EMPOWER YOUR ANALYTICS WITH OPERATIONAL DATA
2019 OSISOFT MUMBAI SEMINAR

Digital Transformation and Enterprise Infrastructure

Gopal GopalKrishnan, P.E.

OSIsoft, LLC.
Oct. 2019

Regional Seminars
Mumbai, INDIA

OSIsoft.

© Copyright 2019 OSIsoft, LLC

Takeaways – Digital Transformation & Enterprise Infrastructure

OT=Operations Technology

- Digital Transformation
  - Digital enablement
  - Automate or Change business process – the way of doing work
  - People, Process, Technology
  - Collaborative work environment

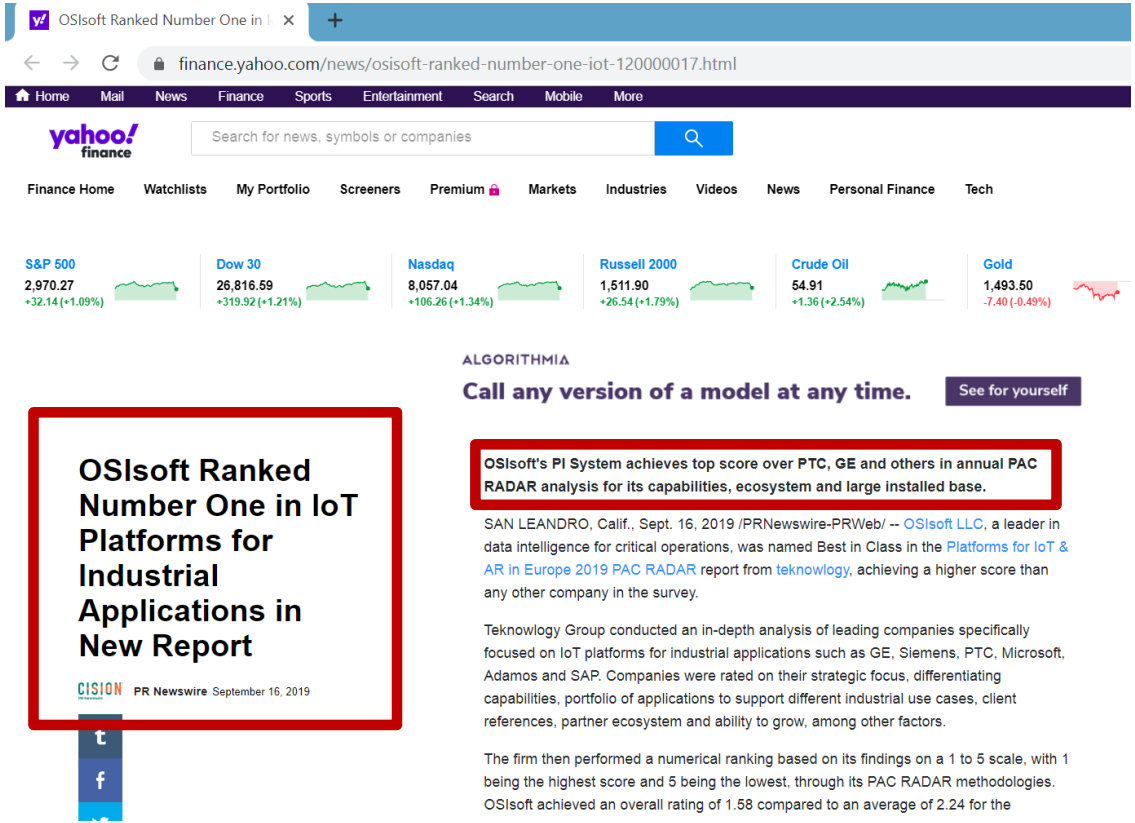
- Enterprise Infrastructure (for OT data)
  - Sensor data (SCADA, PLC,…), IoT data,…
  - Machine condition data – vibration, oil analysis, …
  - Other metadata, contextual data, any data to enrich sensor data…

- PI System as the foundational data infrastructure for operational excellence
  - Layers of Analytics – Descriptive, Diagnostic, Predictive, Prescriptive

- New offerings
  - Edge Data Store (EDS)
  - OSIsoft Cloud Services (OCS)
  - OSIsoft Message Format (OMF)

© Copyright 2019 OSIsoft, LLC

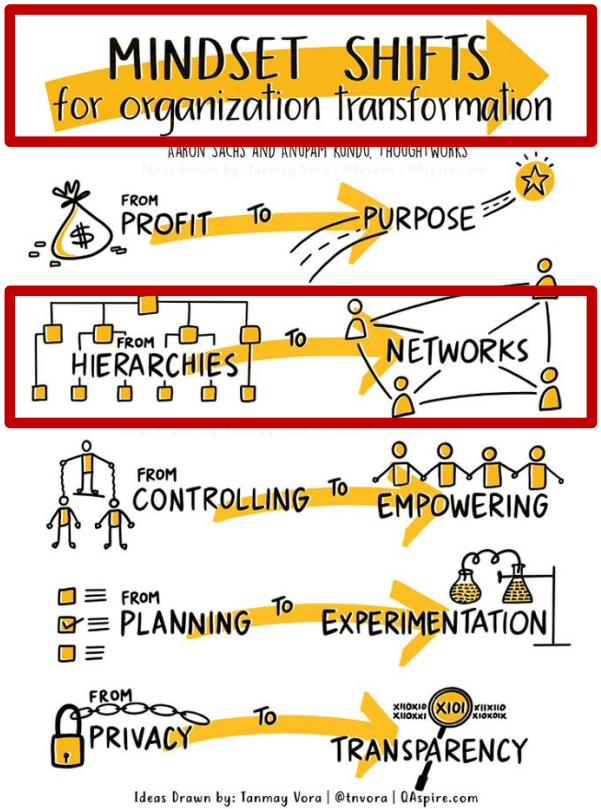
OSIsoft Ranked Number One in IoT Platforms

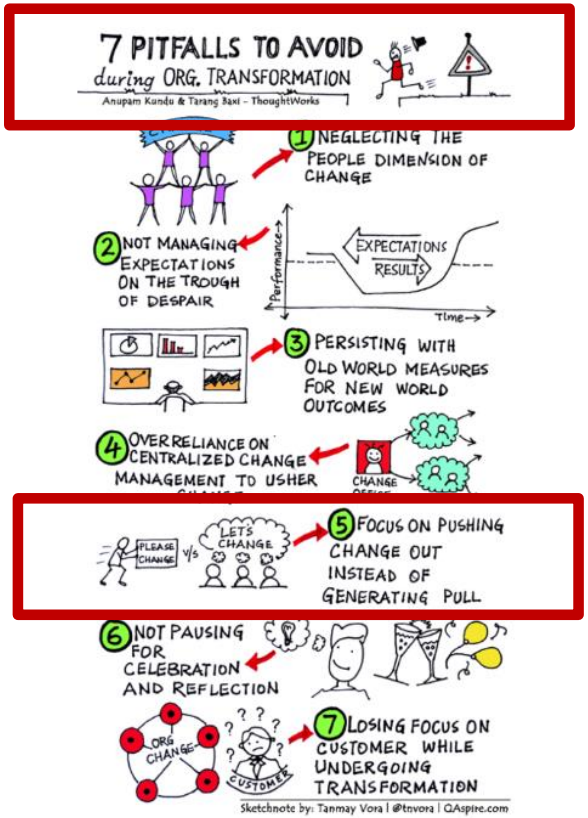


Source: https://finance.yahoo.com/news/osisoft-ranked-number-one-iot-120000017.html

© Copyright 2019 OSIsoft, LLC

Transformation - the Pattern and the Anti-Pattern



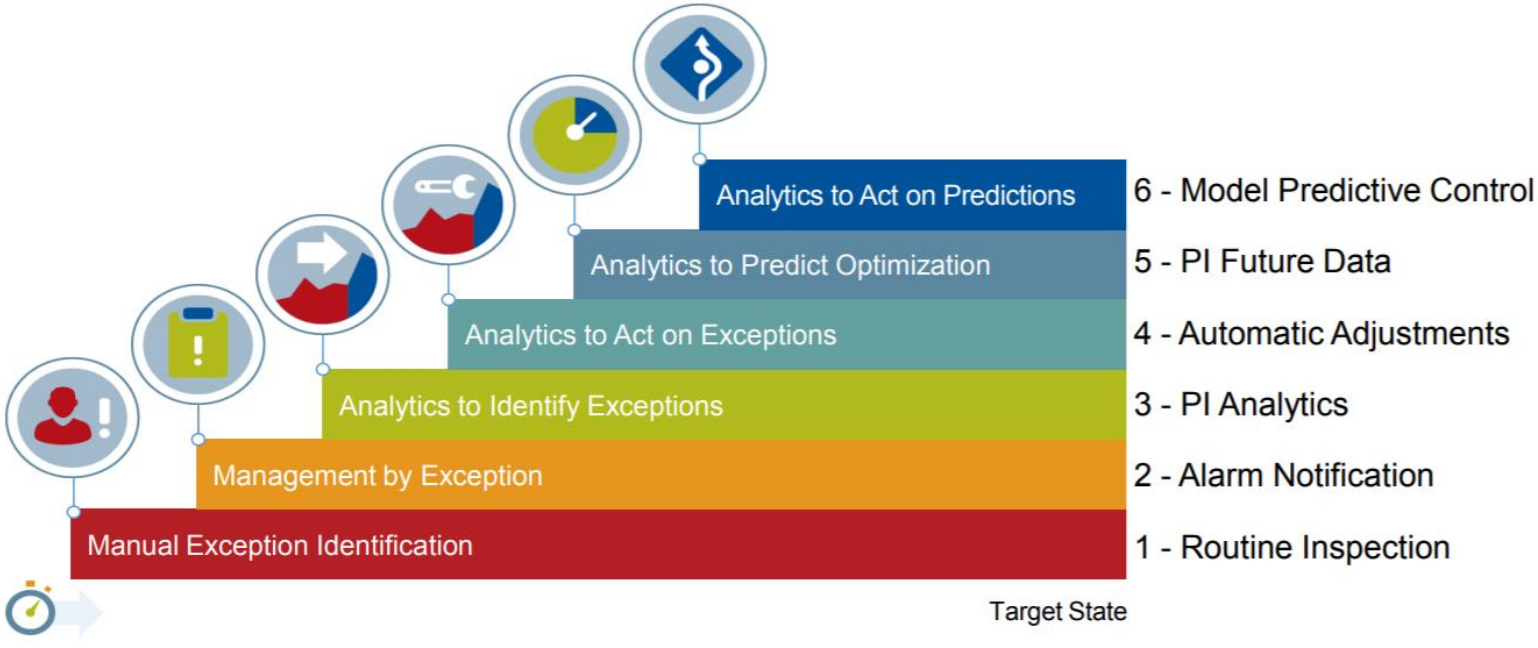


https://www.thoughtworks.com/insights/blog/unfinished-business-organizational-transformation
https://www.thoughtworks.com/insights/blog/seven-pitfalls-avoid-during-organizational-transformation

© Copyright 2019 OSIsoft, LLC

Transforming The Way We Think

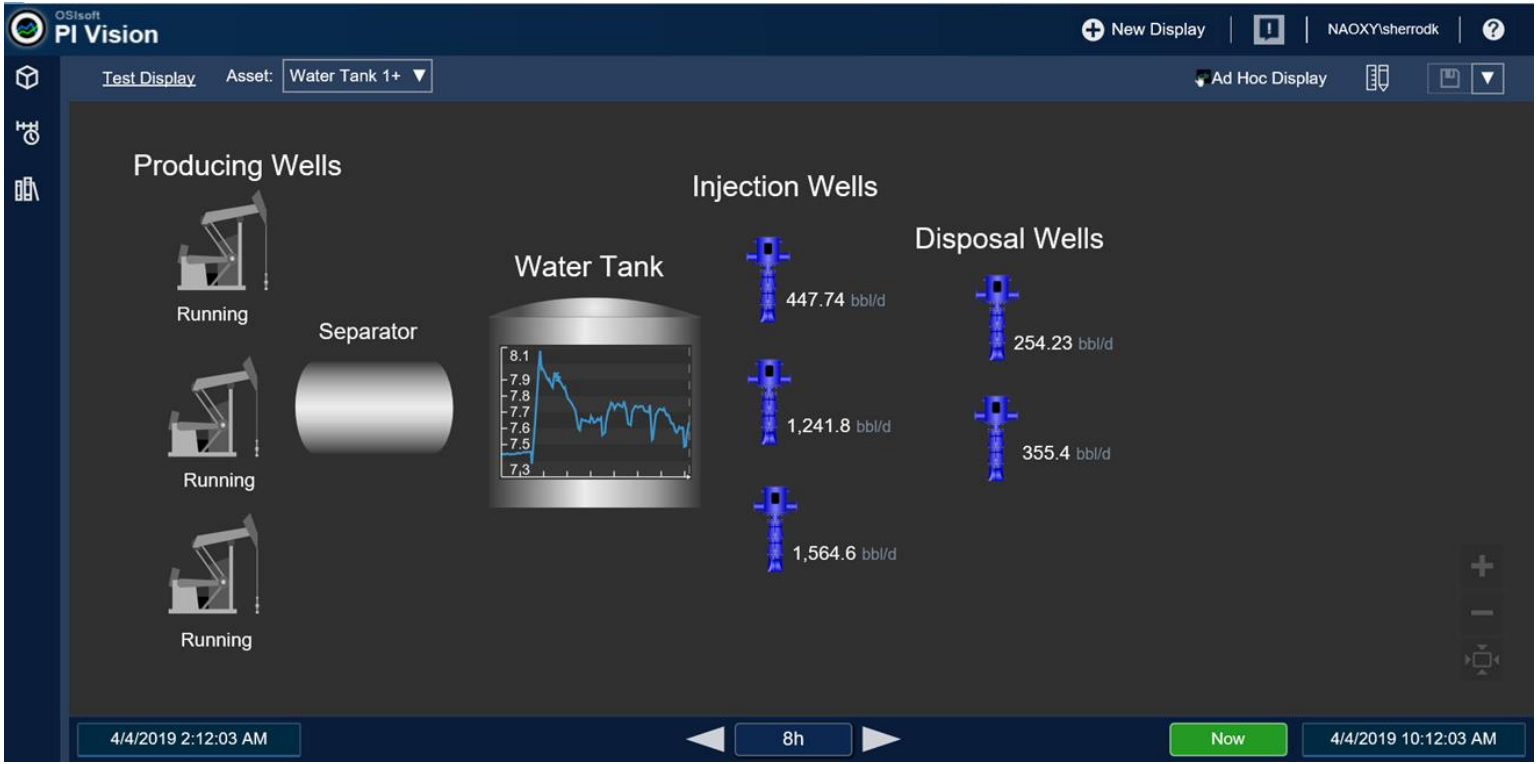
From Digital Transformation to Full Field Analytics



https://www.osisoft.com/presentations/from-digital-oilfield-to-digital-transformation-to-full-field-analytics/

