



The PI System – Enterprise Manufacturing Intelligence Infrastructure

Presented by

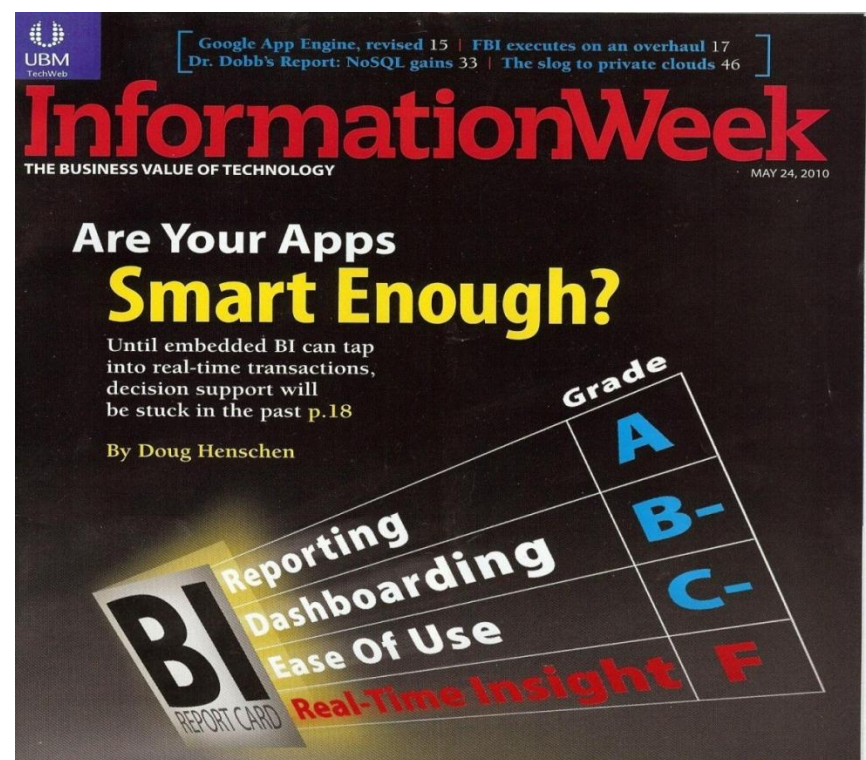
Todd Brown

OSIsoft

Enterprise Manufacturing Intelligence (EMI)

“Manufacturing Intelligence (MI), also known as Enterprise Manufacturing Intelligence (EMI), software **delivers real-time information about manufacturing processes** to help businesses **optimize the performance of these processes** as well as manufacturing yields. MI software **gathers and analyzes production data**, provides **role-based visualization**, and helps manufacturers **reduce waste**. The software also enables the **improvement of manufacturing processes**, **identification of best practices**, and the ability to **respond to exceptions and events**.”

Source: Manufacturing Automation



“If application vendors succeed in delivering real-time transactional insight with reduced information management infrastructure, it would be a game changer.”

EMI Definition Condensed

“Manufacturing Intelligence (MI), also known as Enterprise Manufacturing Intelligence (EMI), software **delivers real-time information about manufacturing processes** to help businesses **optimize the performance of these processes** as well as manufacturing yields. MI software **gathers and analyzes production data**, provides **role-based visualization**, and helps manufacturers **reduce waste**. The software also enables the **improvement of manufacturing processes**, **identification of best practices**, and the ability to **respond to exceptions and events**.”

Manufacturing Intelligence:

- Delivers real-time information about manufacturing processes
- Gathers and analyzes production data
- Provides role-based visualization



Delivered Value:

- Optimize process performance and manufacturing yields
- Reduce waste
- Improve manufacturing processes
- Identification of best practices
- Respond to exceptions and events

