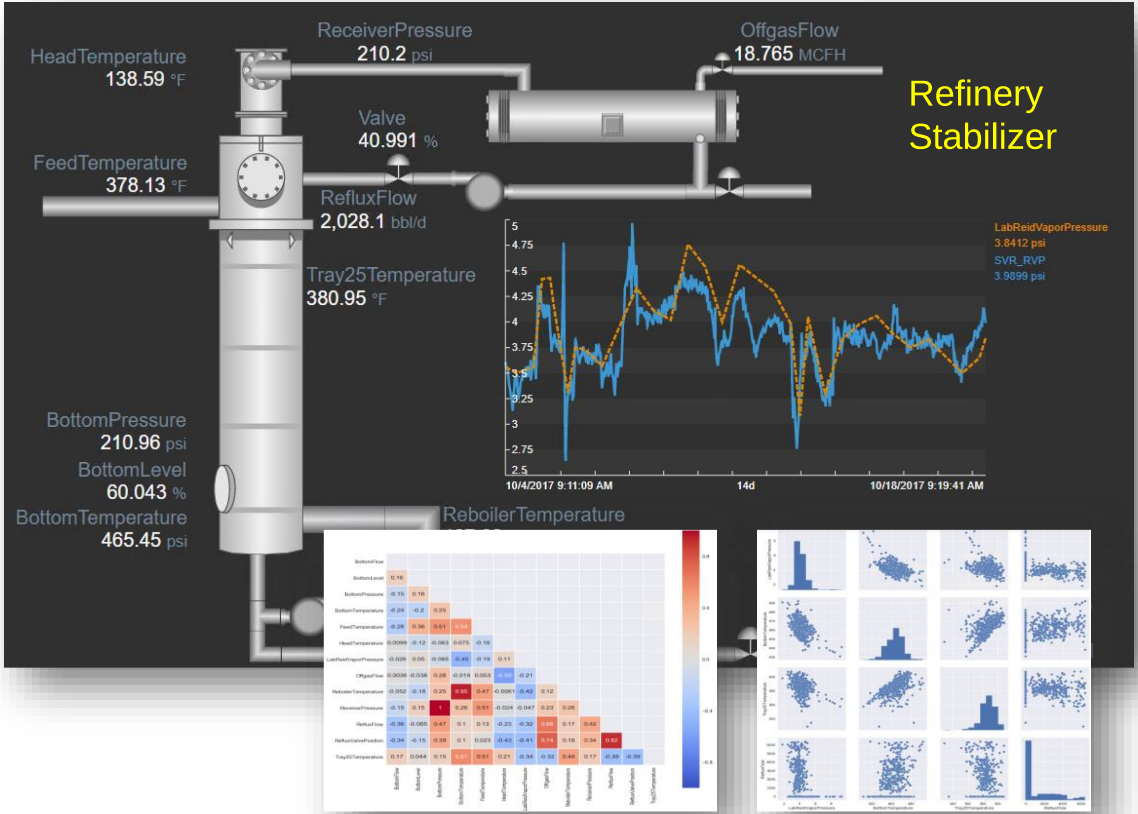



Organiser OSIsoft. Co-host Dimension Software

# Streaming Analytics – *Continuous Property Estimation*

Predict Reid Vapor Pressure (RVP) of a gasoline component in real-time

- Extract process data at lab sample times
  ***PI Integrator for BA***
- Develop predictive model for RVP
  ***Python in Jupyter Notebook***
- Real-time operationalize of model
  ***PI Integrator for BA (Streaming)***
  ***Apache Kafka***



Predictive models to detect probability of engine failure

Predictive alerting of fuel gas valve deviations on turbines

Hydro generator performance to forecast cooling system degradation

Diesel desulfurization predictions at their La Coruña Refinery

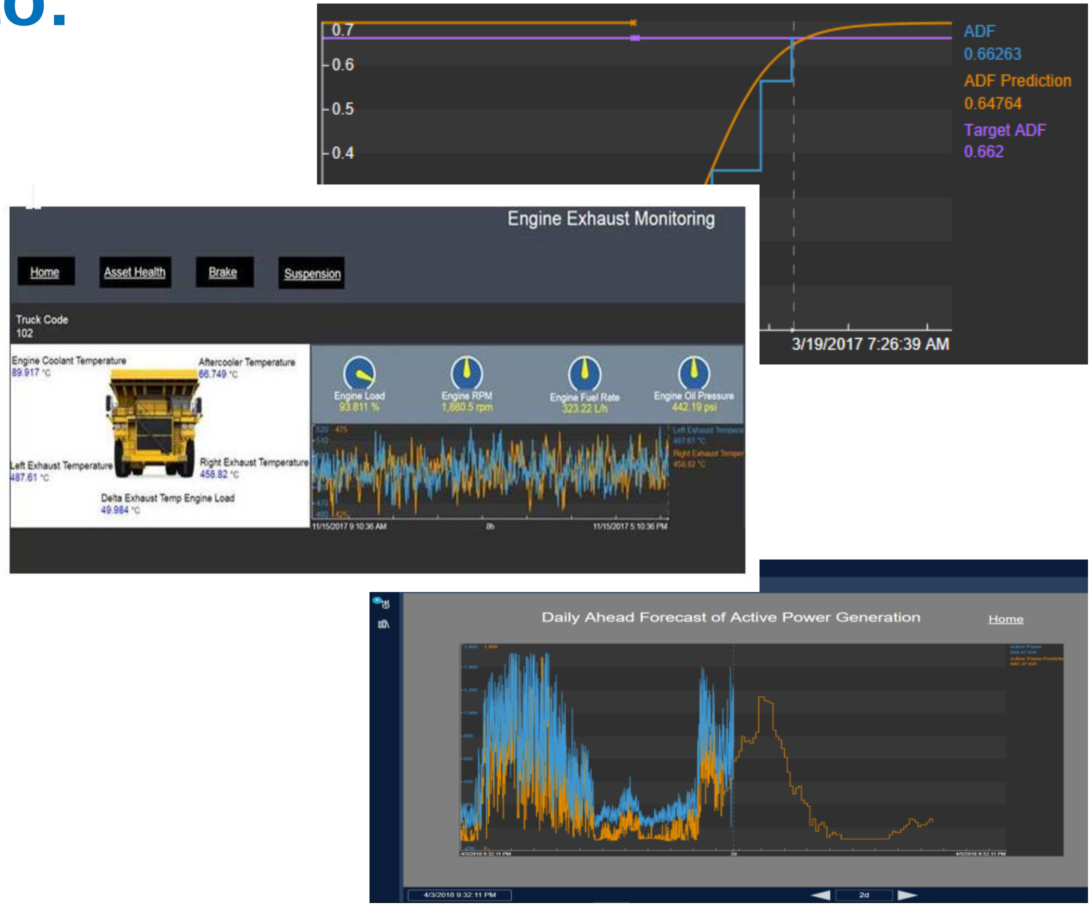
Predict performance of compressor gas cooling system