© Copyright 2019 OSIsoft, LLC

OXY - Water tank - Transformation from Manual to Automated



© Copyright 2019 OSIsoft, LLC

1 – Manual Exception Identification

6 Analytics to Act on Predictions

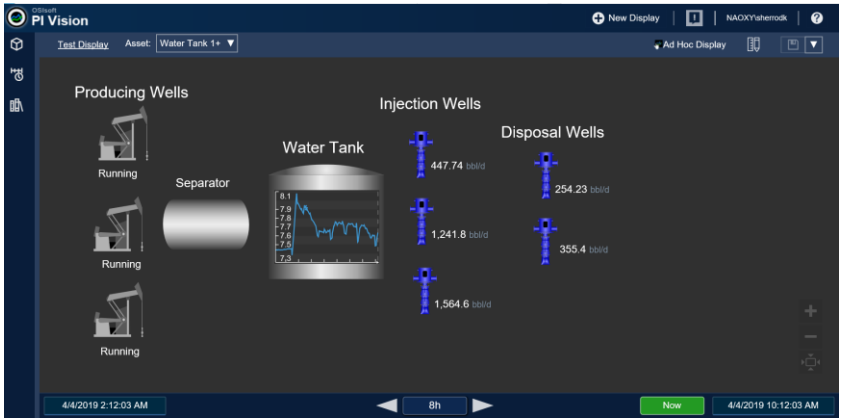
5 Analytics to Predict Optimization

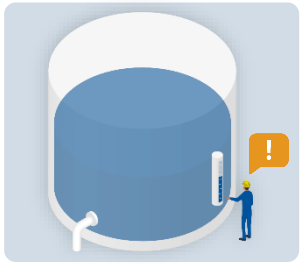
4 Analytics to Act on Exceptions

3 Analytics to Identify Exceptions

2 Management by Exception

1 Manual Exception Identification

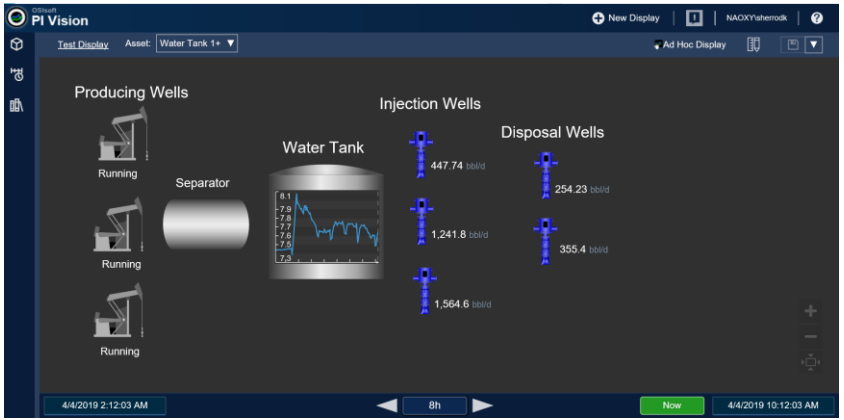


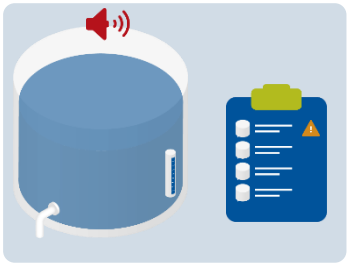


Manual high tank level identified on daily route

© Copyright 2019 OSIsoft, LLC

2 – Management by Exception





Operator receives a high tank level alarm and goes to this facility first

© Copyright 2019 OSIsoft, LLC

3 – Analytics to Identify Exceptions

6 Analytics to Act on Predictions

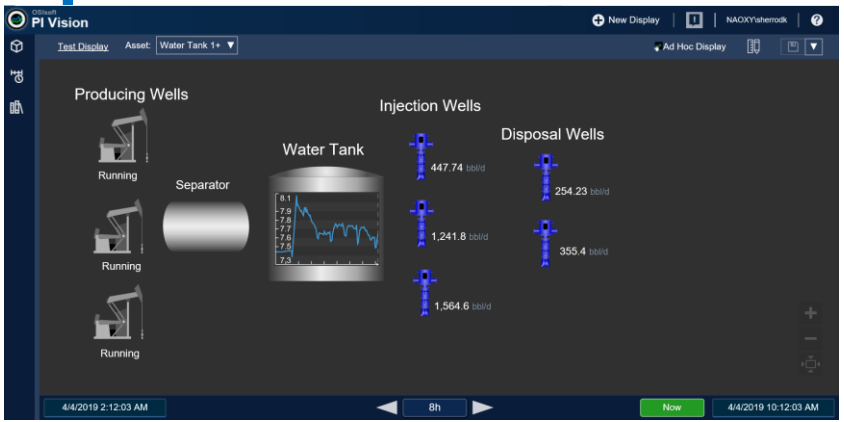
5 Analytics to Predict Optimization

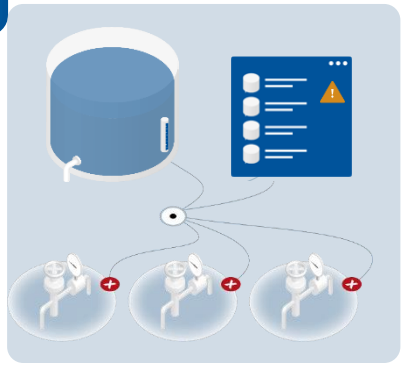
4 Analytics to Act on Exceptions

3 Analytics to Identify Exceptions

2 Management by Exception

1 Manual Exception Identification





PI System Analytics identifies an exception - High water tank level & disposal wells not 100% open

© Copyright 2019 OSIsoft, LLC

4 – Analytics to Act on Exceptions

6 Analytics to Act on Predictions

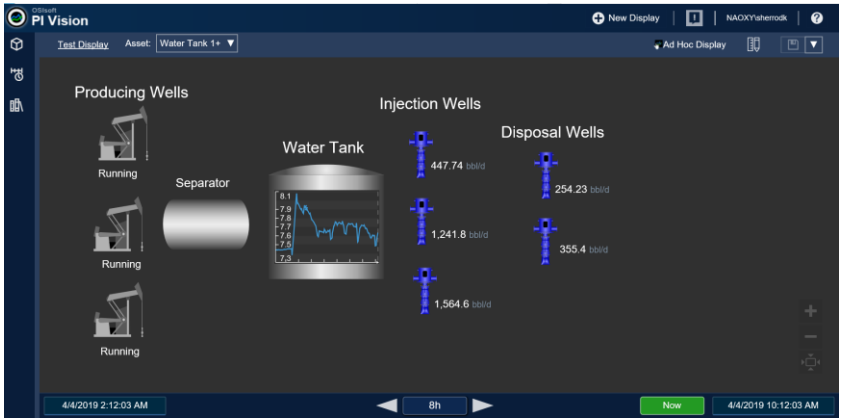
5 Analytics to Predict Optimization

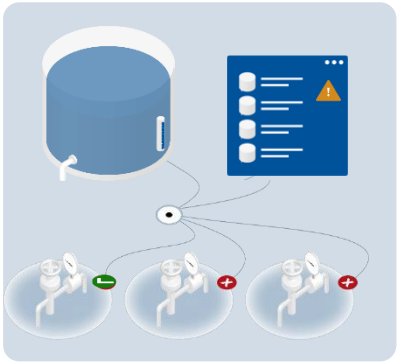
4 Analytics to Act on Exceptions

3 Analytics to Identify Exceptions

2 Management by Exception

1 Manual Exception Identification





Automatic adjustment of disposal wells to reduce high tank level

© Copyright 2019 OSIsoft, LLC

5 – Analytics to Predict Optimization

6 Analytics to Act on Predictions

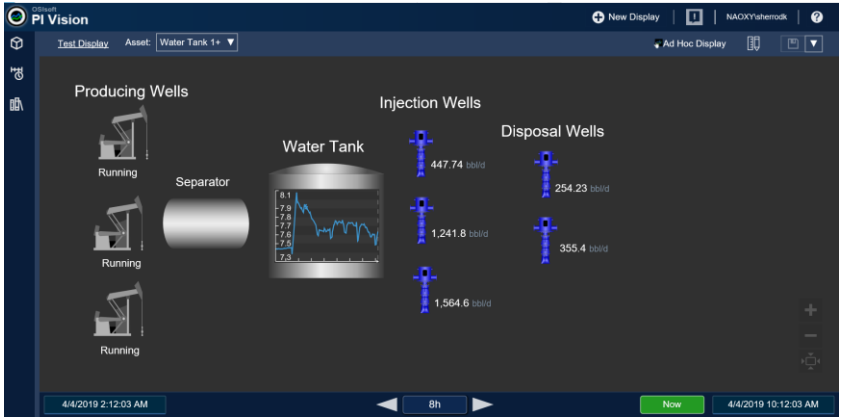
5 Analytics to Predict Optimization

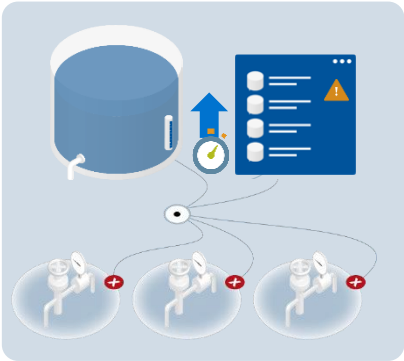
4 Analytics to Act on Exceptions

3 Analytics to Identify Exceptions

2 Management by Exception

1 Manual Exception Identification





PI System Future Data predicts a high level, providing more time to respond

© Copyright 2019 OSIsoft, LLC

6 – Analytics to Act on Predictions

6 Analytics to Act on Predictions

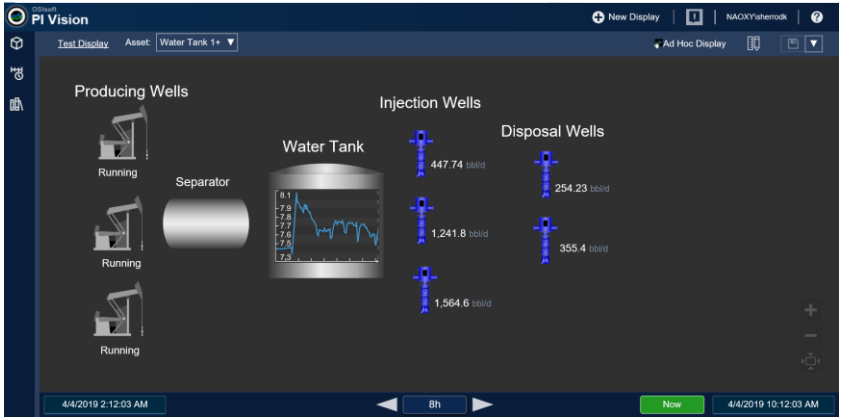
5 Analytics to Predict Optimization

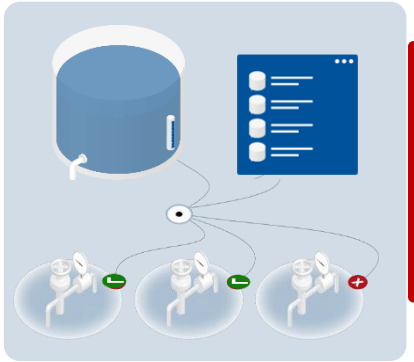
4 Analytics to Act on Exceptions

3 Analytics to Identify Exceptions

2 Management by Exception

1 Manual Exception Identification





Automatic adjustment of disposal and producing wells to maintain optimal tank level

© Copyright 2019 OSIsoft, LLC

Occidental Petroleum
Levering the PI System to Drive Change

CHALLENGE	SOLUTION	RESULTS
Transform the way we work	Operate our fields more like a manufacturing plant using full field analytics	Increasing operational efficiency
• Take advantage of the massive amounts of data we have in our PI systems to change our work processes	• Use PI data to be able to predict and prevent upset conditions	• We're still early in the game, but we're making progress in transforming our operations from reactive to predictive and preventative

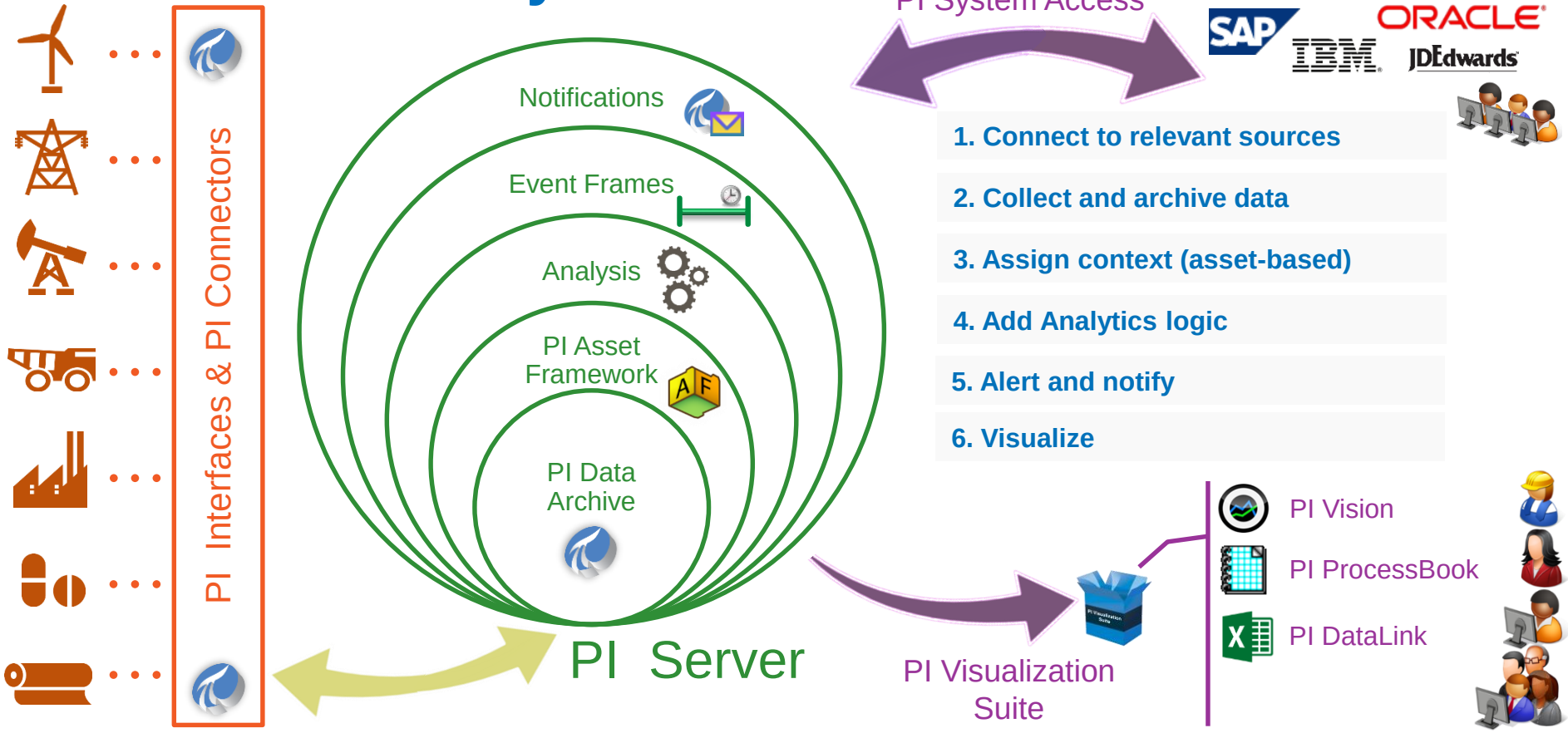
https://www.osisoft.com/presentations/from-digital-oilfield-to-digital-transformation-to-full-field-analytics/

© Copyright 2019 OSIsoft, LLC

What can I do with PI System?