Source: Manufacturing Automation

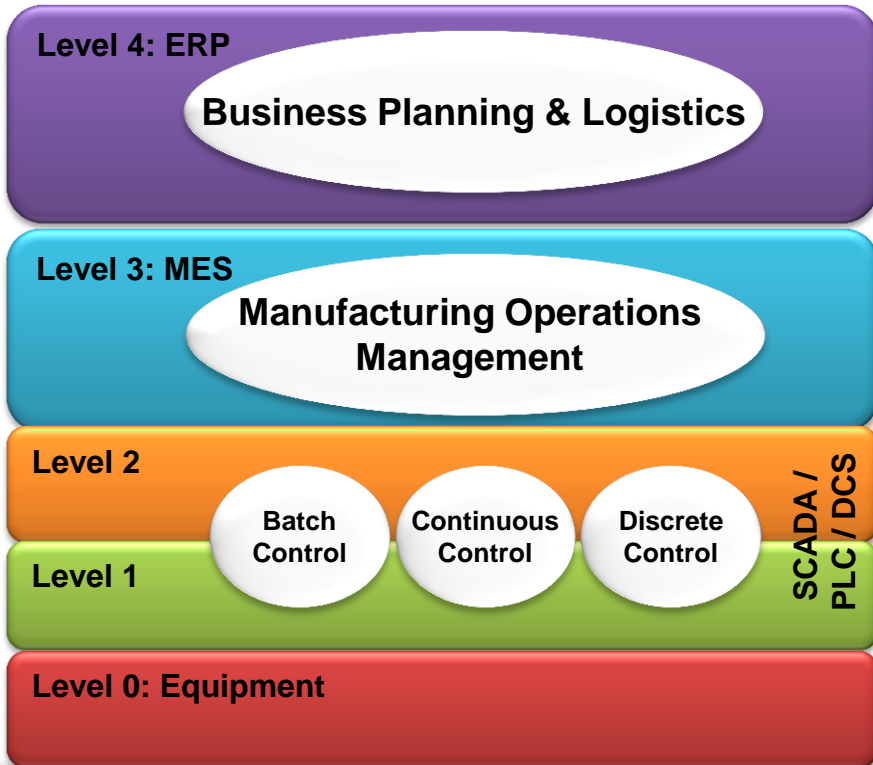


Core Functions of EMI

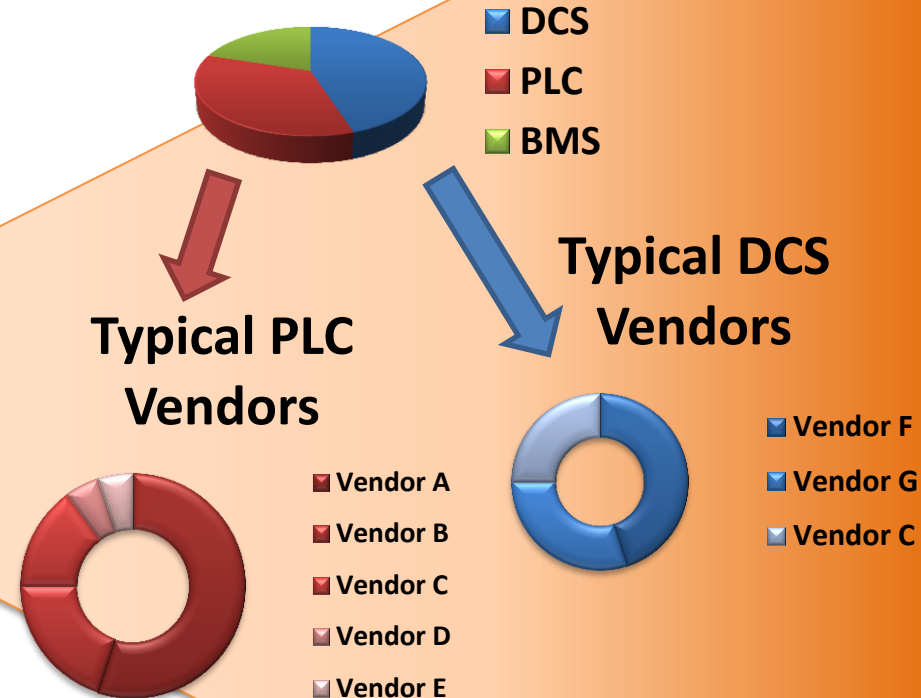
- **Aggregation:** Making available data from many sources, most often databases.
- **Contextualization:** Providing a structure, or model, for the data that will help users find what they need. Usually a folder tree utilizing a hierarchy such as the ISA-95 standard.
- **Analysis:** Enabling users to analyze data across sources and especially across production sites. This often includes the ability for true ad hoc reporting.
- **Visualization:** Providing tools to create visual summaries of the data to alert decision makers and call attention to the most important information of the moment. The most common visualization tool is the dashboard.
- **Propagation:** Automating the transfer of data from the plant-floor up to enterprise-level systems such as SAP, or vice versa.