Energy management and forecasting for production facilities

# Customer Use Cases for Data Science

# Use Cases group into:

- Process Improvement
  - Reduce variability
  - Increase output
  - Improve quality
- Smarter Maintenance
  - Improve reliability
  - Reduce unexpected downtime
  - Reduce overall costs
- Predictive production/consumption
  - Control resource consumption
  - Production planning accuracy
  - Drive sustainability goals



# Experience Shows Analytics is a Journey

PI Tools

3rd Party Tools

PI DataLink
PI System Access

PI Integrators for Business Analytics

| Descriptive Analytics | Diagnostic Analytics | Geo Analytics | Predictive Analytics | Prescriptive Analytics | Artificial Intelligence |
|---|---|---|---|---|---|
| ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ |
| What is happening | Why is it happening | Where will it happen | What will happen | Tell me what to do | Make decisions for me |

# Common Customer Barriers & Challenges

“Having the breadth of quality data”

“Missing failure data”

“Data consistency across the company”

“Lack of SMEs”

“Quantity of change for humans”

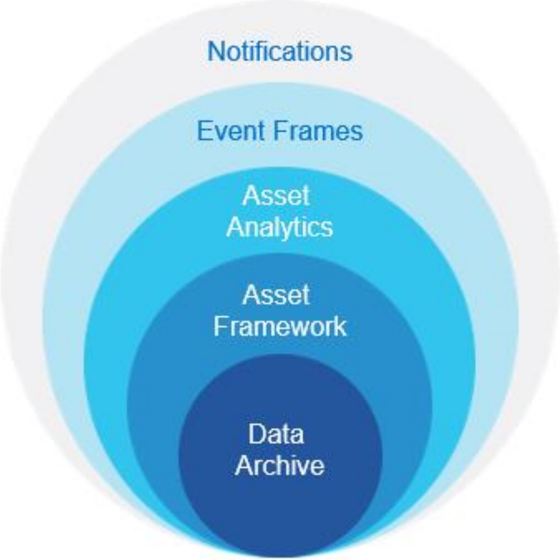
“Time to value of POCs”

“Hype & deception of vendors”

# PI System to prepare the data for Enterprise Tools

*PI Integrators delivers the data for BA Tools*

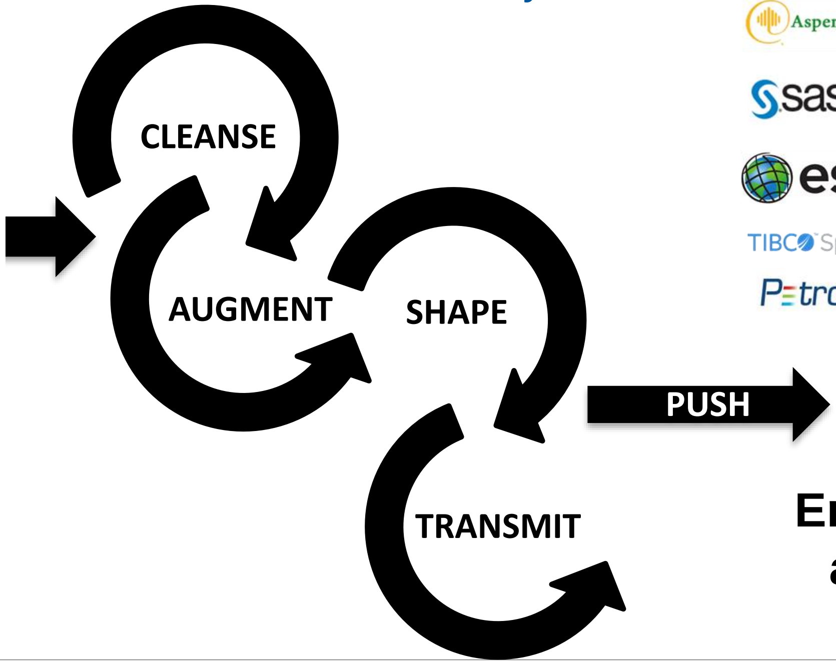
## Operations Data




**PI Server**

## PI Integrators

Translate OT data to IT systems




## Enterprise Tools

Aspen-HYSYS
Microsoft SQL Server Reporting Services
sas
hadoop
esri
MEMSQL
TIBCO Spotfire
Microsoft Azure
Petro-SIM
AWS S3
AWS Redshift

**Enterprise Analytics and Visualization**

Power BI

orange
DATA MINING
FRUITFUL&FUN

R

Microsoft Azure

tableau

python

Google Cloud Platform

Microsoft SQL Server
Reporting Services

jmp
Statistical Discovery. From SAS.

jupyter

amazon web services

APACHE Spark

COGNOS

Qlik

memsql

hadoop

...