© Copyright 2019 OSIsoft, LLC

The Modern PI System



© Copyright 2019 OSIsoft, LLC

A use case

Problem
Wind Farm can't meet generation targets

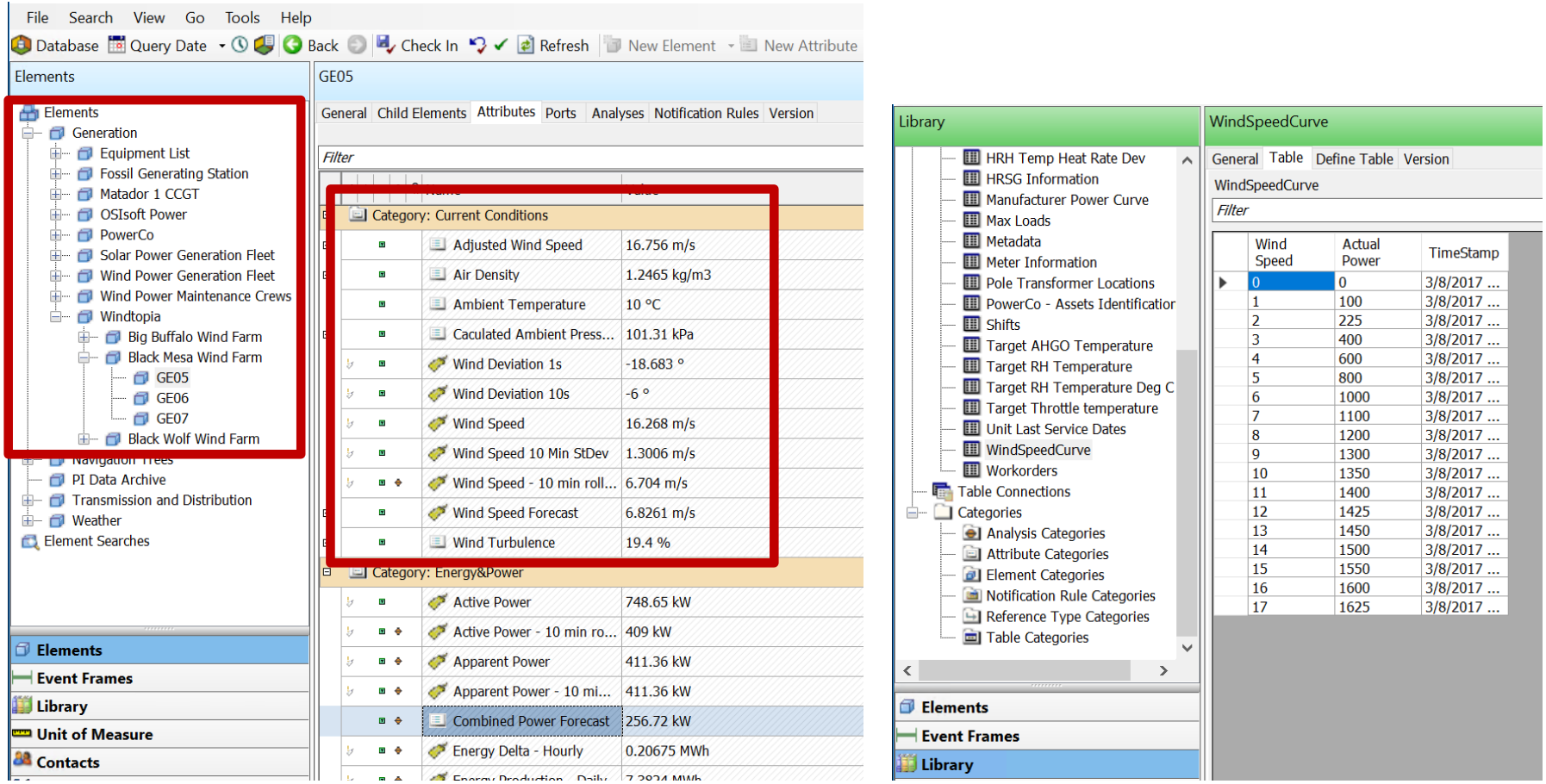
Why?
Wind Turbine availability is low due to curtailment and unplanned downtime

Target
Increase Wind Turbine availability to 95%

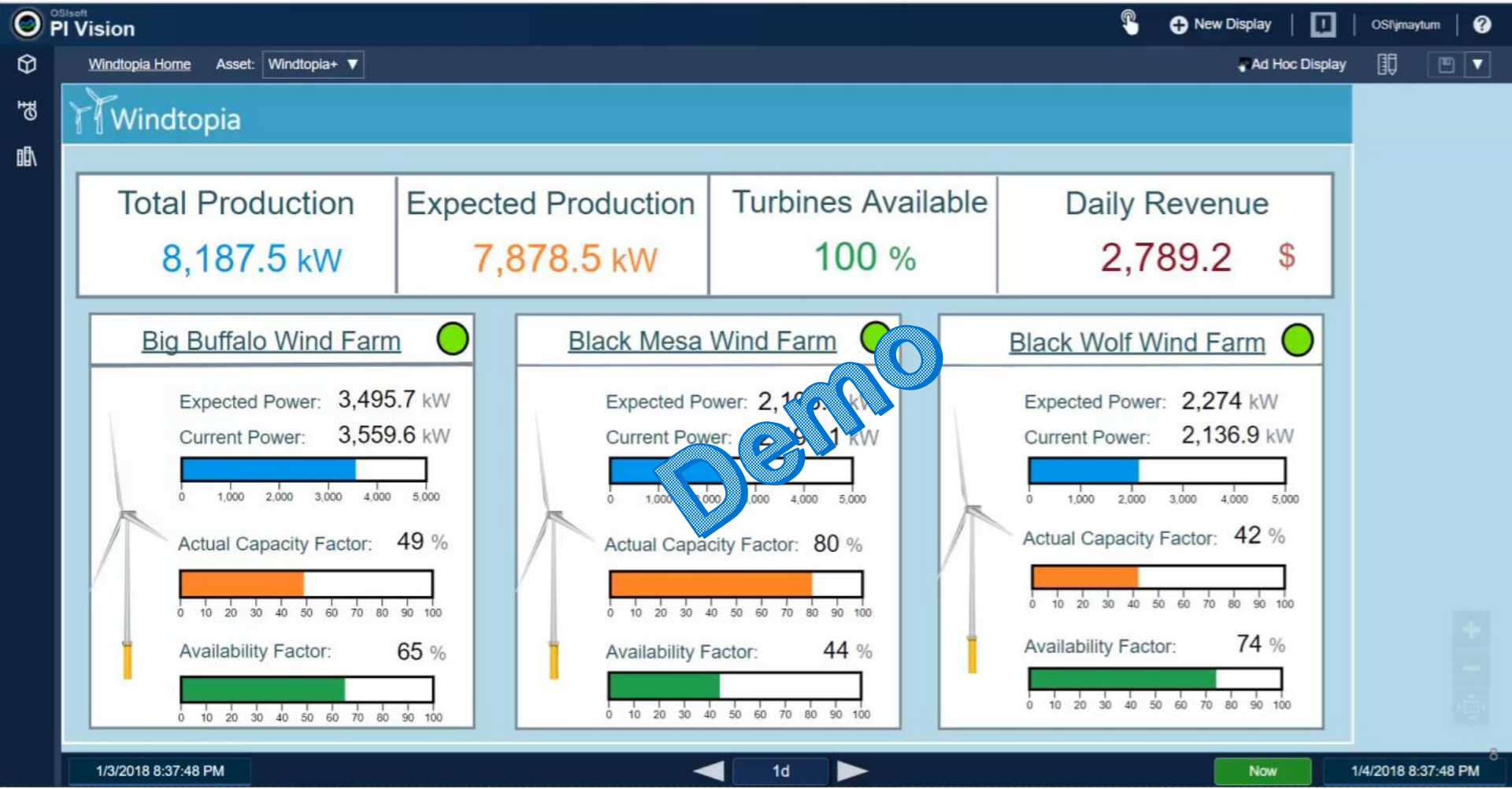
How?
Find biggest cause of lost production

© Copyright 2019 OSIsoft, LLC

Wind farm data model

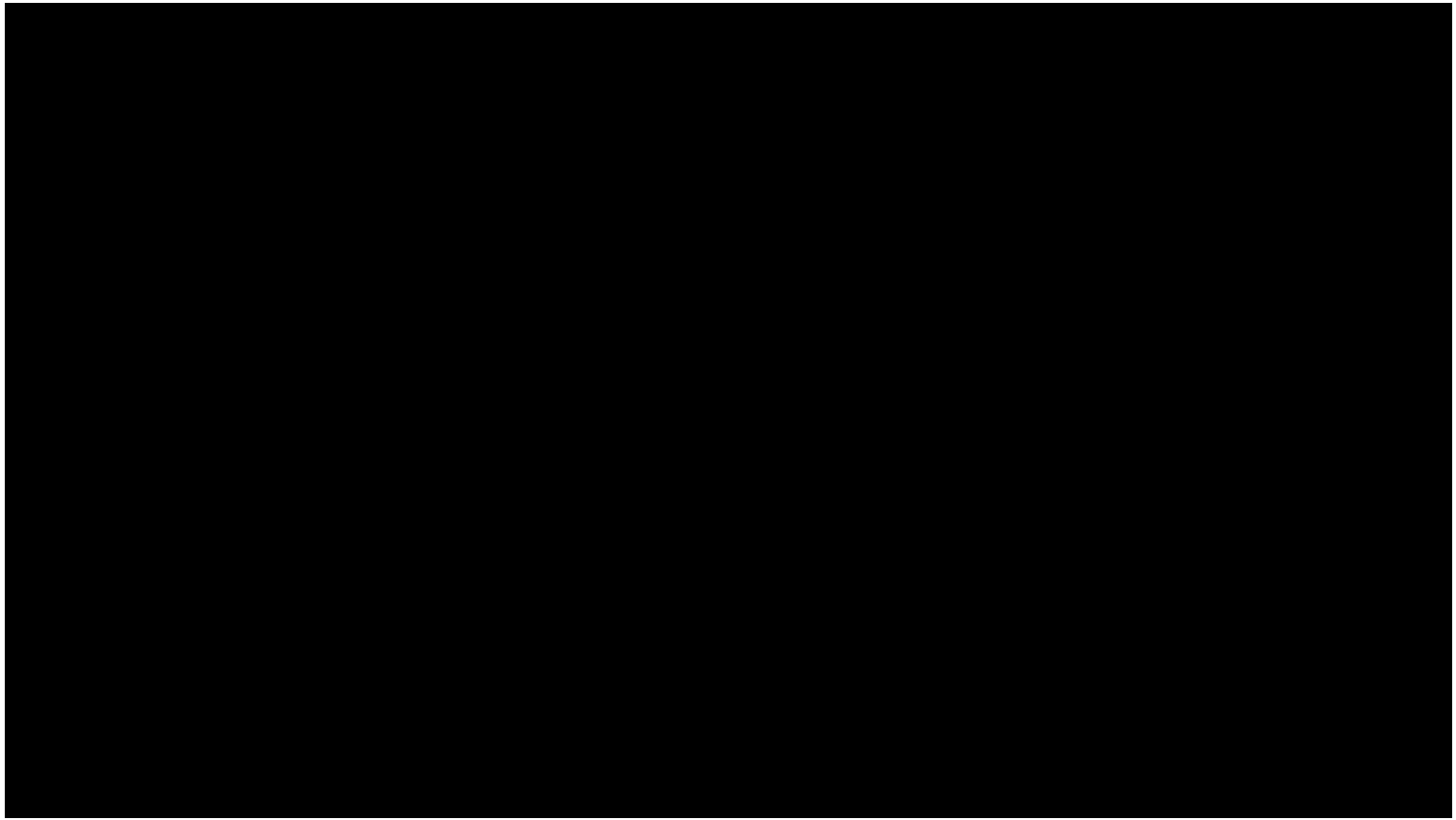


© Copyright 2019 OSIsoft, LLC



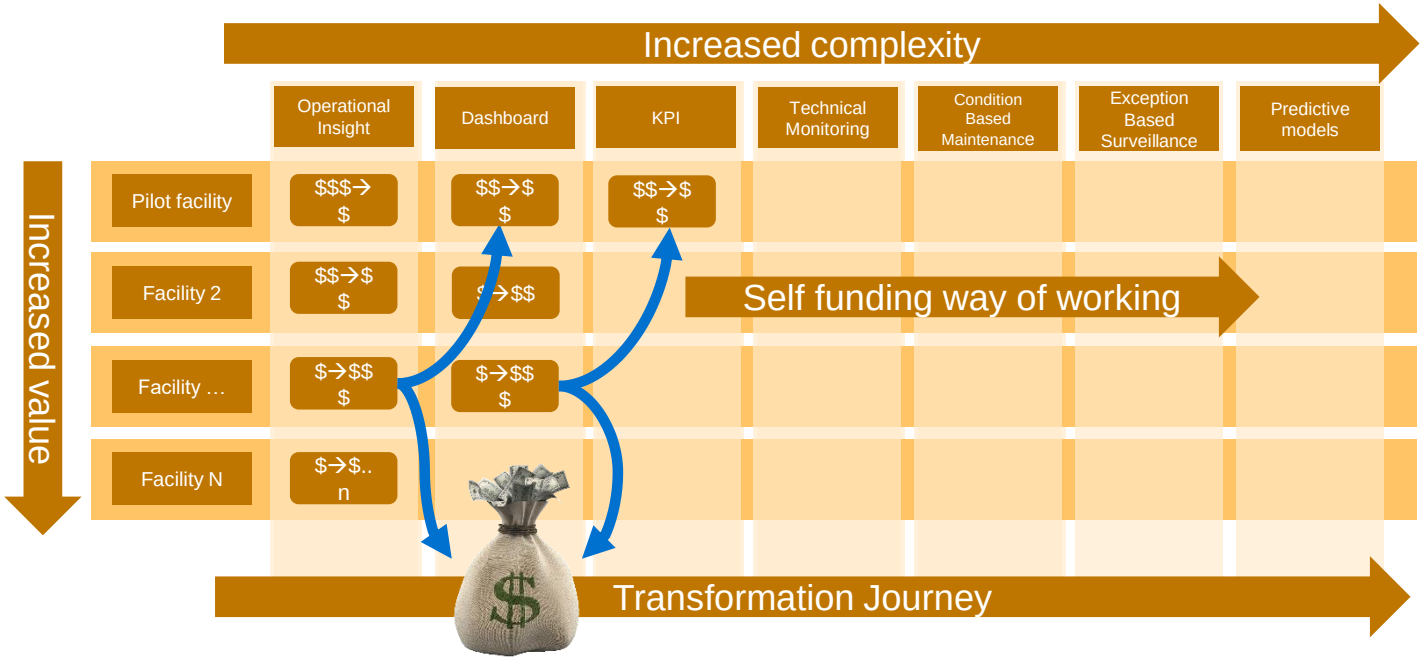
© Copyright 2019 OSIsoft, LLC

Wind Farm



© Copyright 2019 OSIsoft, LLC

Self funding deployment



© Copyright 2019 OSIsoft, LLC

Video – Power Generation Users

https://www.youtube.com/watch?v=Em21-tG4UcQ&t=7s

© Copyright 2019 OSIsoft, LLC

Takeaways – Digital Transformation & Enterprise Infrastructure

- Digital Transformation
  - Digital enablement
  - Automate or Change business process
  - People, Process, Technology
  - Collaborative work environment

- Enterprise Infrastructure (for OT data)
  - Sensor data (SCADA, PLC,…), IoT data,…
  - Machine condition data
  - Other metadata, contextual data, any data to enrich sensor data…

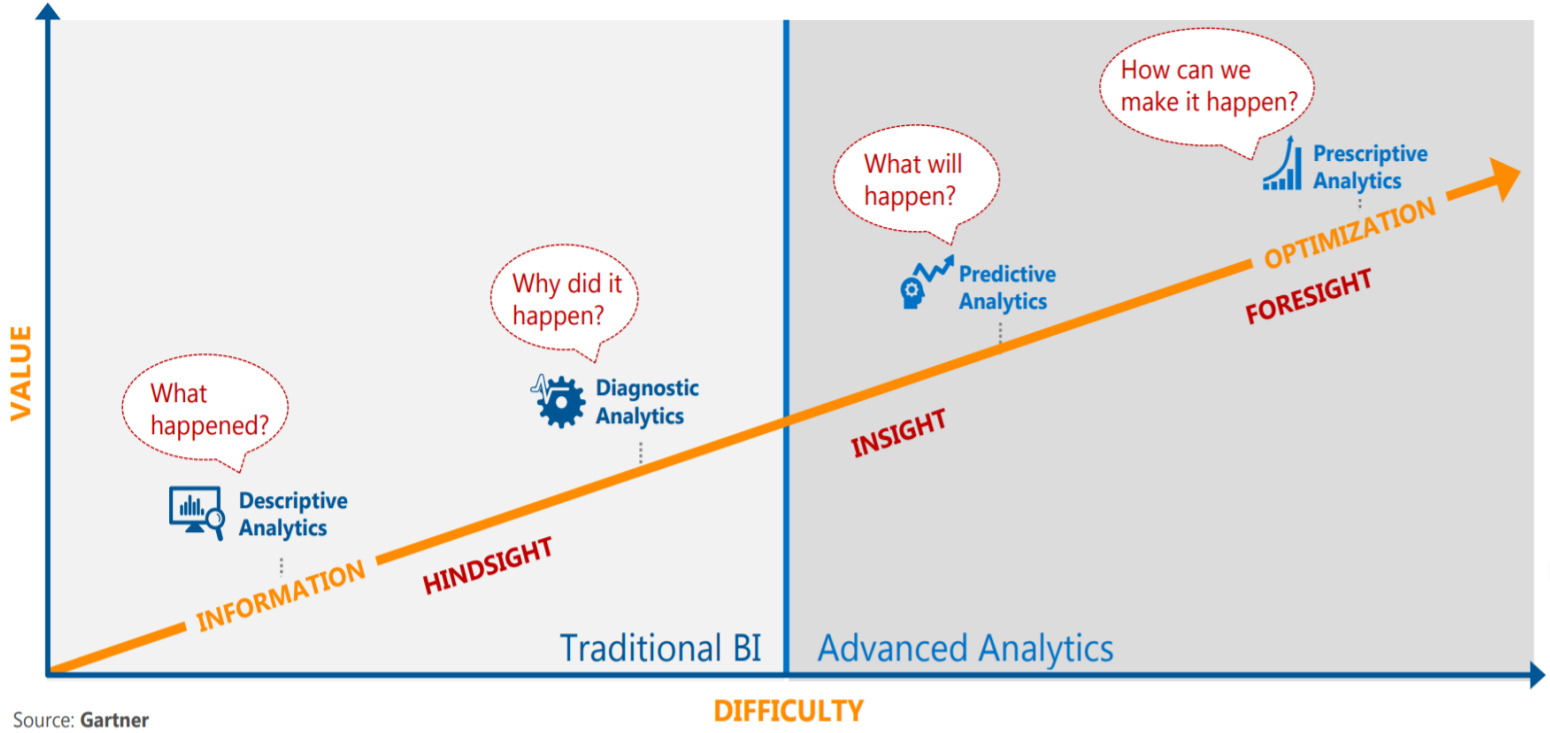
- PI System as the data infrastructure for operational excellence
  - Layers of Analytics – Descriptive, Diagnostic, Predictive, Prescriptive