Aggregation – Enterprise Challenges

ISA S95

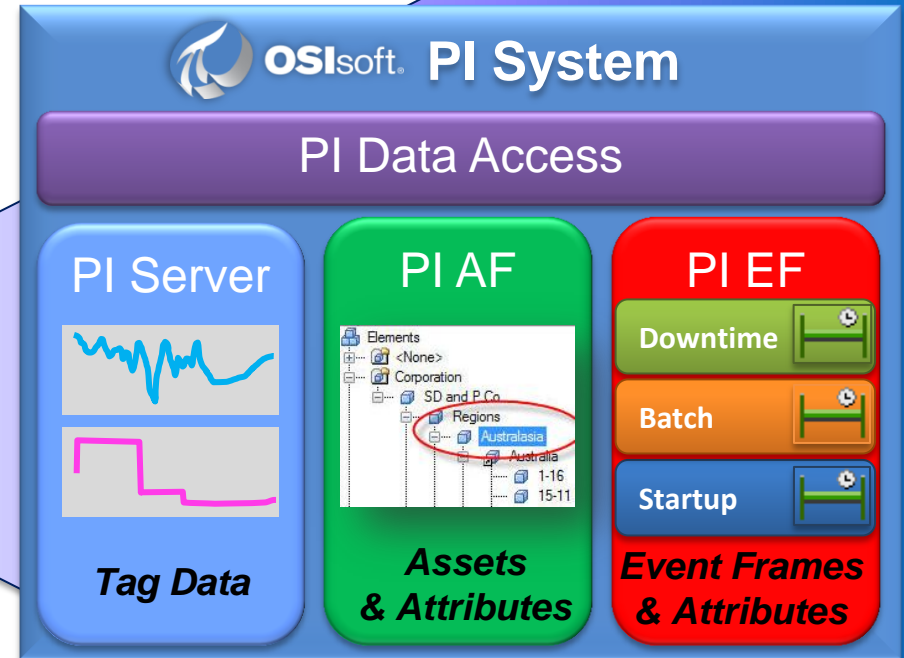
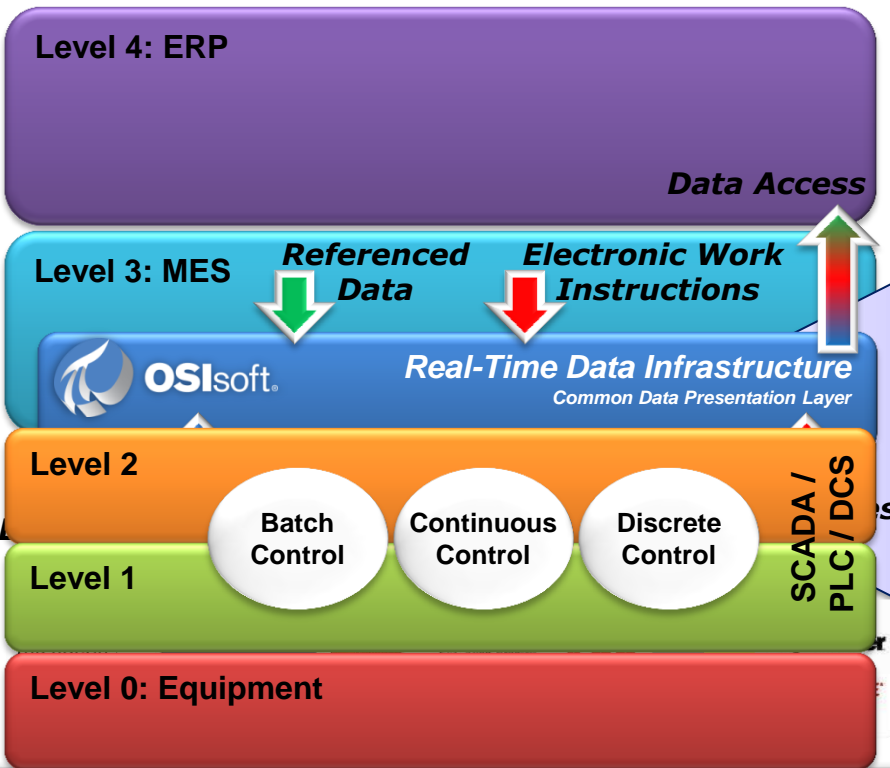


Variable Process Control System Landscape



Aggregation – PI System Data Infrastructure

ISA S95



Aggregation – Referenced Data Sources

- PI AF allows you to tie asset properties to your data
 - Static values, PI Tags from multiple PI Servers, static or linked Tables
 - Custom data references to other data sources
 - MES, other historians, LIMS, Maximo, etc.
- PI EF leverages PI AF functionality, but will add an EF / Batch Context
 - Reference LIMS data associated with a batch.