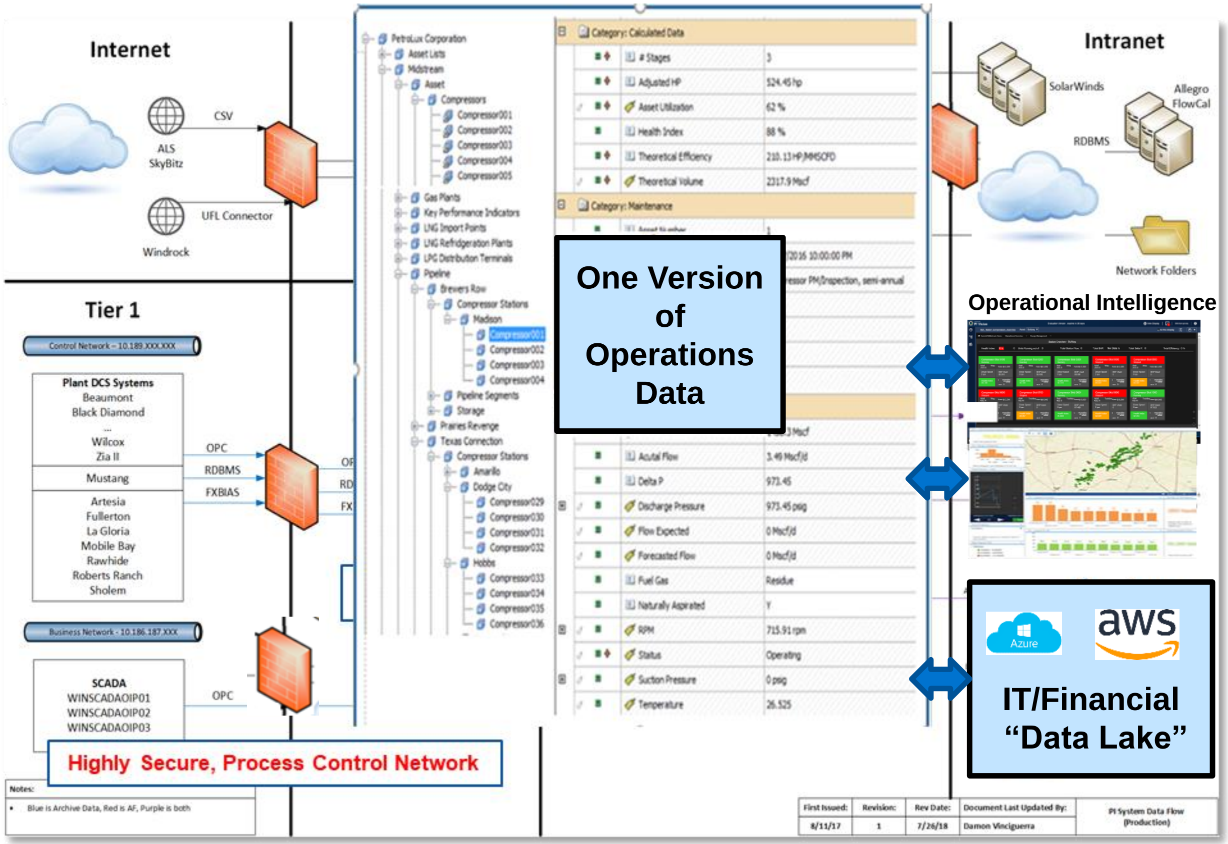
TIBCO Spotfire

# Where Does The PI System Fit in This?

| | |
|---|---|
| PI AF | Provide context for Data Exploration |
| PI Vision | Visual Data Exploration |
| Event Frames and Analytics | Feature Engineering |
| PI Integrator for BA | Data cleansing and shaping |
| PI Data Archive with Future Data | Store predictions back in the PI System |

# PI Integrator in Action at DCP

- **Plant DCS** (OPC, RDBMS, FXBAIS)
- **Wonderware SCADA** (OPC, RDBMS)
- **Allegro** – Market Prices (RDBMS)
- **Windrock Spotlight** (Connector for UFL)
- **VMGSim** (OPC – bidirectional data flow)
- **ACI Compression Modeling** (custom utility – bidirectional data flow)
- **Current local temperature** (custom utility)
- **FlowCal** – Volumes and GC (RDBMS)
- **SkyBitz** – remote tank monitoring (UFL)
- **ALS** – lab tests of oil samples (UFL)
- **SolarWinds** – network equipment status (Connector for UFL)
- **FieldSquared** – Operator rounds (custom utility and UFL)




Reference: DCP Midstream's PI World 2018 Presentation

# Customer Success Stories in Azure

## Deschutes Brewery

Deschutes used Machine Learning to improve their brewery processes

- Saving up to 72 hours per batch
- Deferring an $8 million upgrade.