- New offerings
  - Edge Data Store (EDS)
  - OSIsoft Cloud Services (OCS)
  - OSIsoft Message Format (OMF)

OT=Operations Technology

© Copyright 2019 OSIsoft, LLC

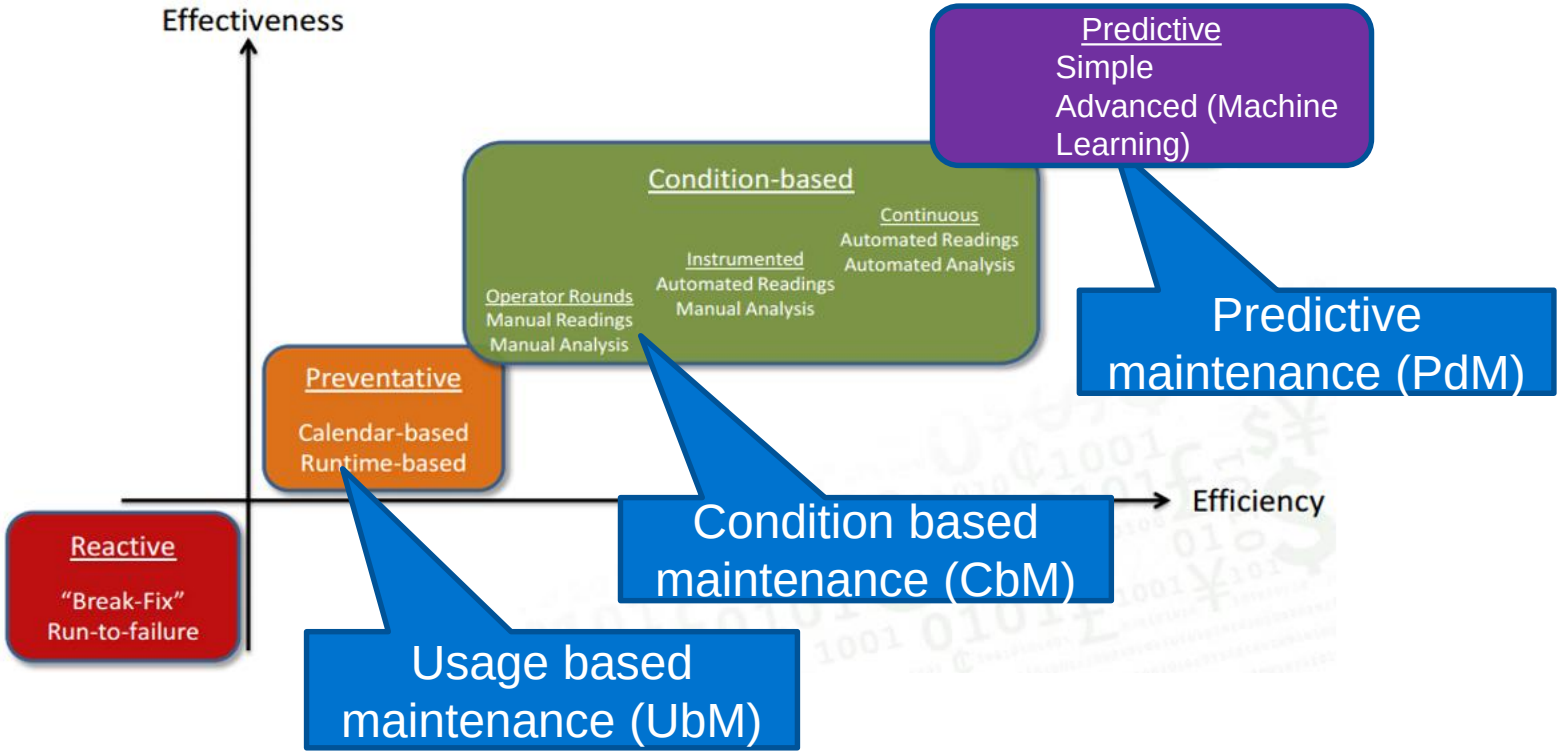
Layers of Analytics - Process Operations



https://www.osisoft.com/presentations/pi-system-analytics--fit-for-purpose/

© Copyright 2019 OSIsoft, LLC

Layers of Analytics - Maintenance & Reliability

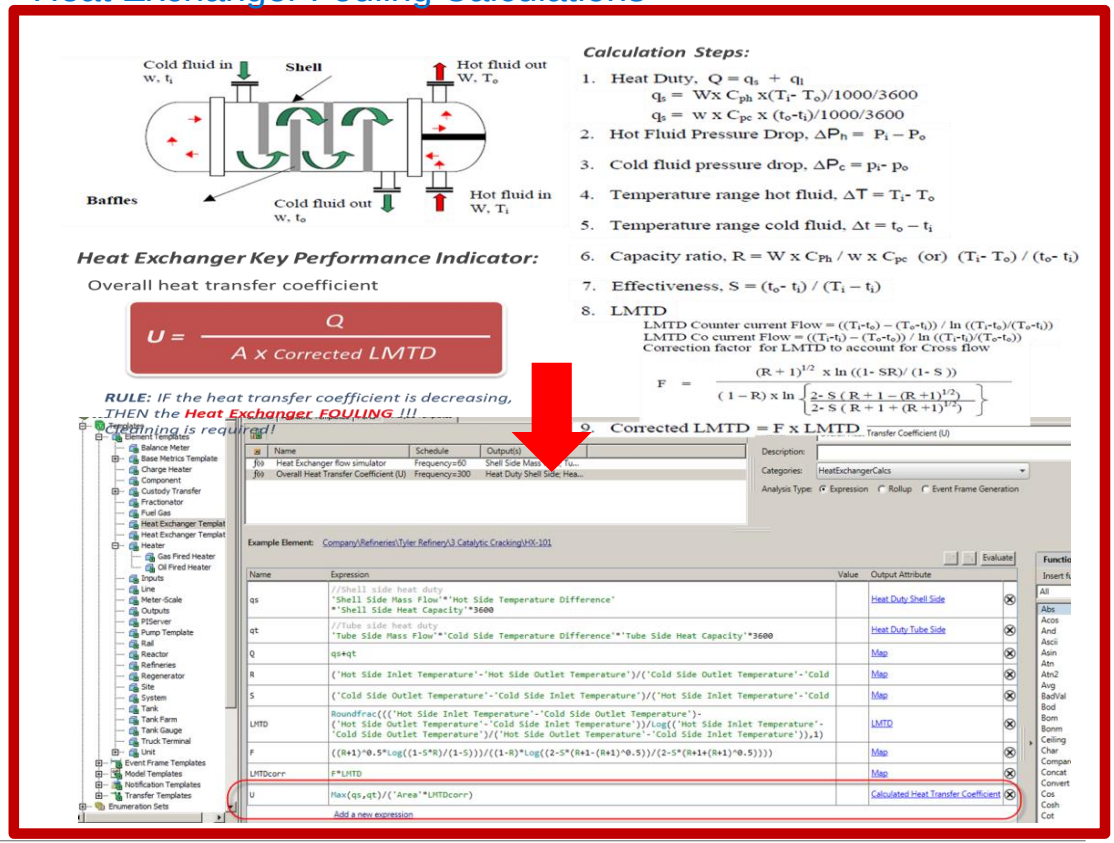


© Copyright 2019 OSIsoft, LLC

Descriptive Analytics – *Asset Analytics*

Heat Exchanger Fouling Calculations

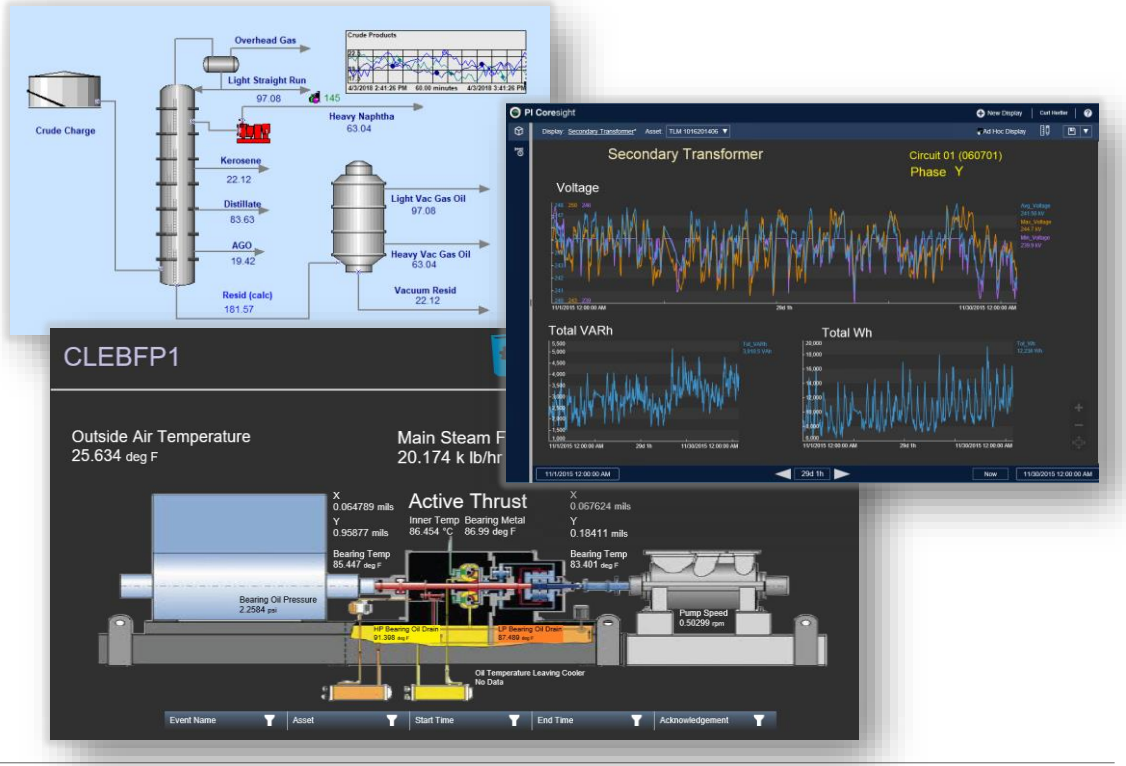
- *Configure* calculations for transparency and scale
- Math, statistical, and time-based functions
- Integration with R/Python/MATLAB
- Testing and operationalization of predictive analysis models
- Condition-based notification
- Supports future data for forecasting



© Copyright 2019 OSIsoft, LLC

Diagnostic Analytics – *Trending and Event Awareness*

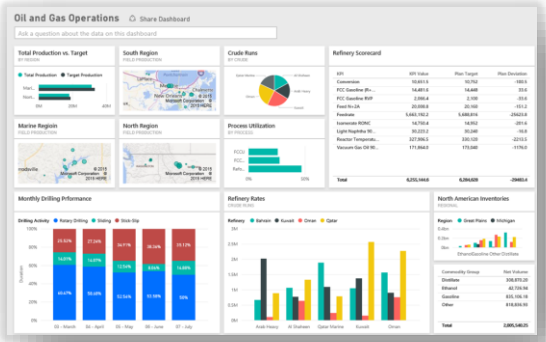
- Access to operational data in real-time with tools suited to Operations
- Supports ad hoc, self-service investigation



© Copyright 2019 OSIsoft, LLC

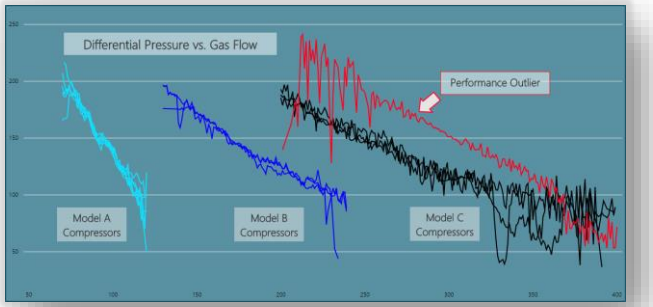
Diagnostic Analytics – *Multidimensional Visualization, Dashboards*

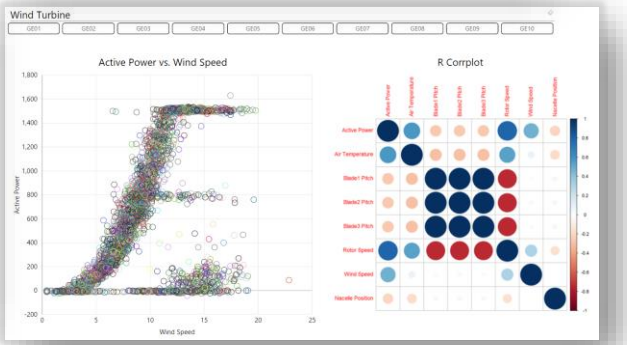
Business Analysis
Product inventories



Dashboards
Collaboration

Asset Performance
Benchmarking





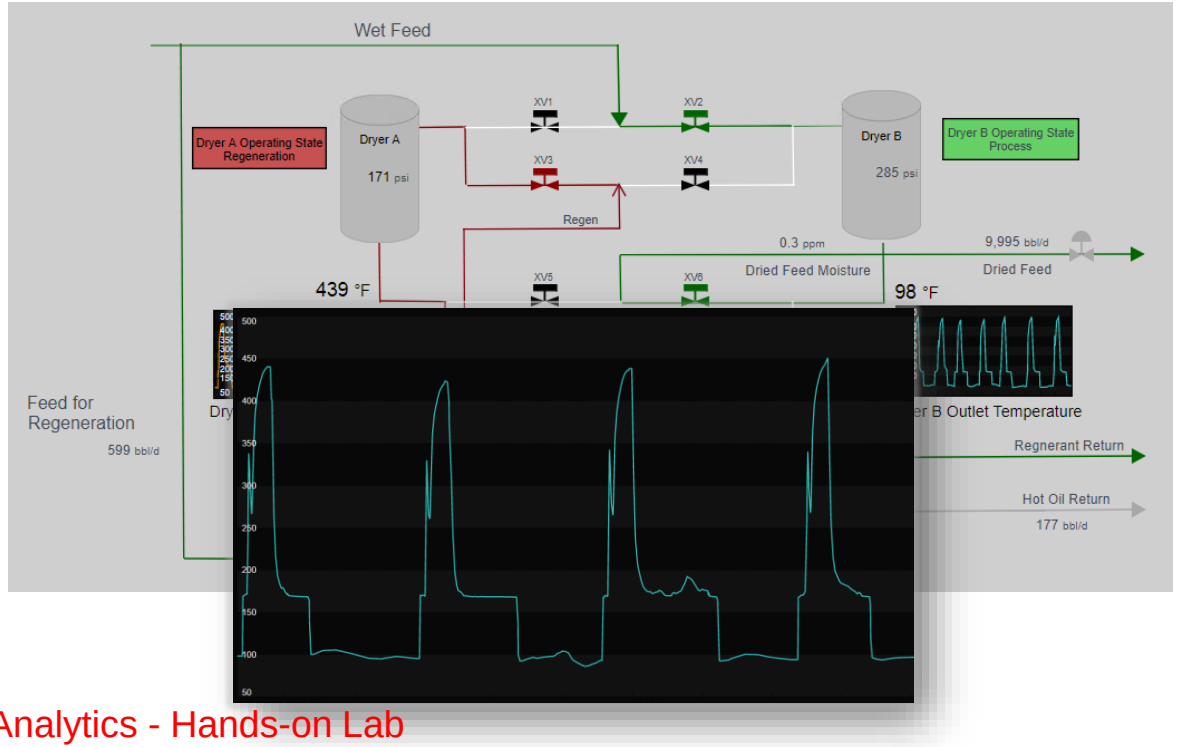
Analytics
Measurement Correlation

© Copyright 2019 OSIsoft, LLC

Predictive and Prescriptive Feed Drying Process - *Process and Regeneration Cycles*