The screenshot shows the 'UP_BF_END:1-1' dialog box with the 'Referenced Elements' tab selected. The 'Data Table Edit' window is open, displaying a table with the following data:

TestCode	assayresult	stringresult	HighLimit	LowLimit	status
KF1-1001[001]			0.1	0	NC
GC1-1001[002]			4	3	NC
HPLC11-1001[003]			1	0.7	NC
PH1-1001[004]			248	222	NC
GC1-1002[002]			7.2	6.4	NC
CELL1-1002[003]			5	0	NC
SG1-1002[004]			3	2.5	NC
ML1-1002[005]			6	4	NC
HPLC11-1002[006]			436	400	NC
PH1-1002[007]			0.2	0	NC
KF1-1003[001]			240	220	NC

The dialog box also includes a 'System Message' section at the bottom with two entries: 'Unit Procedure Finished' and 'Unit Procedure Started', both with a value of 0.

PI AF

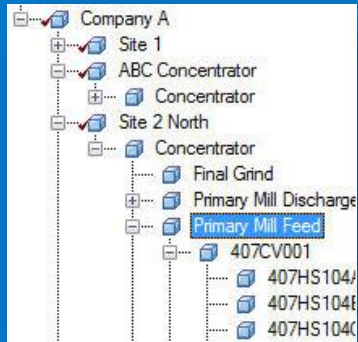
Contextualization

- PI AF provides a **configurable and flexible data abstraction model** to help different users **easily find information** they need to make decisions

PI AF

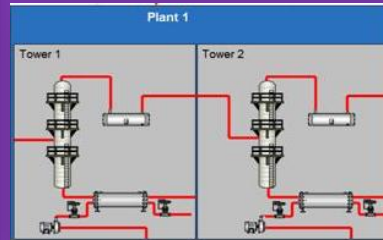


Physical / Logical



Element Hierarchy

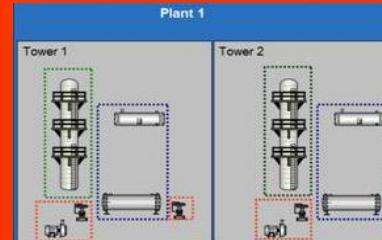
Process Connectivity



Models

Role

***Pumps
Used in Report
Critical Parameters
Batch Info***



Categories

Event / Time

Name	Start Time	End Time	Reason Code
Gas Turbine 1 Downtime Event...	2/28/2011 4:00:00 PM	2/28/2011 4:15:00 PM	Seal Leakage
Gas Turbine 2 Downtime Event...	2/28/2011 4:00:00 PM	2/28/2011 4:30:00 PM	Mechanical
Gas Turbine 1 Downtime Event...	3/1/2011 5:00:00 PM	3/1/2011 5:15:00 PM	Seal Leakage