## Lonza

Expanded production capacity limits

- Used Machine Learning to identify major drivers for reaction times
- 6 weeks – total time to value

- ✓ **Process optimization**
- ✓ **Improved maintenance**
- ✓ **Energy management**
- ✓ **Predictive operations**
- ✓ **And more…**

# Customer Success Story in SAP

## Marathon Oil

### System of Record for Operational Data

The PI System collects 700,000 data points with 1,400 updates per second

### OT Data, Enterprise Analytics

Over 100,000 PI System data points fed every five minutes to SAP Hana

### Simplified Processes

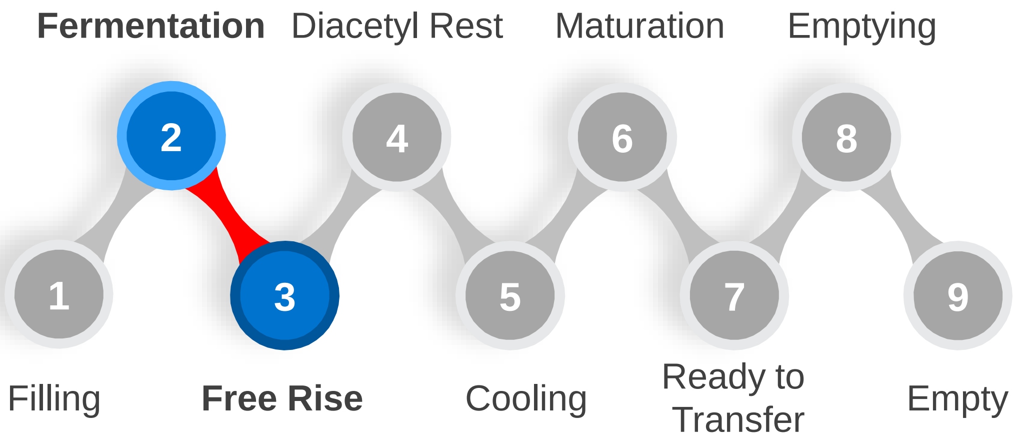
- Data Prep Automated
- Agile Application Development
- Optimized E&P processes

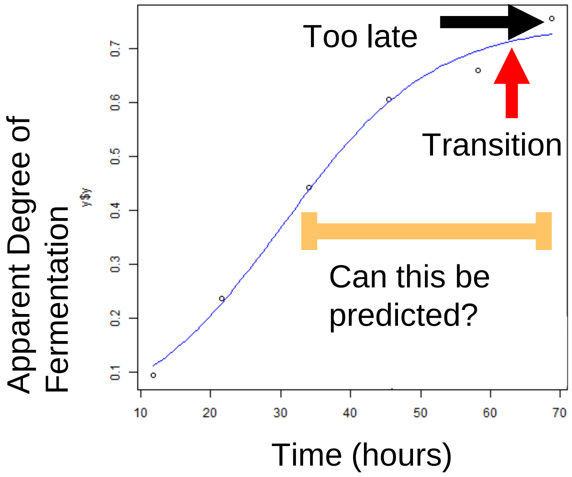
# Customer Success Stories in AWS

| TransCanada | Georgia Pacific | TEPCO |
|---|---|---|
| Gas demand forecasting | Self-service analytics and data lakes | Running PI System workloads in AWS |