- Molecular sieve dryers remove water from hydrocarbon feedstock before entering reactor
- Proper regeneration is critical to avoid corrosion in acidic reaction
- Cyclic operation between **Process** and **Regeneration** cycles
- Regeneration cycle is indicated by high be outlet temperatures

Dryer A Regeneration **Dryer B Regeneration**

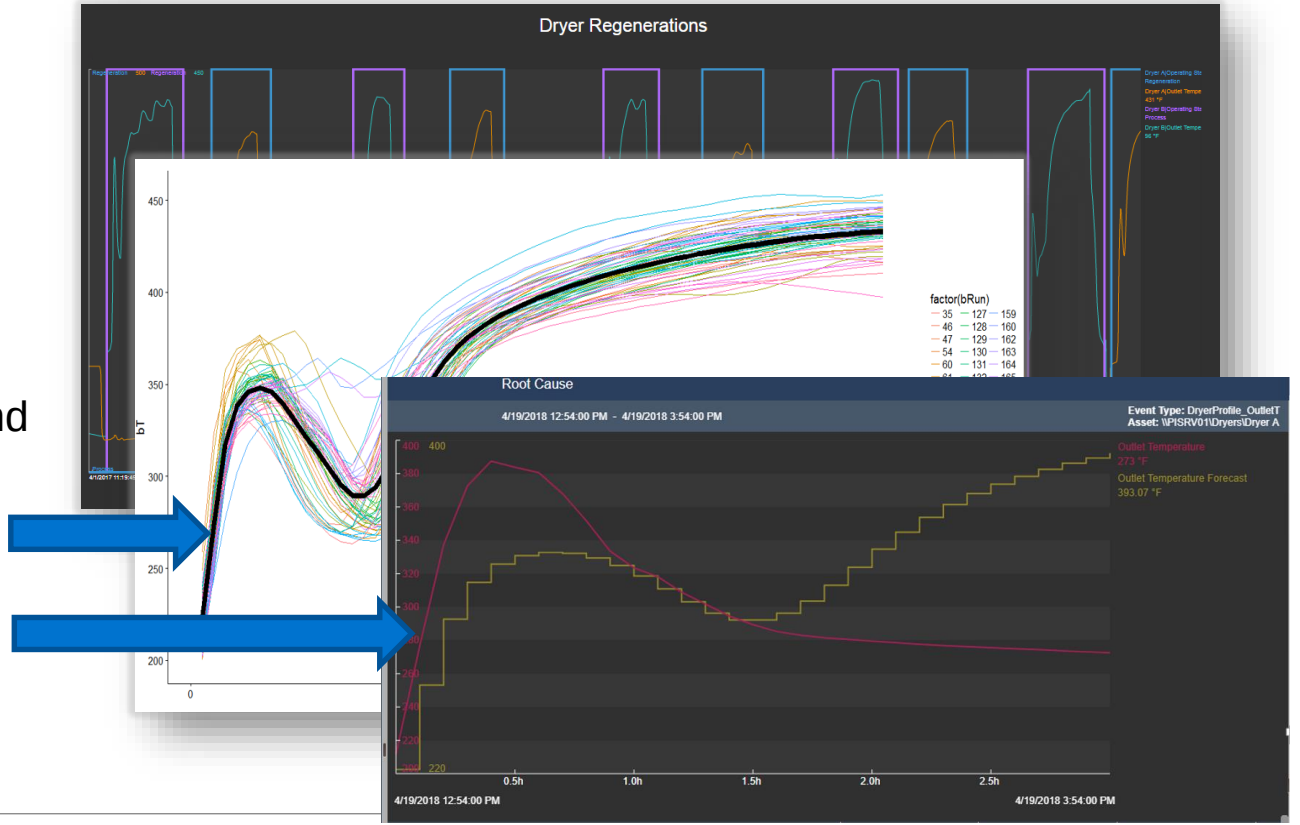


Also see PI World 2018 - Layers of Analytics - Hands-on Lab

© Copyright 2019 OSIsoft, LLC

Predictive Analytics – *Dryer Regeneration Guidance for Operations*

- During **Regeneration**, monitor bed Outlet Temperature against a modeled profile, notify operator of deviations
- Prepare data using AF Analytics and Event Frames
- Publish dataset for model development and training
- Develop model in R/MATLAB
- Operationalize model using AF Analytics and R/MATLAB

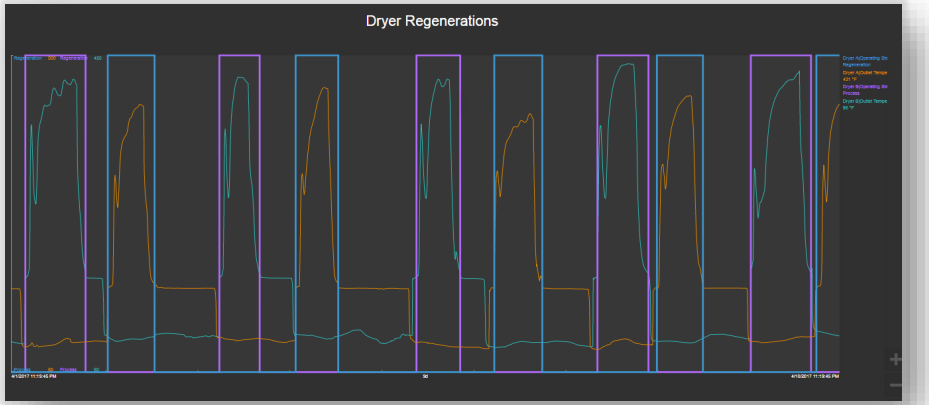


© Copyright 2019 OSIsoft, LLC

Feed Dryer Status – *Regeneration Event Frames*

- AF Analytic defines the beginning and end of regeneration cycle
- Digital state for each dryer with Process of Regeneration states
- Start temp. = 170 F, End temp = 175 F
- Confirm five hours since last regeneration to avoid short cycles caused by initial temperature fluctuation
- Backfill through 2017

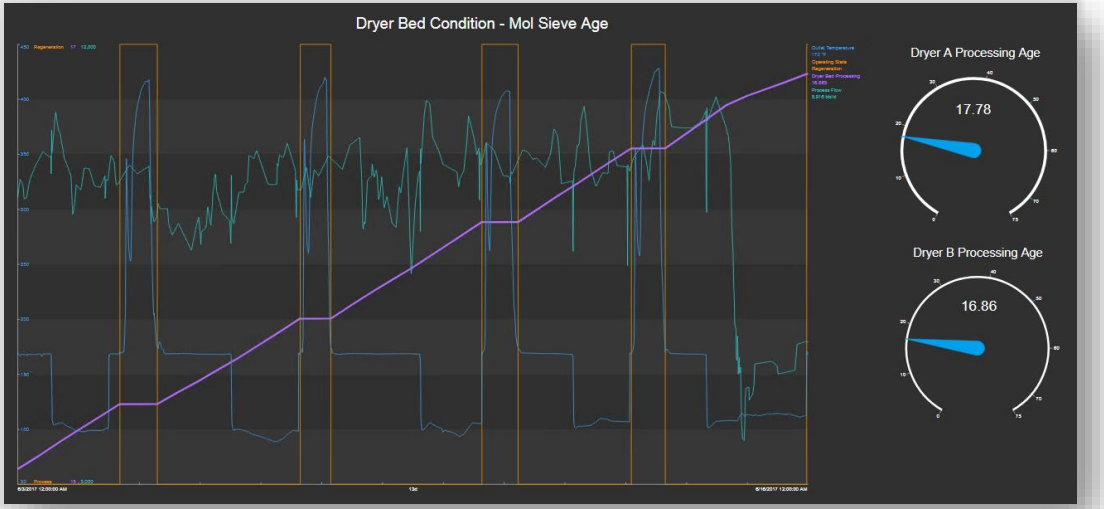
```
If('Outlet Temperature' >= 'Outlet Temperature|Start of Regeneration Temperature'
   And PrevVal('Operating State', '*-5h') = "Process")
Then (If PrevVal('Operating State', '*')="Regeneration"
      Then NoOutput()
      Else "Regeneration")
Else
  (If('Outlet Temperature' <= 'Outlet Temperature|End of Regeneration Temperature'
      And PrevVal('Operating State', '*-5h') = "Regeneration")
   Then (If PrevVal('Operating State','*') ="Process"
         Then NoOutput()
         Else "Process")
   Else NoOutput())
```



© Copyright 2019 OSIsoft, LLC

Feed Dryer Bed Age – *"Dryer Bed Processing Age"*

- AF Expression analytic determines processing age of molecular sieve desiccant
- Enables bed balancing for maximum service
- Calculate Lifetime Total Dried Feed, converts total volume from a volumetric rate
- Processing age :
  - $\frac{\text{Lifetime Total Dried Feed}}{\text{Loaded Wt. of Mol. Sieve}}$
- Backfill through 2017

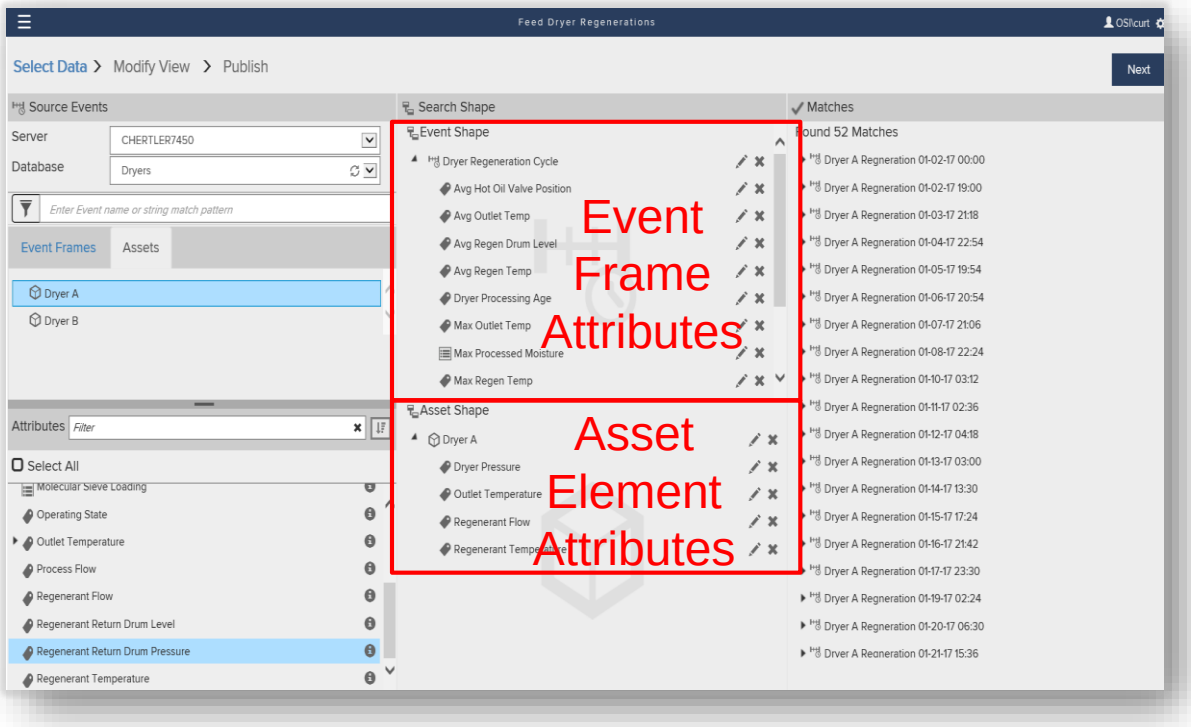



```
If ('Operating State' = "Process"
     And Not(BadVal('Process Flow'))
     And Not(BadVal(PrevVal('Process Flow','*'))))
 Then 'Lifetime Total Dried Feed' +
    TagTot('Process Flow', PreviousProcessFlowTime,'*')
 Else NoOutput()
```


© Copyright 2019 OSIsoft, LLC

Dryer Regeneration – *Publishing Summarized Dataset*

- Leverage AF model to ***Select***, ***Shape*** and ***Publish*** tabular views to a variety of endpoints
- Event Views publish Event Frame data in either ***Summarized*** or ***Sampled*** structures
- ***Sampled*** view combines aggregations taken over the Event Frames duration with Asset data sampled at intervals throughout the duration



© Copyright 2019 OSIsoft, LLC

Dryer Regeneration - *Sampled Event Publication*

Event Frame
Event Frame
Event Frame
Event Frame

Interpolated Values – 6 min.

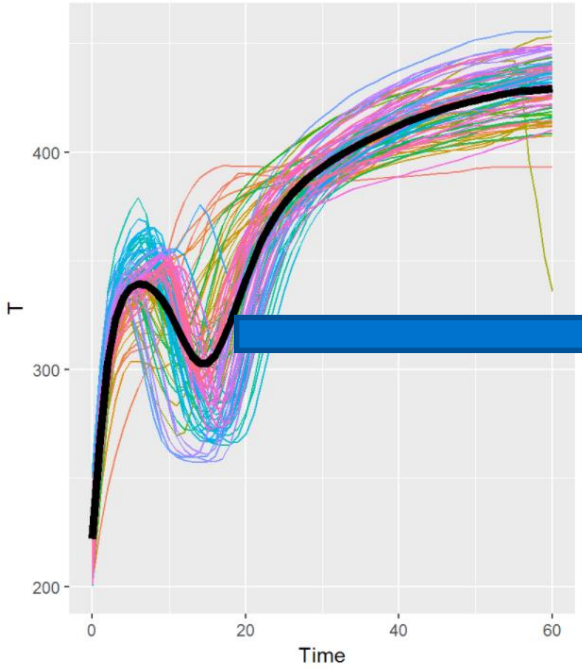
Dryer	Time Stamp	Duration	Elapsed Time	Dryer Pressure	Outlet Temperature	Regenerant Flow	Regenerant Tempe
Dryer A	1/2/2017 12:00:00 AM	5.3	0	170.4697	436.9	603.2525	496.1
Dryer A	1/2/2017 12:06:00 AM	5.3	6	170.4824	437.8	603.6448	496.2
Dryer A	1/2/2017 12:12:00 AM	5.3	12	170.495	438.6	605.063	496.4
Dryer A	1/2/2017 12:18:00 AM	5.3	18	170.5076	439.5	599.6411	496.8
Dryer A	1/2/2017 5:18:00 AM	5.3	318	204.1571	173.8	314.5962	287.9
Dryer B	1/2/2017 7:00:00 AM	9.6	0	169.723	170.2	596.6678	480.7
Dryer B	1/2/2017 7:06:00 AM	9.6	6	170.4792	170.3	598.8013	484.8
Dryer B	1/2/2017 7:12:00 AM	9.6	12	171.0217	170.4	597.2024	487.9
Dryer B	1/2/2017 4:36:00 PM	9.6	576	168.8051	174.9	896.8521	173.8
Dryer A	1/2/2017 7:00:00 PM	11.3	0	169.5046	170	596.4086	425.6
Dryer A	1/2/2017 7:06:00 PM	11.3	6	170.3642	170.1	598.5709	442.7
Dryer A	1/2/2017 7:12:00 PM	11.3	12	170.2456	170.2	600.7331	466.3
Dryer A	1/3/2017 4:54:00 AM	11.3	594	167.147	196.4	547.8572	173.4
Dryer B	1/3/2017 8:48:00 AM	9.3	0	169.3378	170.2	592.8909	491.6
Dryer B	1/3/2017 8:54:00 AM	9.3	6	168.1517	171.1	617.2303	490
Dryer B	1/3/2017 9:00:00 AM	9.3	12	167.7706	205.2	617.502	488.7