Event Frames

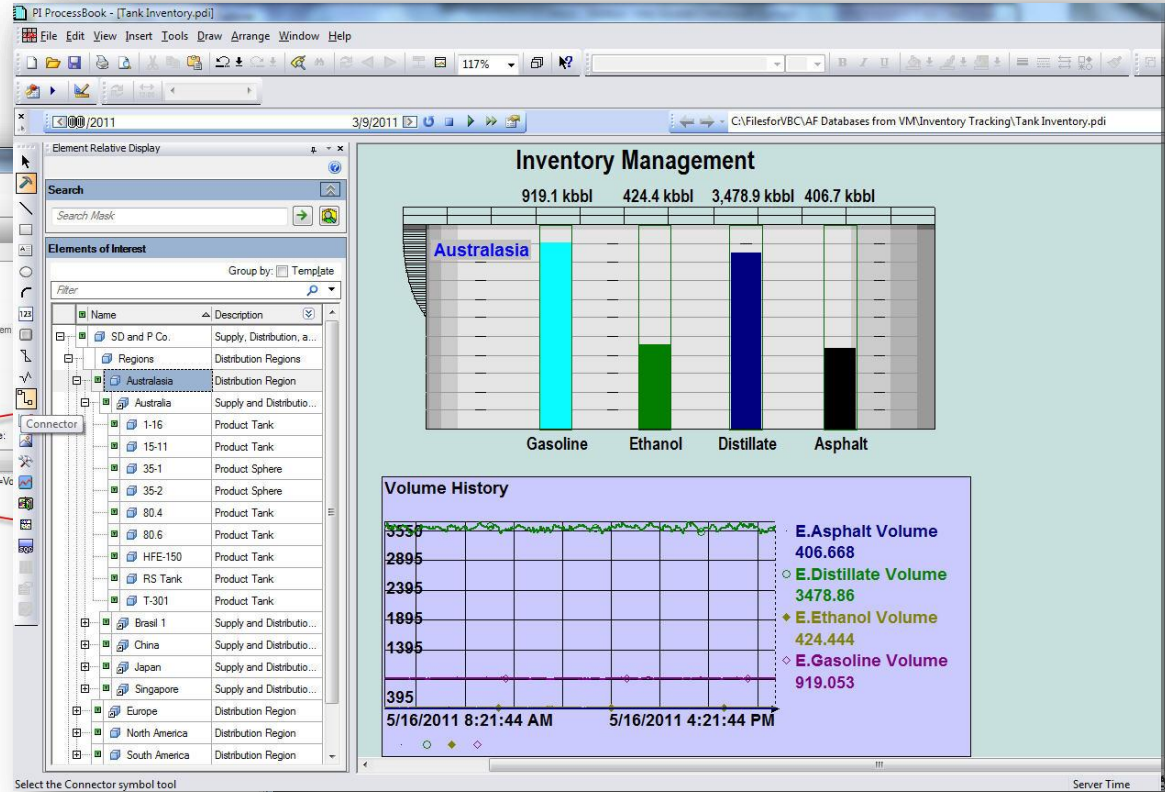
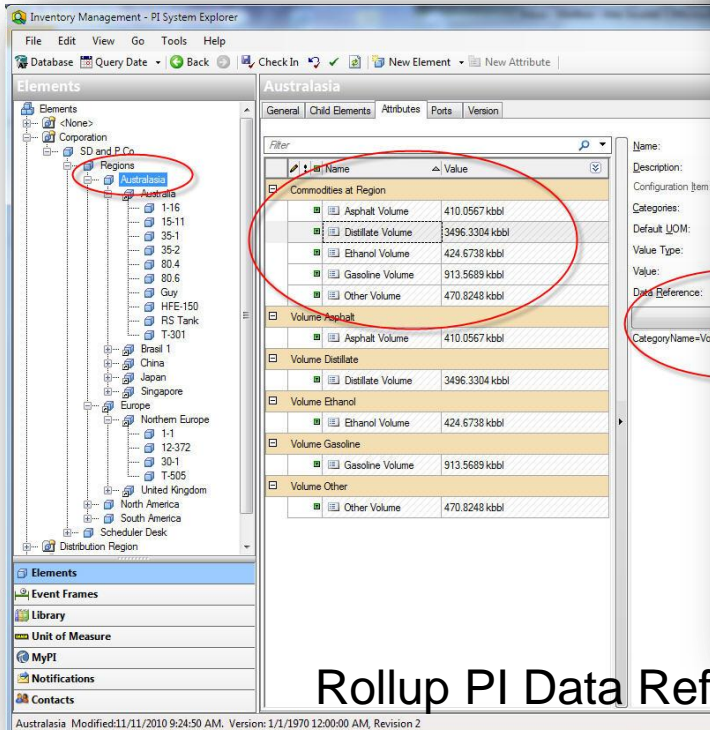
Associated Info

Name	Value
Meter Alarming	
High Amps	1500 A
High Voltage	245 V
Low PF	90 %
Meter Configuration	
Contracted Amps	150 A
Coordinates	
Installation date	1/1/2007 12:00:00 AM
Last inspection	1/1/2007 12:00:00 AM