# Need to Predict Transition from Fermentation to Free Rise



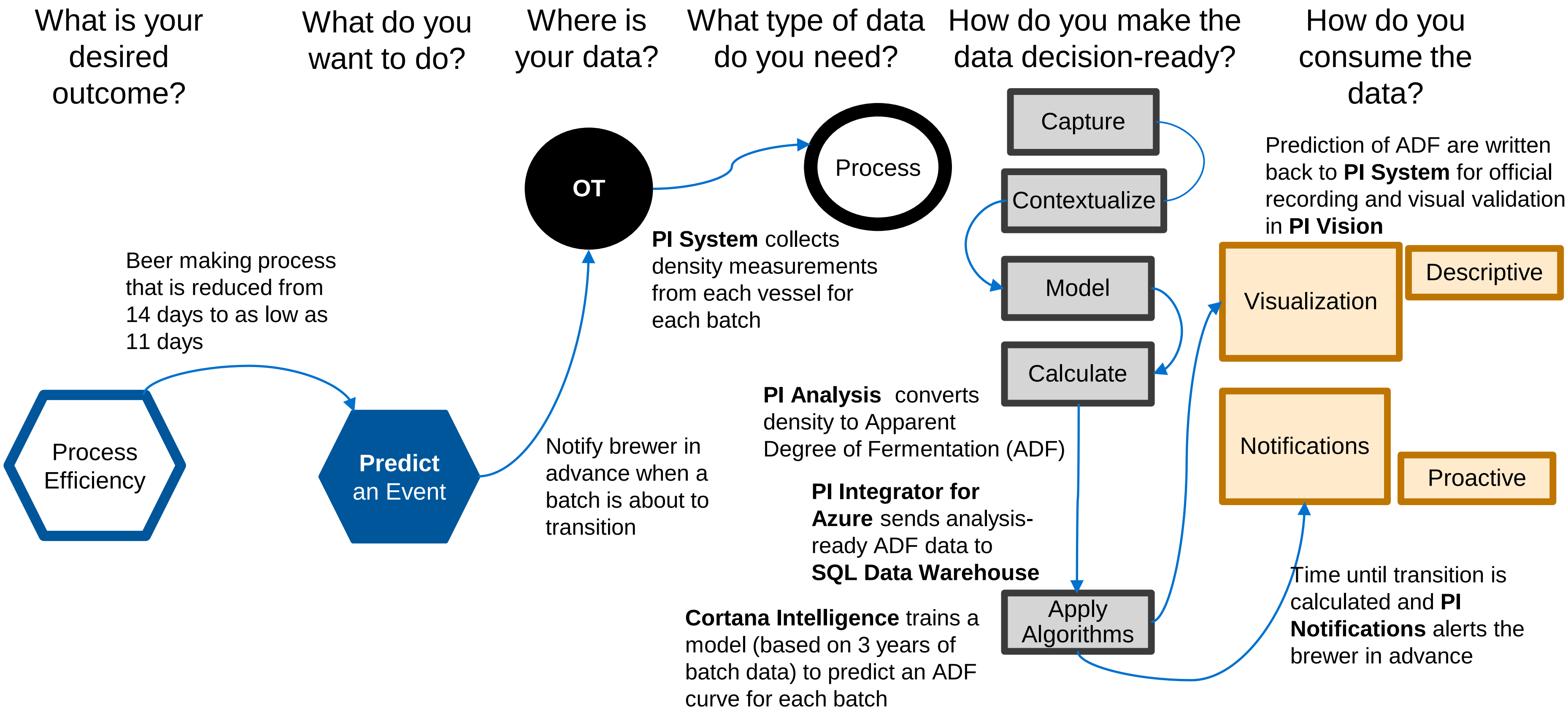




**Constraints**
- One manual density measurement per vessel every 8-10 hours
- Large capital expenditure not an option

**Impact**
- Up to 72 hours lost in production

**Options**
- $750k for inline density meters
- Manually predict transition in spreadsheets

# Deschutes' Journey from Outcome to *How*



# Process Optimization and Efficiency

## COMPANY and GOAL

Deschutes Brewery is the 7th largest craft brewery in the US and wanted to maximize production with its existing infrastructure, avoid unnecessary CapEx projects, and fund construction of a second brewery

## CHALLENGE

Batch phase transition happens between manual density measurements occurring every 8-10 hours

- Impact: different beers transition from one phase to the next at different times.
- Requires regular manual readings and extra time to ensure processing

## SOLUTION

Use data science to achieve accurate predictive analytics for determining a batch's density measurements

- PI System
- PI Integrator for Microsoft Azure
- SQL Data Warehouse
- Azure Machine Learning
- Azure Data Factory

## RESULTS

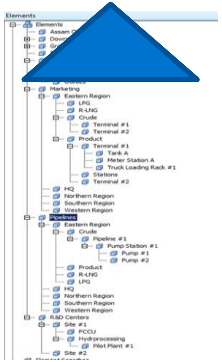
Ability to eliminate production time losses and increase production capacity

- Accurate predictions saving up to 72 hours per batch
- Savings used to fund expansion project

# Defining, Rationalization & Distribution of "Analytics" ……"Layers of Analytics"

SAP HANA

Microsoft Azure



Integrated Control
& Safety Systems
Excel Files

**IT/Business ML/AI**
**Big Data/Advanced Analytics**
**Enabled by the OT Infrastructure**

**OT /Machine Learning**
**Big Data/Advanced Analytics**
**Enabled by the OT Infrastructure**

**Real-time Analytics**
**In the OT Infrastructure**

**Human Analytics**
**Enabled By *and* In the OT Infrastructure**

**Analytics and Predictions for :**

- Dynamic or "smart" IOW/targets/APM/PSM
- "How do you "smooth" operations?
- How do you optimize the yields?
- How do we optimize the fuels value chain?

**Analytics & Predictions for :**

- Coker Hotspot
- Hydro treater sulfur in product
- Hydro treater cloud point
- Bromine Index Benzene
- Coke drum filling & removal

27+ OT ML Apps in production

**Analytics and Predictions for:**

- Corrosion analytics (HTHA, chlorides, etc.)
- Natural gas & electrical peak exceedances
- CBM – exchangers, rotating equipment, etc.
- Environmental Limit predictions.

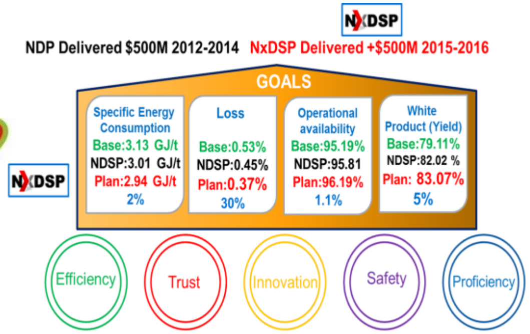
**Enablement of:**

- Data Based Decisions
- Real-time situational awareness
- Management by exception

61,000 Event Frames across 6 plants

# Delivering $1B Business Value from Digital Transformation in ~5 years




## COMPANY and GOAL

Deliver $1B in EBITDA by a business transformation enabled by a digital transformation

Leveraging the PI System as a strategic OT data infrastructure for advanced predictive and proactive analytics

## CHALLENGE

**Deliver strategic business value** to respond to increasing competitive threats; **Change a diverse culture** to **"act as one"** with Operational Excellence & continuous improvement enablement.

- Increasing competitive environment in Eastern Europe
- Variable cracked spread
- Diverse culture across 8 countries
- Low use of data and analytics
- Poor business performance 4th Qtle

## SOLUTION

**Evolved the use of the PI System** as a tag based historian to an asset based infrastructure to **support cultural change** and **data based decision making and support** with advanced predictive and proactive analytics.

- Evolved from Tag to PI AF based infrastructure across the MOL fuels value chain
- Normalized tag, asset, UOM, and time using PI AF as an abstraction layer
- Used data and information to support business transformation

## RESULTS

**Delivering on the MOL Downstream business transformation goal of $1B** and more importantly, a sustainable **cultural change based on data and information** to drive **operational excellence** going forward into the 21st century.