Event Frame Attributes\Features

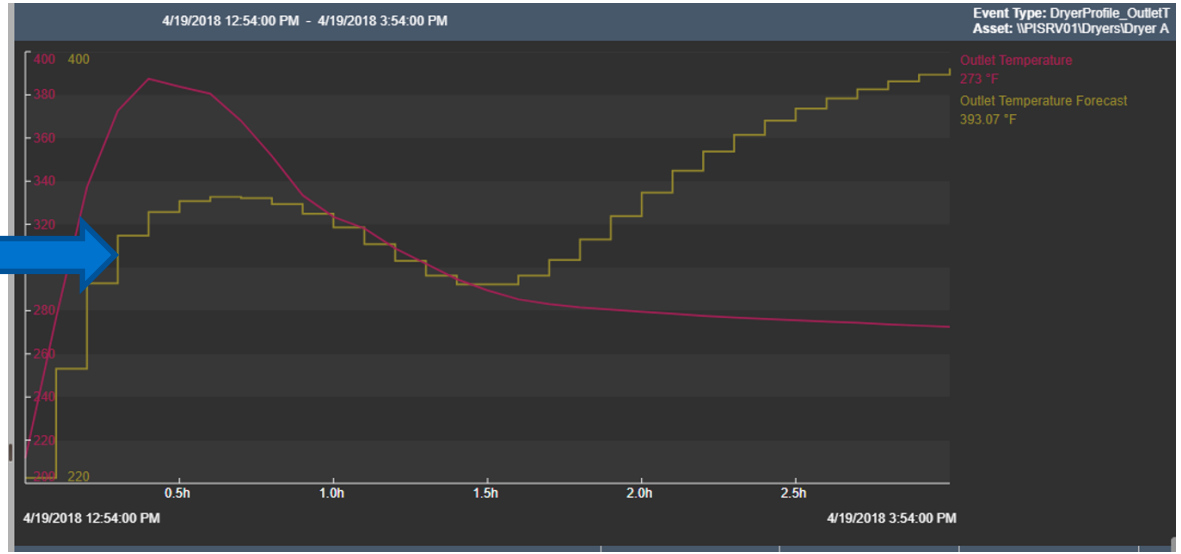
Dryer Regeneration Cycle	Avg Outlet Temp	Avg Regen Temp	Dryer Processing Age	Total Processed Feed
Dryer A Regneration 01-02-17 00:00	319.9179	229.7132	0.0005072668	4474.716
Dryer B Regneration 01-02-17 07:00	357.6974	404.2589	0.05128649	2742.962
Dryer A Regneration 01-02-17 19:00	332.5292	364.0818	0.1004348	5302.277
Dryer B Regneration 01-03-17 08:48	357.8753	399.4613	0.1699348	6347.083

© Copyright 2019 OSIsoft, LLC

Operationalize - Expected Temperature Profile (Prescriptive)

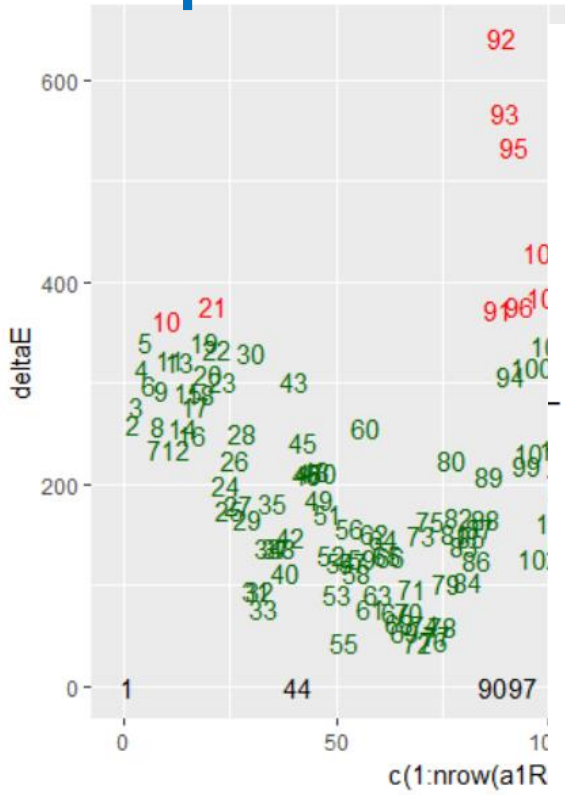


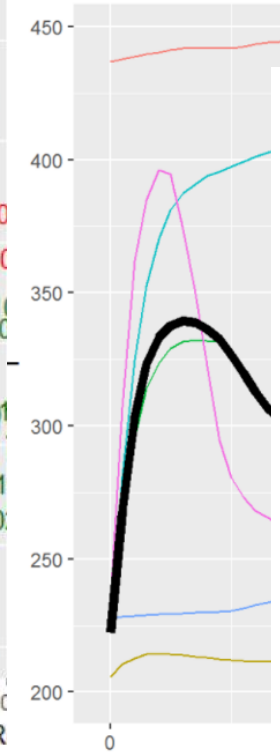
via Future data tag



© Copyright 2019 OSIsoft, LLC

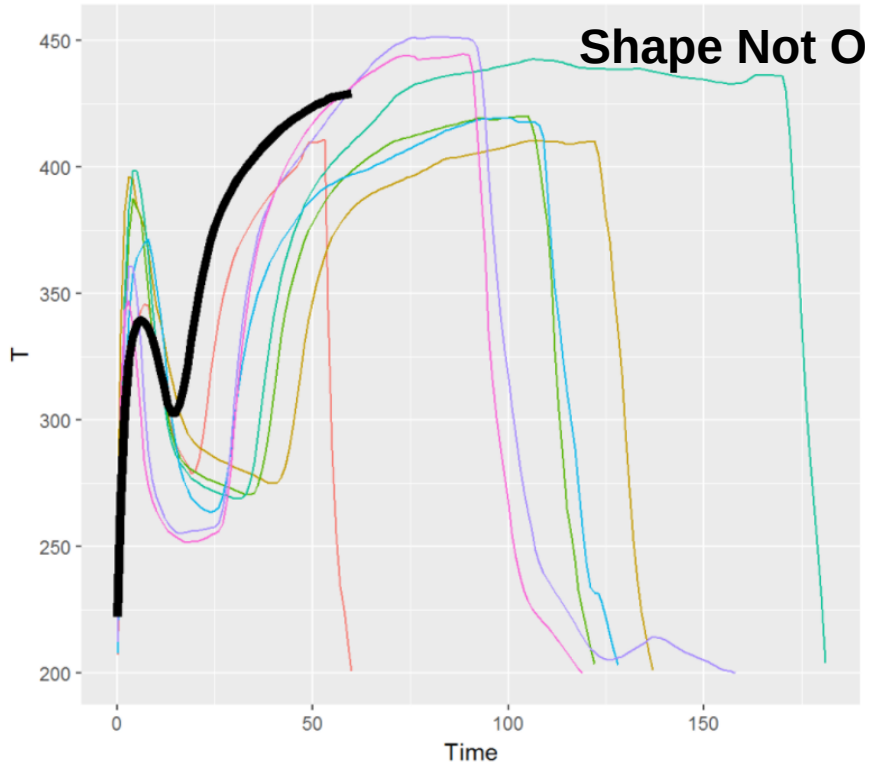
Shape Metrics - Regen Cycles Not OK or Bad Data





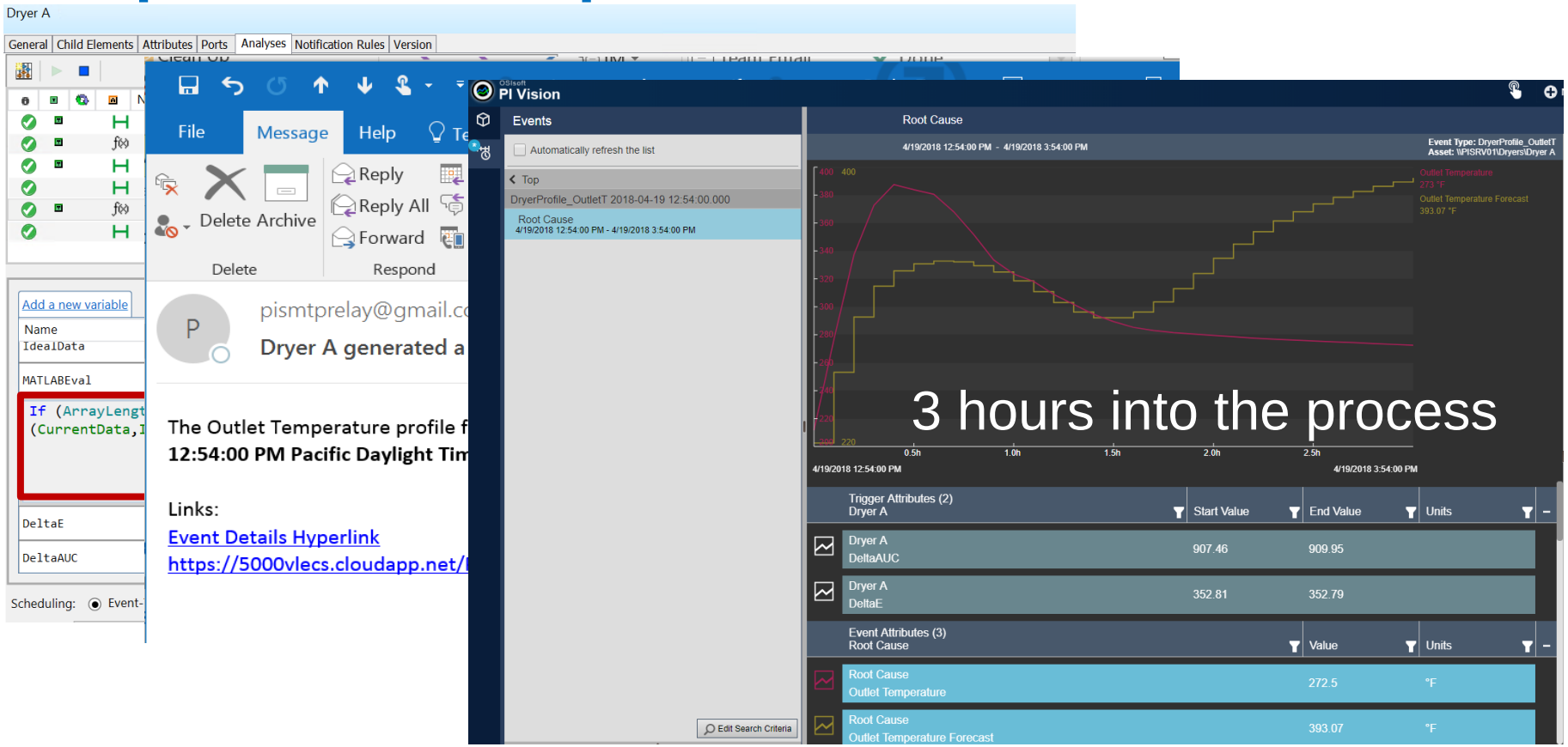
Bad Data

Shape Not OK



© Copyright 2019 OSIsoft, LLC

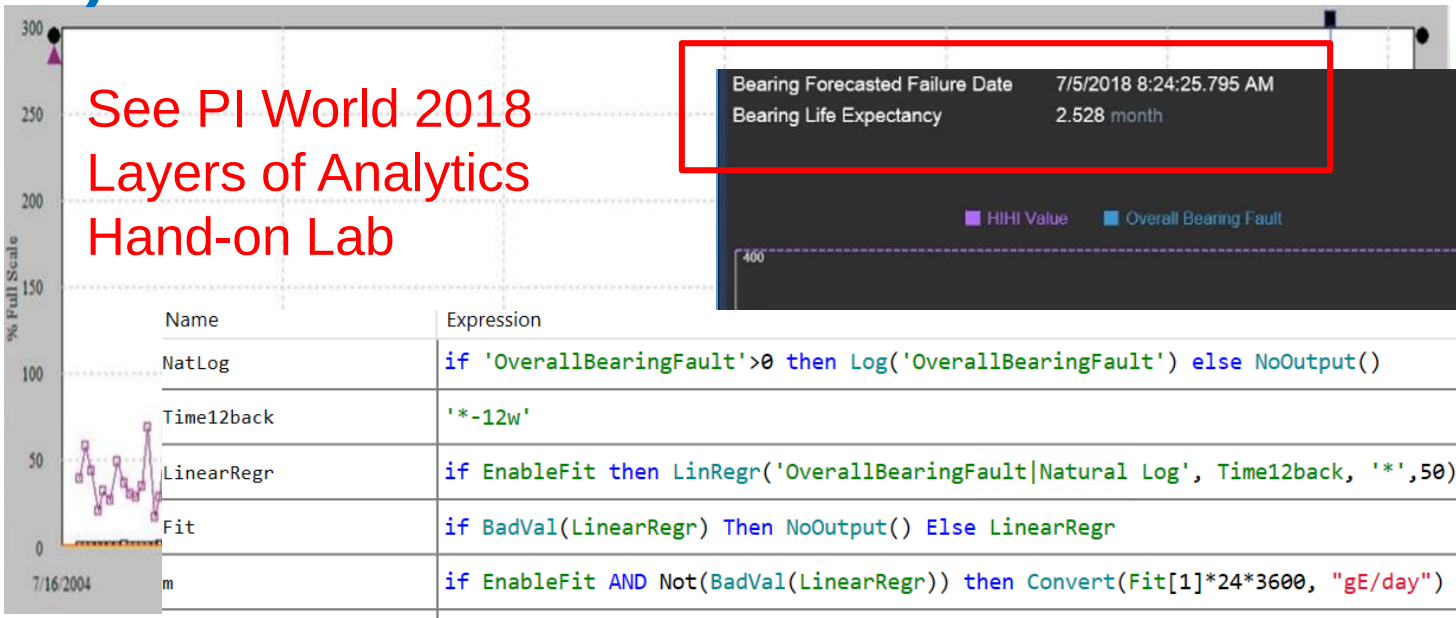
Shape Metrics - Operationalize the Model



© Copyright 2019 OSIsoft, LLC

Maintenance – Predictive – RUL (remaining useful life)

See PI World 2018
Layers of Analytics
Hand-on Lab



Name	Expression	Output Attribute
NatLog	`if 'OverallBearingFault'>0 then Log('OverallBearingFault') else NoOutput()`	OverallBearingFault|Natural Log
Time12back	`'*-12w'`	Map
LinearRegr	`if EnableFit then LinRegr('OverallBearingFault|Natural Log', Time12back, '*',50)`	Map
Fit	`if BadVal(LinearRegr) Then NoOutput() Else LinearRegr`	Map
m	`if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[1]*24*3600, "gE/day")`	OverallBearingFault|m
b	`if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[2], "gE") else NoOutput`	OverallBearingFault|b
rsquared	`if EnableFit AND Not(BadVal(LinearRegr)) then Convert(Fit[3],"ratio") else NoOutp`	OverallBearingFault|r_squared
LifeExpectancy	`if EnableFit AND Not(BadVal(LinearRegr)) and m>0 and rsquared>.400 then Convert((`	BearingLifeExpectancy
ForecastedFailDate	`if EnableFit AND Not(BadVal(LinearRegr)) and m>0 and rsquared>.400 then TimeStamp`	BearingForecastedFailureDate

© Copyright 2019 OSIsoft, LLC

Takeaways – Digital Transformation & Enterprise Infrastructure

- Digital Transformation
  - Digital enablement
  - Automate or Change business process
  - People, Process, Technology
  - Collaborative work environment

- Enterprise Infrastructure (for OT data)
  - Sensor data (SCADA, PLC,…), IoT data,…
  - Machine condition data
  - Other metadata, contextual data, any data to enrich sensor data…