Attributes

Analysis

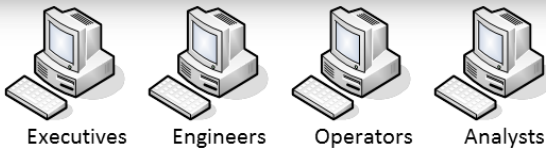
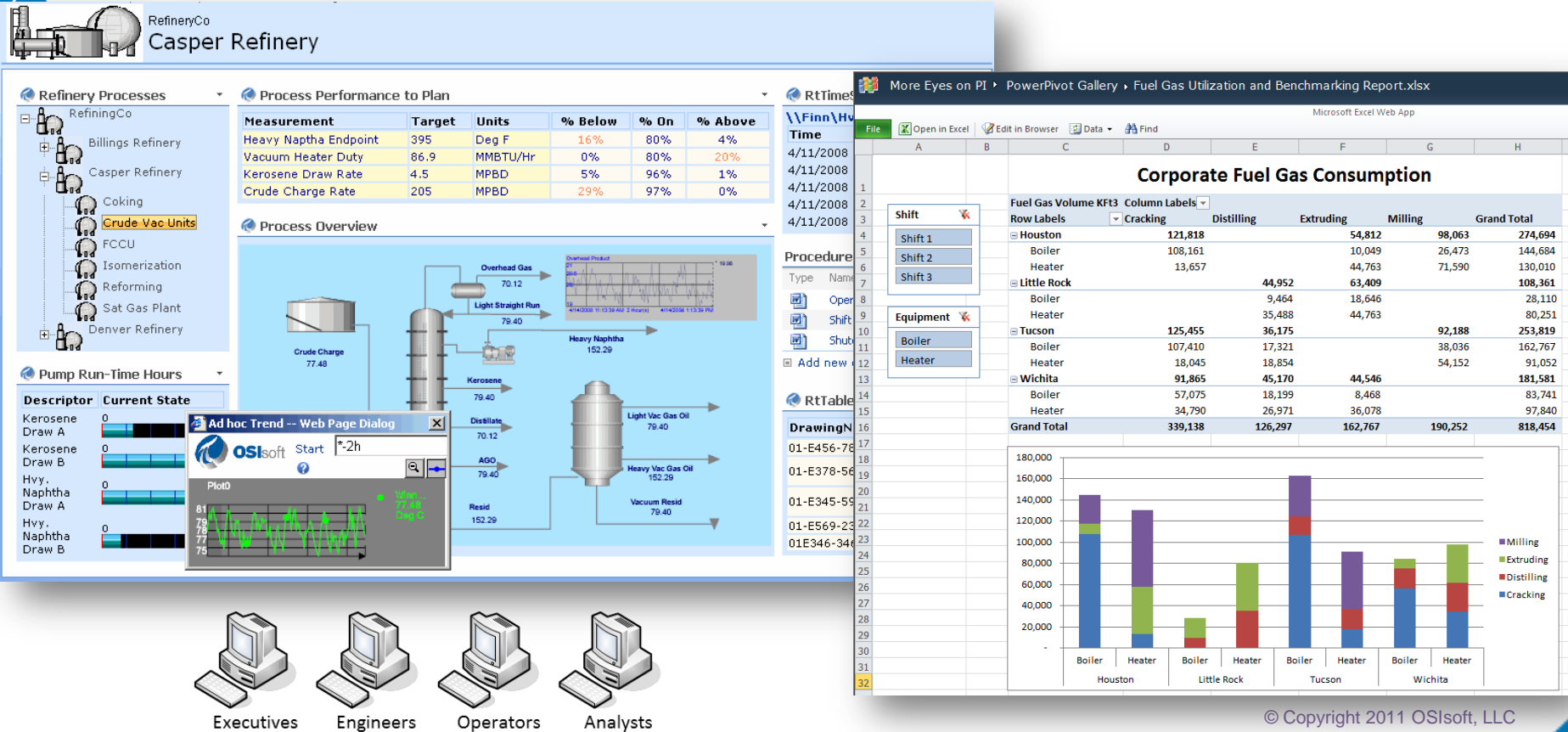
Inventory – Region Level



Rollup PI Data Reference