- *Leading Process Safety Management*
- *1st Quartile in energy, yields, loss, and utilization*
- *OT infrastructure enabling time to value and value momentum with advanced analytics including machine learning*

# CEMEX AI: On an Industry 4.0 Journey


CEMEX Autonomous kiln 2022

- Increased Efficiencies
- Reduced fuel & energy consumption
- Better Quality
- Reduced Costs
- Improved Decision Making

# Use Case: Clinker Cooler Optimization

The cooler transfers the heat from clinker to combustion air to:

- Increase heat recovery
- Obtain clinker at a temperature suitable for grinding
- Maximize clinker potential strength through rapid cooling

## Goal

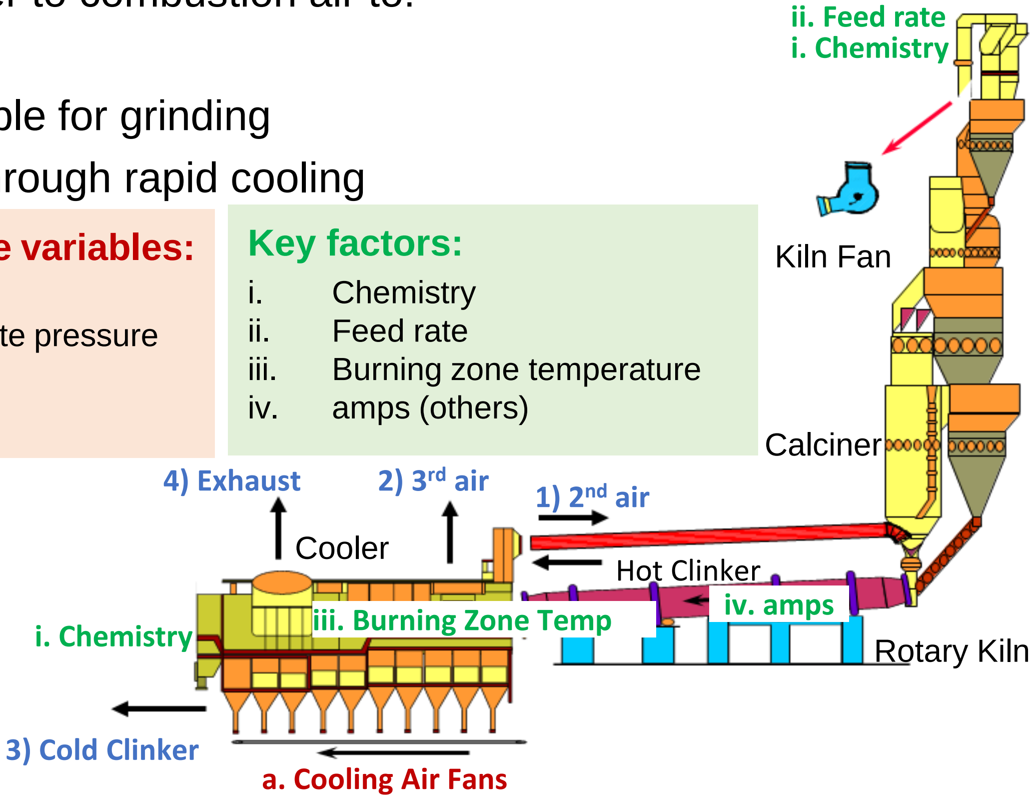
1) Maximize 2nd air heat
2) Maximize 3rd air heat
3) Minimize Cold Clinker heat
4) Minimize exhaust gas heat

## Controllable variables:

a. Fan flow
b. Undergrate pressure

## Key factors:

i. Chemistry
ii. Feed rate
iii. Burning zone temperature
iv. amps (others)



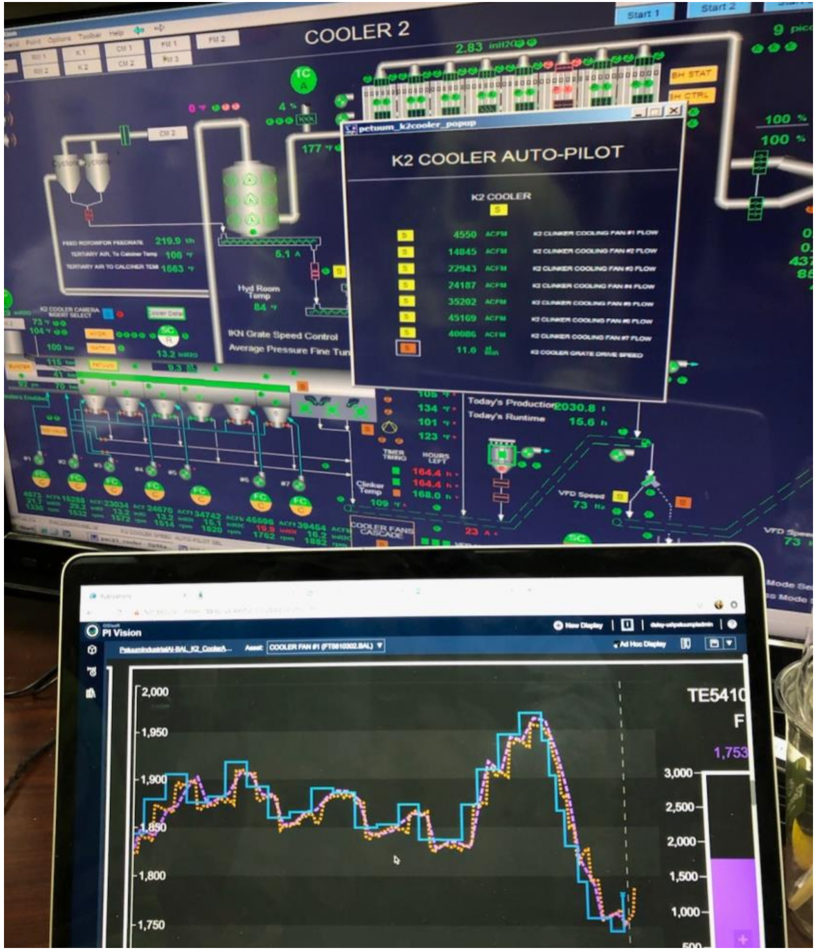

**Note:** Variables and key factors full list depends on use case complexity; typically contains 40+ variables

# Final Result

**Auto-pilot operation of kiln's cooler section (Mode: Autosteer)**

- The AI model submits setpoints for the control variables in real time to control system via PI
- Operators can monitor in real-time if auto-pilot operation is aligned to normal operating parameters
- Kiln operator can engage-disengage autopiloting the control system in case of process disruptions (i.e.- power failure, kiln push, blockages, etc.)