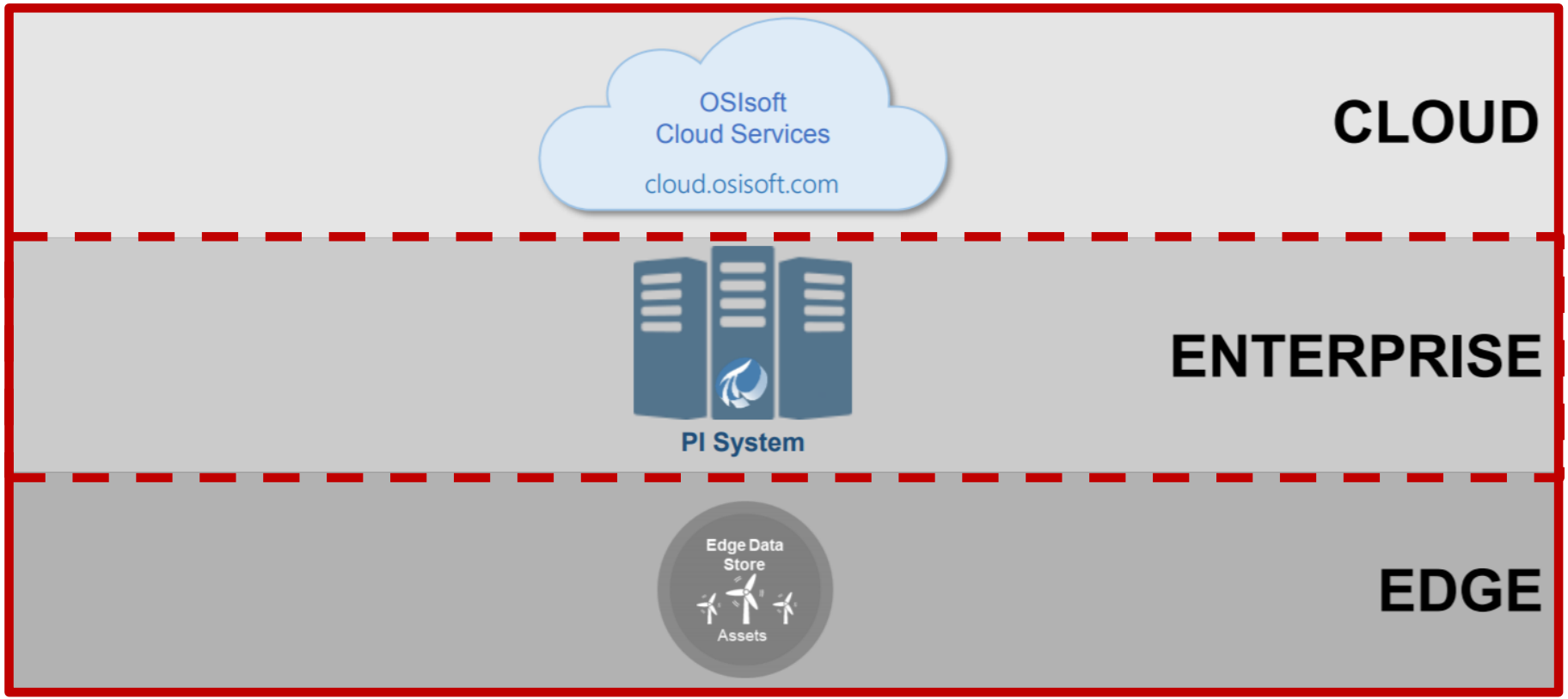
- PI System as the data infrastructure for operational excellence
  - Layers of Analytics – Descriptive, Diagnostic, Predictive, Prescriptive

- New offerings
  - Edge Data Store (EDS)
  - OSIsoft Cloud Services (OCS)
  - OSIsoft Message Format (OMF)

OT=Operations Technology

© Copyright 2019 OSIsoft, LLC

Extending the OSIsoft Data Infrastructure



https://www.osisoft.com/presentations/pervasive-data-collection-1x/

© Copyright 2019 OSIsoft, LLC

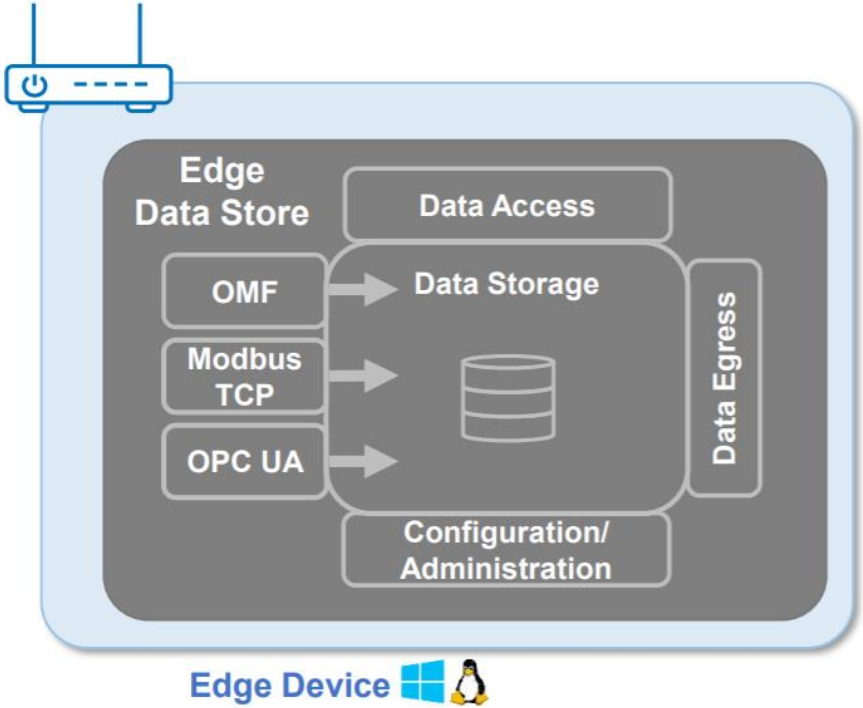
Edge Data Store Design

The Edge Data Store is a newly developed set of data collection, storage, access and transfer technologies, built to run on lightweight devices and interoperate with real-time, operational data sources.

https://www.osisoft.com/presentations/pervasive-data-collection-1x/

© Copyright 2019 OSIsoft, LLC

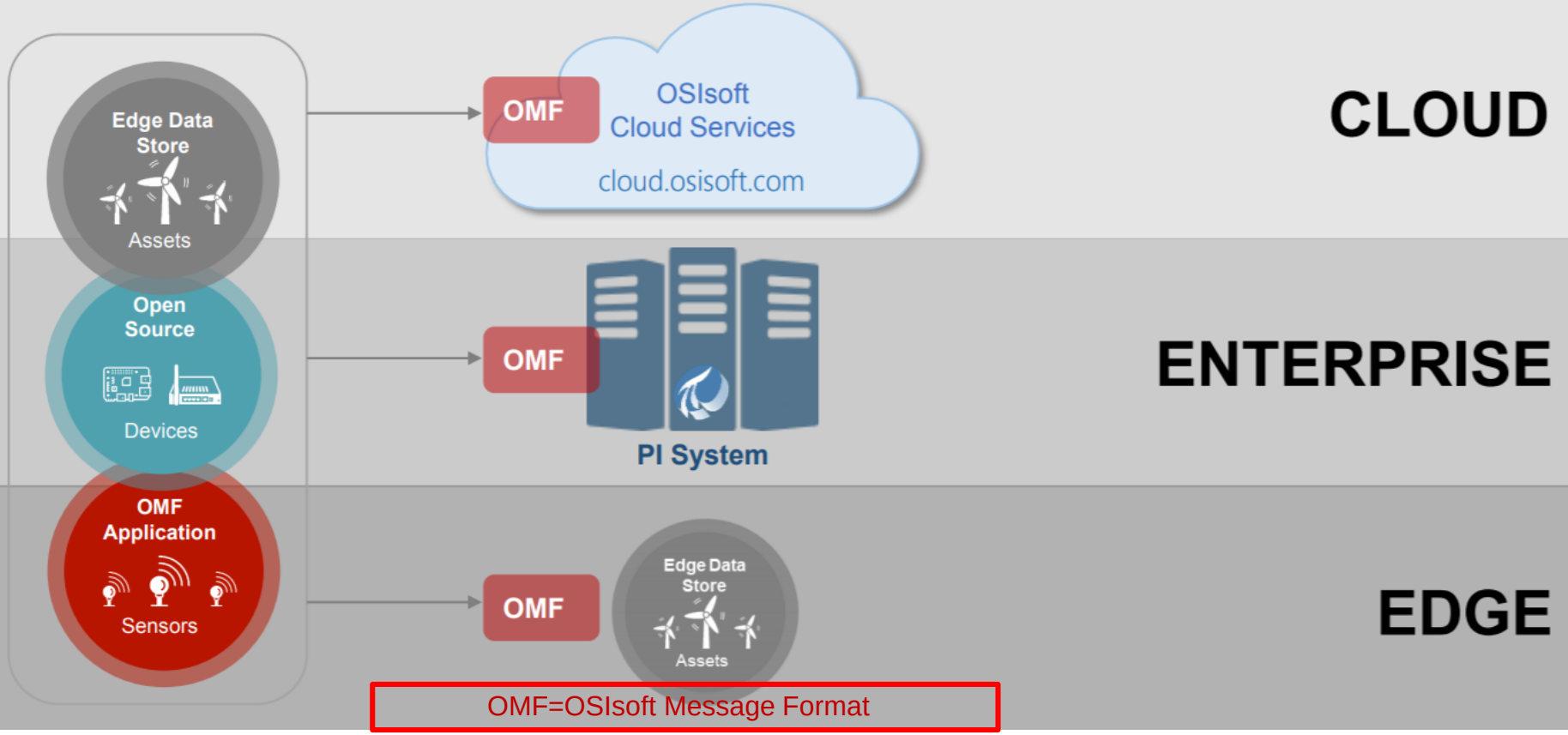
Edge Data Store v1 Hardware Compatibility



https://www.osisoft.com/presentations/pervasive-data-collection-1x/

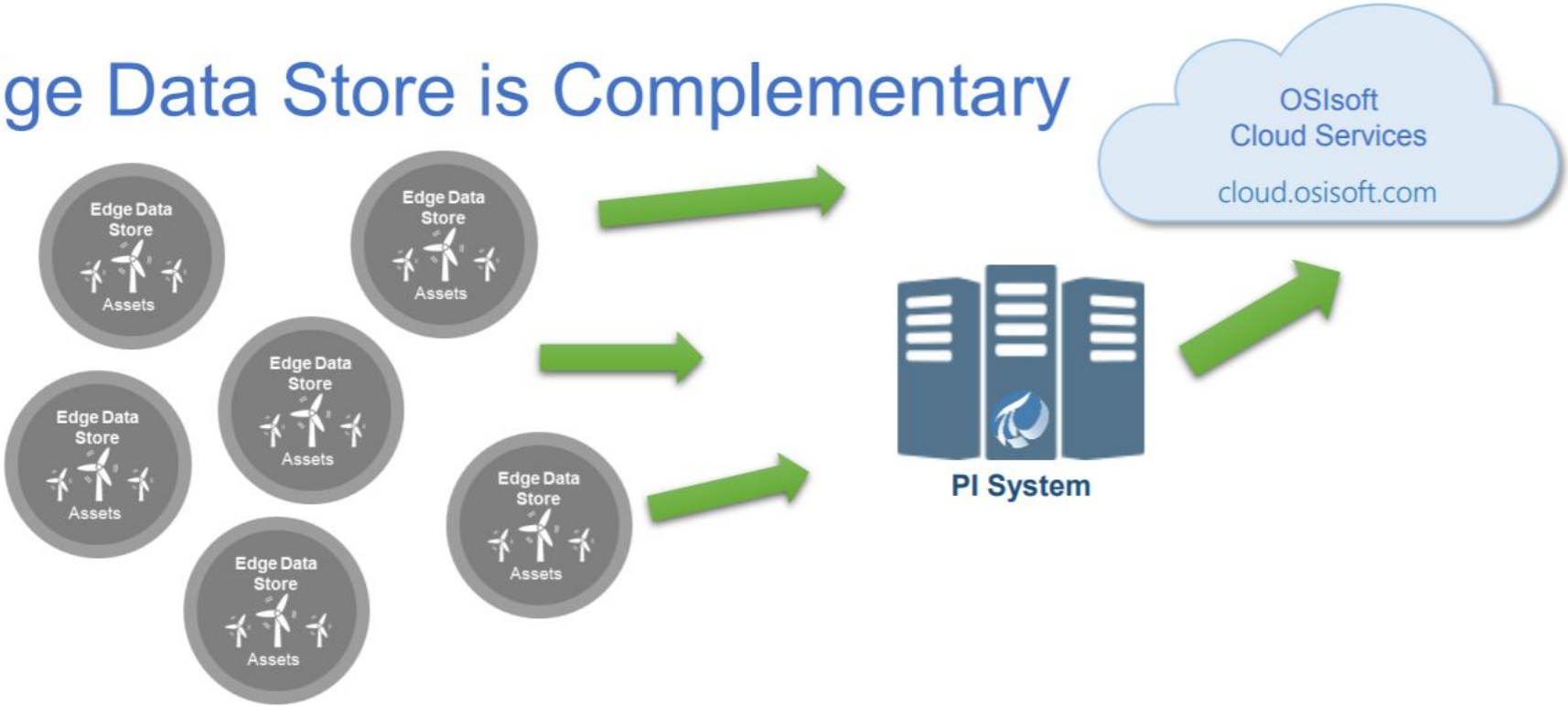
© Copyright 2019 OSIsoft, LLC

Extending Connectivity to All OSIsoft Systems



© Copyright 2019 OSIsoft, LLC

Edge Data Store is Complementary



Operational data is sent between Edge Data Stores and PI Systems

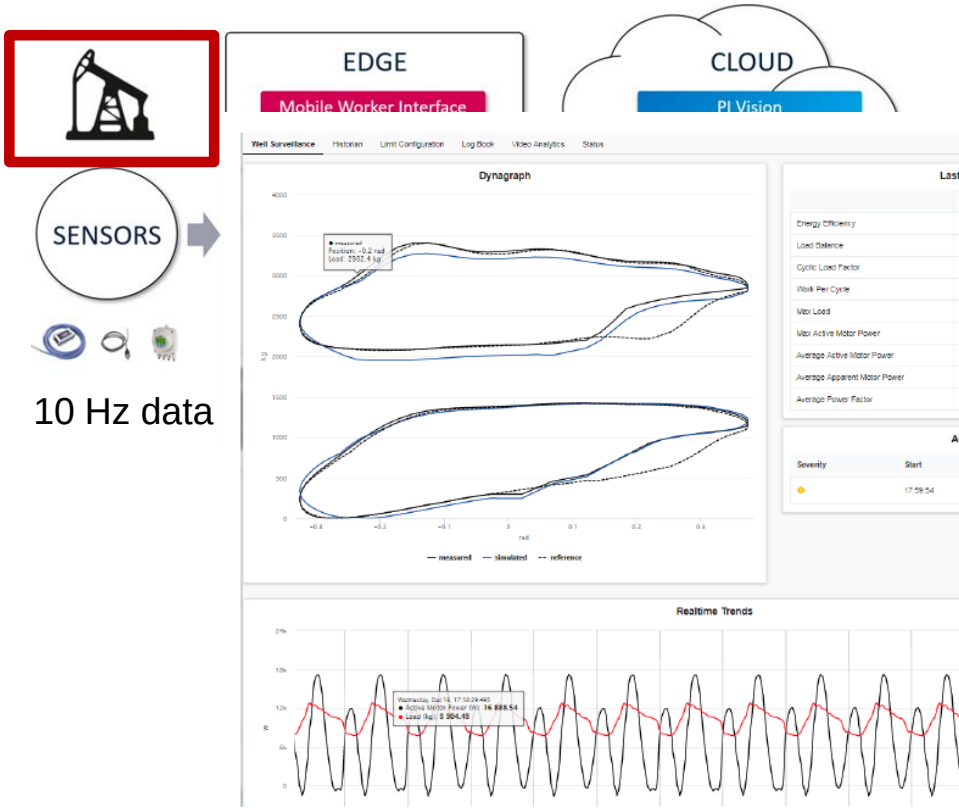
… and also between Edge Data Stores and OSIsoft Cloud Services.