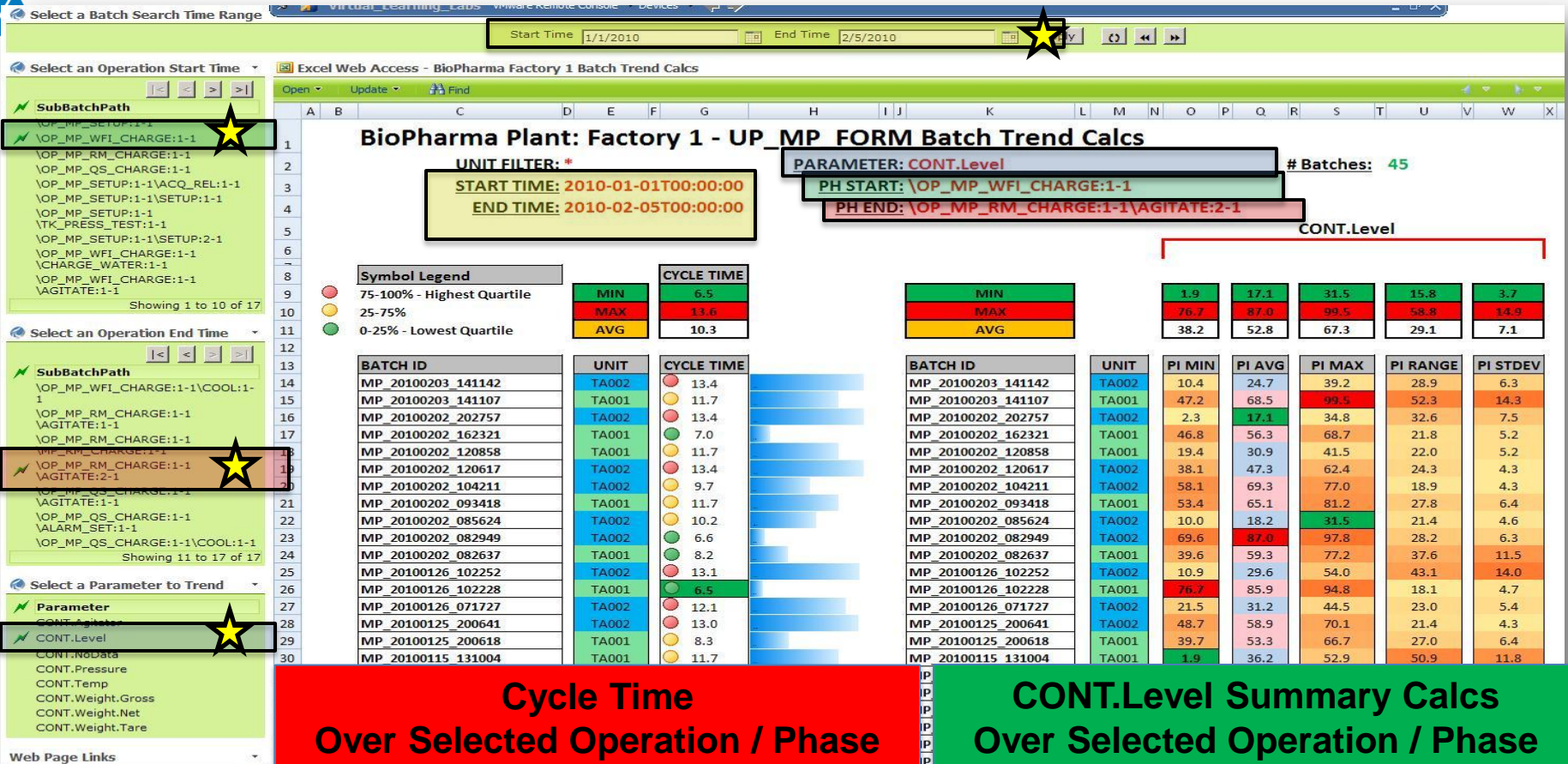
Providing tools to create visual summaries of the data to alert decision makers and call attention to the most important information of the moment.