Operators can supervise auto-pilot operation while concentrating on other kiln parameters (similar to a car's cruise control).



# CEMEX

## LEVERAGING THE PI INFRASTRUCTURE & PETUUM INDUSTRIAL AI AUTOPILOT WITH AUTOSTEER TO DRIVE AI-ENABLED AUTONOMOUS OPERATION

### CHALLENGE

Predictable, repeatable ”golden day” operations – high yield, high quality at low cost sustainably

- Prove AI / ML capabilities to optimize production processes
- Complex, highly variable operations
- No real time prediction, reactive operator actions

### SOLUTION

- Petuum Industrial AI taps into PI System and other sources to deliver real time forecast of process variables, prescriptions for operator actions and a supervised auto-steer
- Integration with OSIsoft suite of products for configuration, data streaming and visualization
  - PI Cloud Connect, PI WebAPI
  - PI AF, PI OPC Read-Write
  - PI Vision incl. Custom Controls

### RESULTS

Expected yield and energy improvements in the range of 2-7% from combined use cases

- Reduced process variability
- Increased throughput
- Cost reductions from increased energy recovery:
  - Secondary Air ΔT: +100 °F
  - Tertiary Air ΔT: +15 °F
  - Clinker Temp ΔT: +5 °F (did not decrease; acceptable)

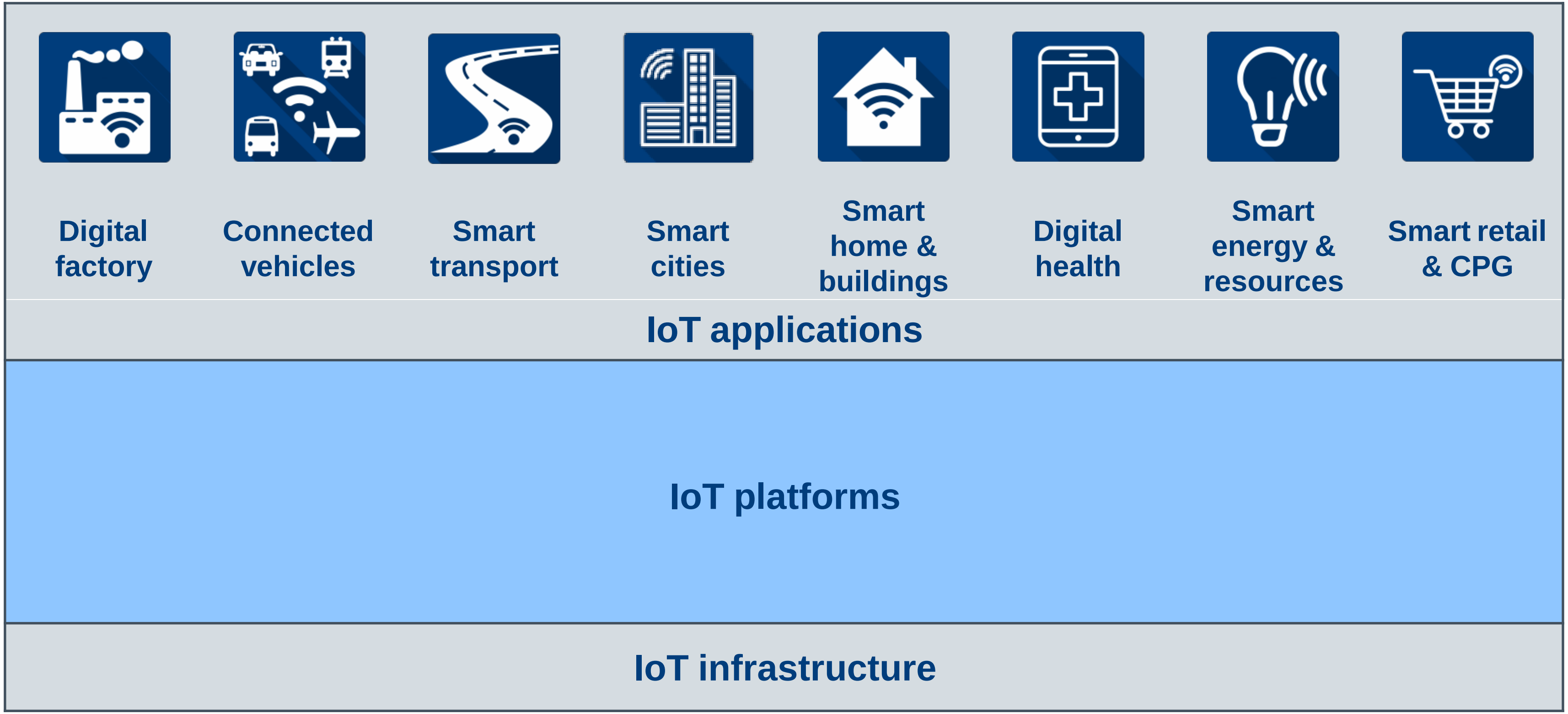
**“This is a giant step in digital transformation towards safe, highly standardized operations, that will help us strengthen our high-quality products portfolio while also ensuring we meet our operational and sustainability goals, and minimize costs.” – Rodrigo Quintero, CEMEX**