© Copyright 2019 OSIsoft, LLC

Gain Insights from Remote Assets

© Copyright 2019 OSIsoft, LLC

Edge – Beam Pump

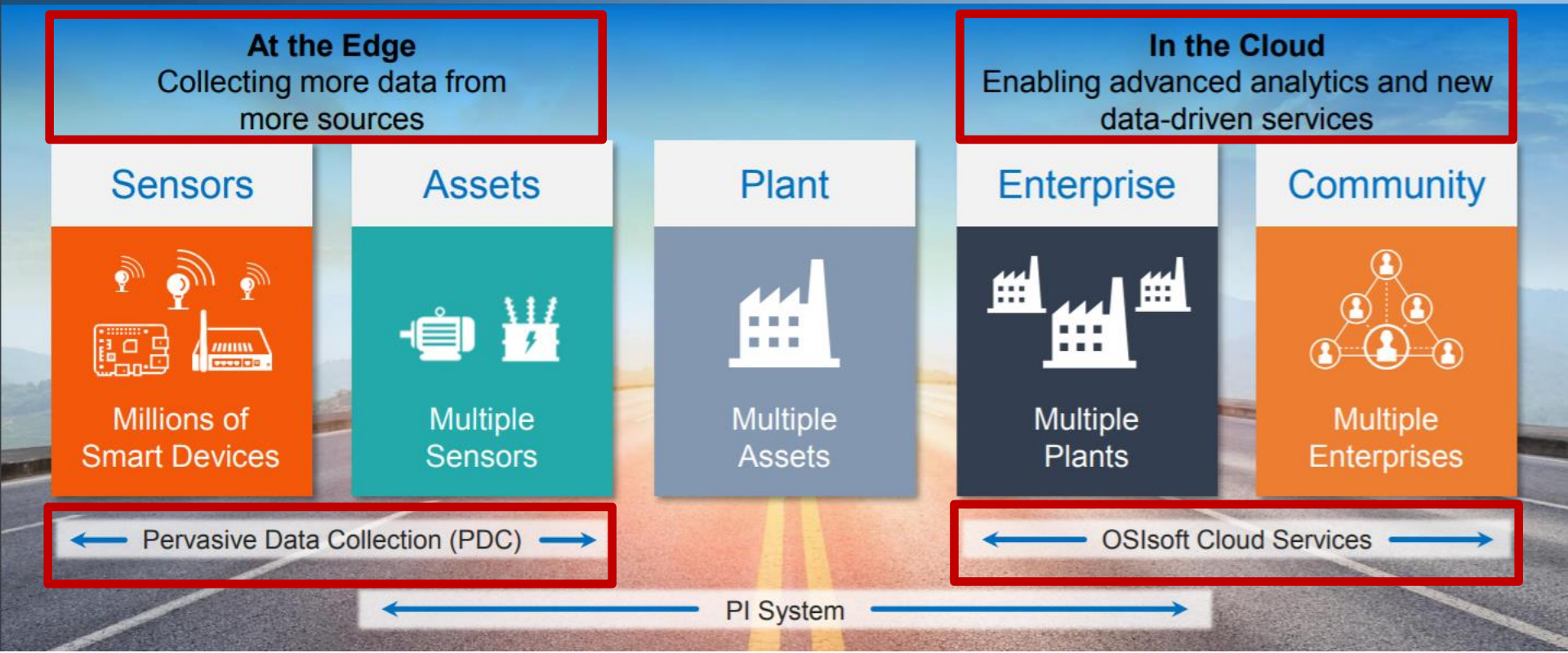


- High frequency data capturing
- Pump issues diagnostics
  - Soft sensing: Dynamo graph from power meter replacing load cell and inclinometer
- Edge Analytics performed on industrial gateway
- Alarms transmission to office for further action

https://www.osisoft.com/Presentations/Gather--Data-connectivity-options-for-the-PI-System-and-the-Cloud/

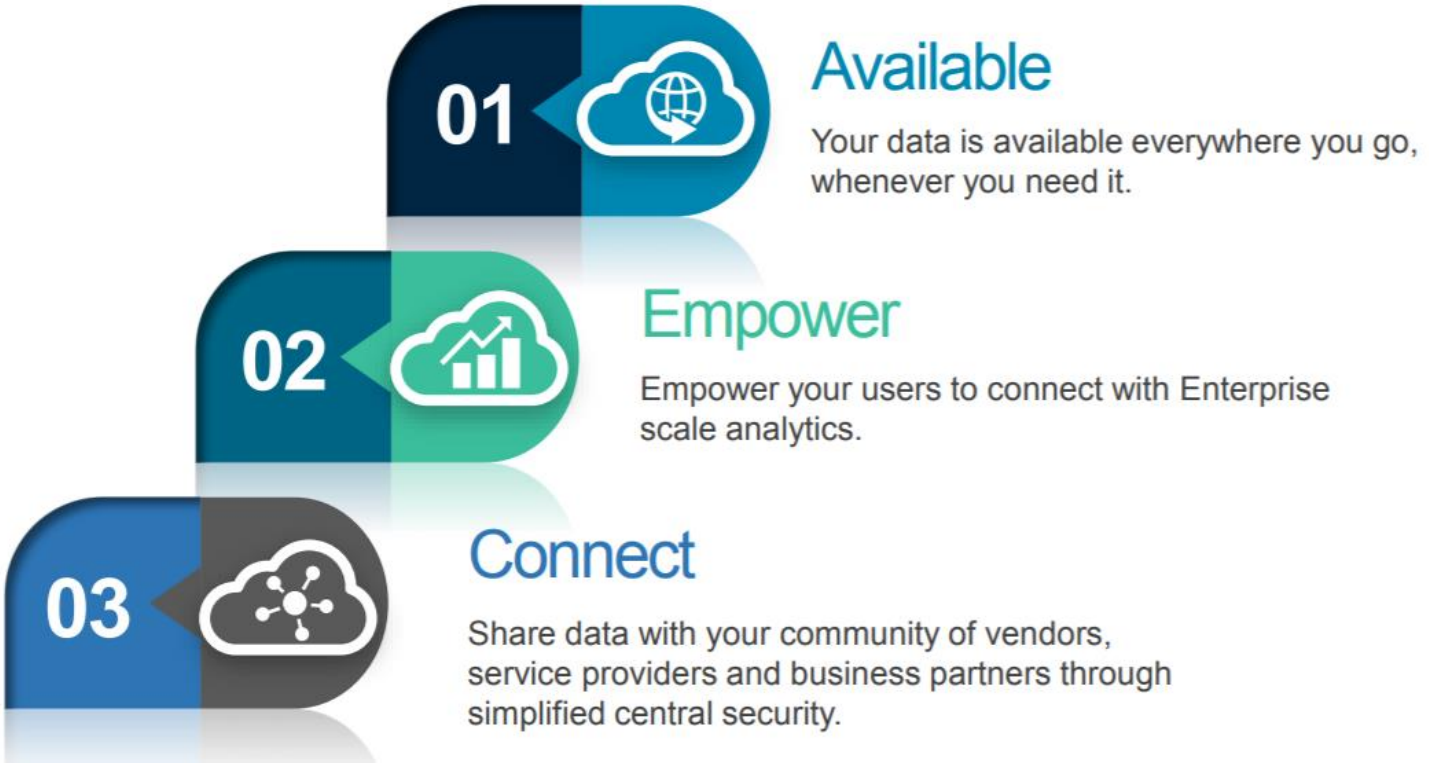
© Copyright 2019 OSIsoft, LLC

Extending Your Data Infrastructure from Edge to Cloud



© Copyright 2019 OSIsoft, LLC

Why OSIsoft Cloud Services?



https://www.osisoft.com/presentations/cloud-services-1x/

© Copyright 2019 OSIsoft, LLC

OSIsoft Cloud Services Design

PI System

≠

cloud.osisoft.com

OSIsoft Cloud Services is a newly developed, cloud native platform, built for real time operational data.

https://ocs-docs.osisoft.com/Documentation/OSIsoft_Cloud_Services.html

© Copyright 2019 OSIsoft, LLC

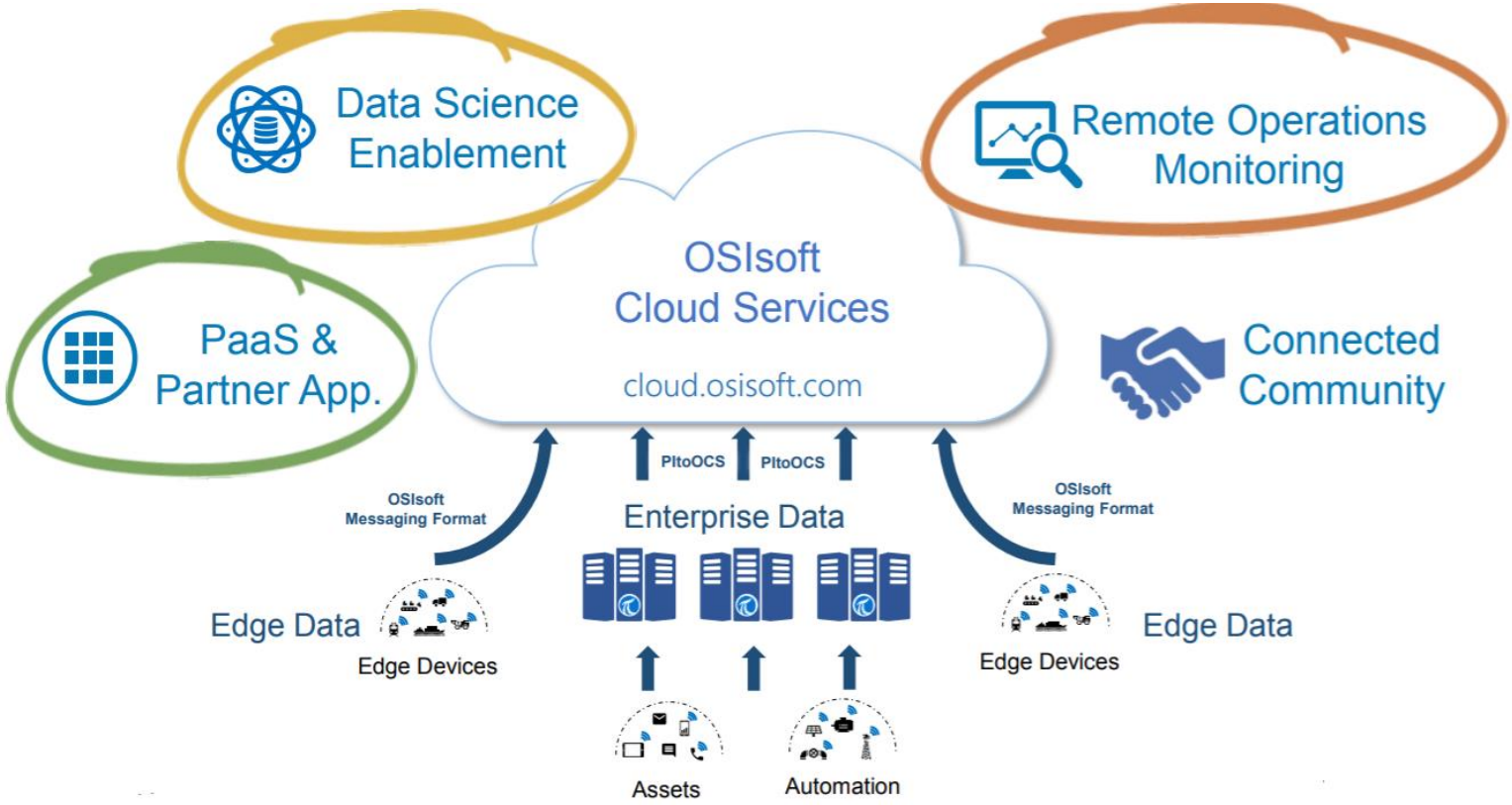
OSIsoft Cloud Services are complementary

Operational data is transferred between PI Systems and OCS

… and also between Edge components and OCS.

© Copyright 2019 OSIsoft, LLC

OCS – Initial Use Cases



© Copyright 2019 OSIsoft, LLC

OCS - Remote Operations Monitoring - Data Center Cooling Units

Operational Challenges of a Datacenter

Facts

- 14 Sites
- 35+ Generators, 300+ CRACs, 5000+ Cabinets
- 24x7x365 On-Site Staff

Requirements & Objectives

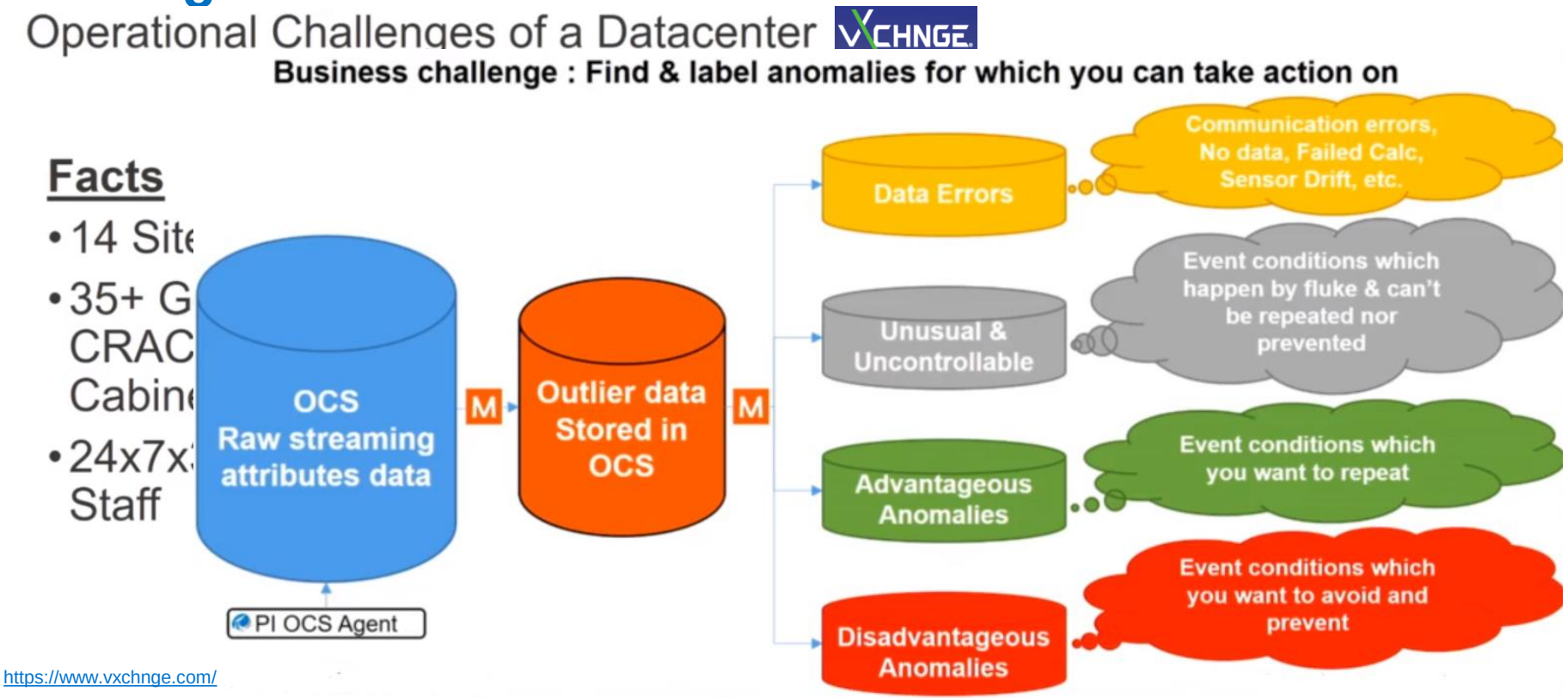
- 99.9999% uptime SLA
- Keep our customers informed
- Maintain visibility into critical equipment
- Identify & troubleshoot issues quickly

https://www.vxchnge.com/

https://www.osisoft.com/presentations/data-cleansing-and-anomaly-detection-made-easy-with-pi-system-and-osisoft-cloud-services/

© Copyright 2019 OSIsoft, LLC

OCS - Remote Operations Monitoring - Data Center Cooling Units



https://www.vxchnge.com/

https://www.osisoft.com/presentations/data-cleansing-and-anomaly-detection-made-easy-with-pi-system-and-osisoft-cloud-services/

© Copyright 2019 OSIsoft, LLC

OCS - Remote Operations Monitoring - Data Center Cooling Units

Operational Challenges of a Datacenter

Business challenge : Find & label anomalies for which you can take action on "Motor Overheating" or "Power & Amp Spike" or "Power Spike" (…)

Facts

- 14 Site
- 35+ G CRAC Cabin
- 24x7x Staff

Disadvantageous Anomalies

https://www.vxchnge.com/

https://www.osisoft.com/presentations/data-cleansing-and-anomaly-detection-made-easy-with-pi-system-and-osisoft-cloud-services/

© Copyright 2019 OSIsoft, LLC

Takeaways – Digital Transformation & Enterprise Infrastructure

- Digital Transformation
  - Digital enablement
  - Automate or Change business process
  - People, Process, Technology
  - Collaborative work environment

- Enterprise Infrastructure (for OT data)
  - Sensor data (SCADA, PLC,…), IoT data,…
  - Machine condition data
  - Other metadata, contextual data, any data to enrich sensor data…

- PI System as the data infrastructure for operational excellence
  - Layers of Analytics – Descriptive, Diagnostic, Predictive, Prescriptive

- New offerings
  - Edge Data Store (EDS)
  - OSIsoft Cloud Services (OCS)
  - OSIsoft Message Format (OMF)

OT=Operations Technology

© Copyright 2019 OSIsoft, LLC

Thank You

Next Steps:

>Your Digital Transformation use case

>PI Workshop

>https://learning.osisoft.com

>https://pisquare.osisoft.com (Community and Developer)

OSIsoft.

© Copyright 2019 OSIsoft, LLC