# Machine Learning Resources for Human Learning

| Course \| Topic | Type | Language | Platform | Complexity | Curve | Theoretical | Practical |
|---|---|---|---|---|---|---|---|
| Data Science Bootcamp | Course | Python | Udemy | 2 | 5 | 2 | 4 |
| The Analytics Edge | Course | R | edX | 3 | 5 | 4 | 4 |
| Statistical Learning in R | Book | R | Book | 3 | 5 | 5 | 5 |
| Machine Learning | Course | Matlab | Coursera | 3 | 4 | 5 | 4 |
| TensorFlow Deep Learning | Course | Python | Udemy | 3 | 4 | 2 | 3 |
| Neural Networks and Deep Learning | Course | Python | Coursera | 3 | 3 | 5 | 3 |
| Hands-On Machine Learning | Book | Python | Book | 4 | 5 | 4 | 5 |
| Deep Learning Specialization | Course | Python | Coursera | 4 | 4 | 5 | 4 |
| Machine Learning for Coders | Course | Python | Fast.AI | 4 | 4 | 4 | 4 |
| Practical Deep Learning For Coders | Course | Python | Fast.AI | 4 | 4 | 3 | 5 |
| Deep Learning with Python | Book | Python | Book | 4 | 4 | 4 | 5 |
| Deep Learning | Book | Python | Book | 4 | 2 | 5 | 1 |
| Cutting Edge Deep Learning For Coders | Course | Python | Fast.AI | 5 | 4 | 3 | 5 |
| Time Series Analysis | Course | R | edX | Unknown | | | |
| Big Data Analytics Using Spark | Course | Python | edX | Unknown | | | |

**and https://learning.osisoft.com/**

# Basic IoT Stacks




Reference: teknowlogy/PAC GmbH EMEA PI World 2019 presentation

# Segmentation of the current IoT platform market

Digital factory | Connected vehicles | Smart transport | Smart cities | Smart home & buildings | Digital health | Smart energy & resources | Smart retail & CPG

**IoT applications**

**IoT platform segments for non-developers**

IoT platforms for rapid application deployment

**IoT platform segments for developers**

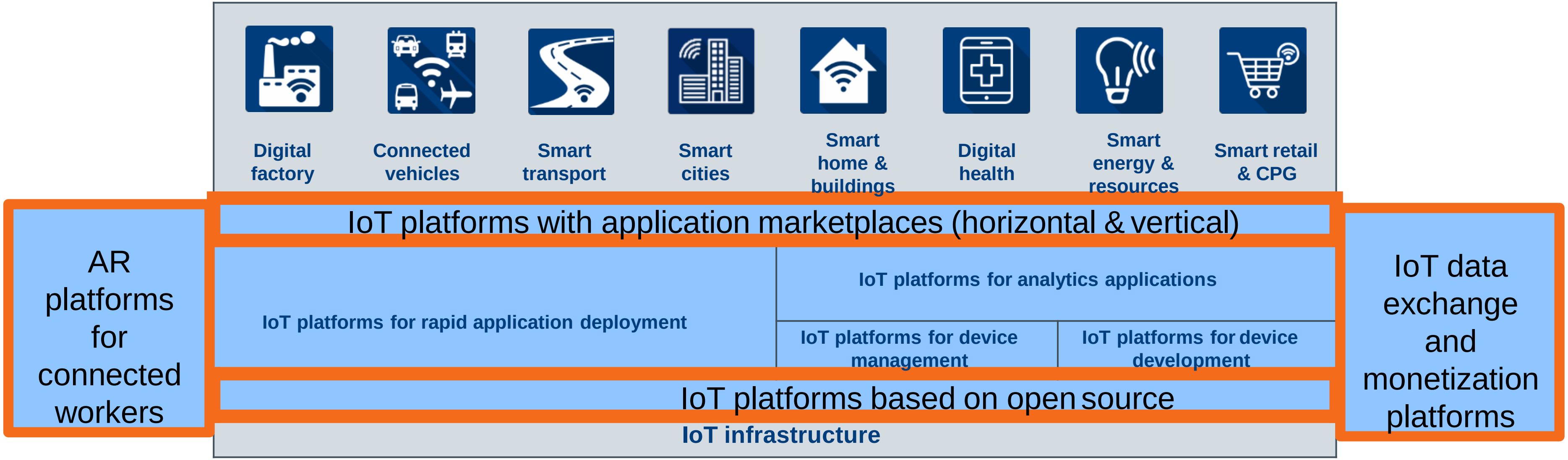
IoT platforms for analytics applications

IoT platforms for device management

IoT platforms for device development

**IoT infrastructure**

# Newly Emerging Segments in the context of IoT platforms



# Key Evaluation Criteria

**Technology-related:**

- Real-time data management capabilities
- Out-of-the-box connectivity to many different industrial devices
- Open marketplace with many industrial applications for different use cases

**Ecosystem-related:**

- A strong ecosystem of application development partners (this gives users fast and easy access to diverse and innovative applications, enabling them to boost the operational efficiency of their connected devices)

**Growth-related:**

- Strategic focus and activities in the last 12 months (partner strategy)
- A strong existing client base (this attracts new application development partners)

# OSIsoft Evaluation

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# Results

PAC RADAR IoT platforms for industrial applications in Europe 2019

# Contact Information


Name: Ann Moore
Title: Industry Principal
Email: amoore@osisoft.com
Phone: +86 15810496757/+1 858 531 7524

# Thank You

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Co-host

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