Visualization – PI WebParts & Microsoft SharePoint

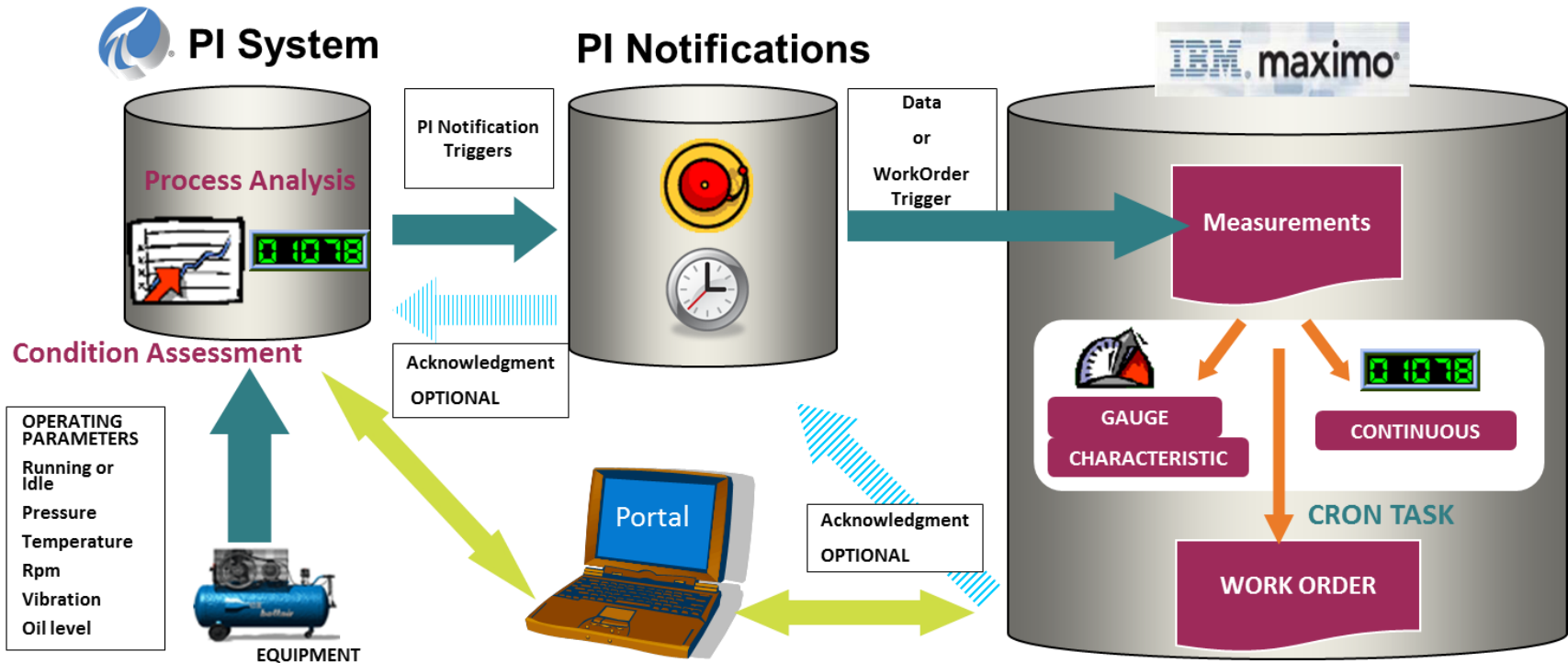


Providing tools to create visual summaries of the data to alert decision makers and call attention to the most important information of the moment.

Visualization – PI WebParts & Microsoft SharePoint



Propagation – PI AF, PI Notifications, PI Data Access



Core Functions of EMI – Satisfied by the PI System



Aggregation



Contextualization



Analysis



Visualization



Propagation



How is the PI System different?



Aggregation



Contextualization



Analysis



Visualization



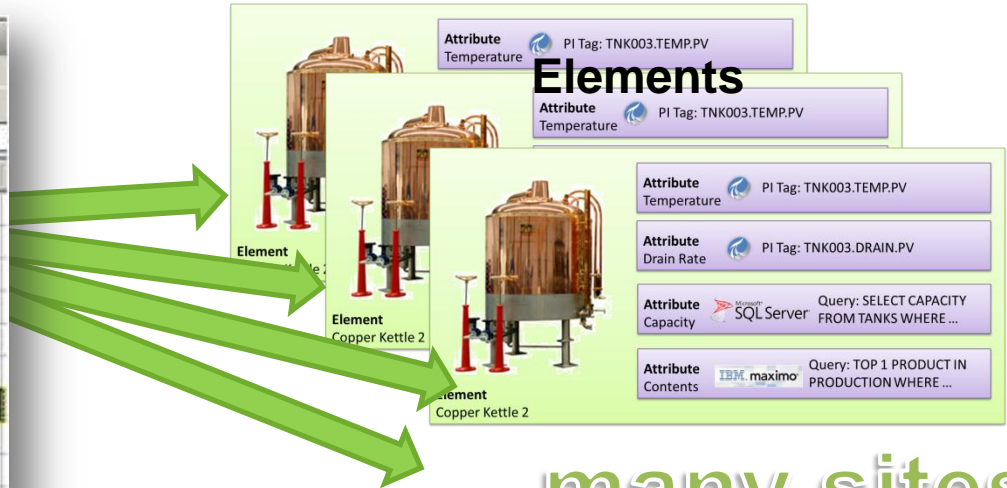
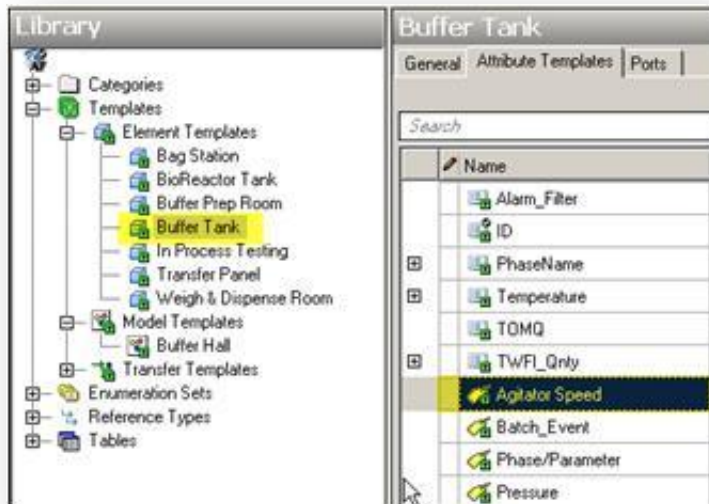
Propagation

- True Enterprise View & Management
 - PI AF Element Templates
 - PI EF Templates
 - PI AF Unit of Measure
 - Enterprise Deployment Options
- Infrastructure Approach to EMI
 - Reactive vs. Proactive



Enterprise Management – PI AF Element Templates

- Standardize across your enterprise – common asset model
- Maintain many elements with your template and grow your PI AF database as an analysis tool over time
- Leverage templates in analytics/calculations, notifications, reports, visualization, and integration with other systems.



... many sites



Enterprise Management – PI EF Templates

- Standardize on PI Event Frame templates across the Enterprise for a variety of use cases:
 - Shift Analysis
 - Startup / Shutdown
 - Downtime & Overall Equipment Effectiveness (OEE)
 - Excursions
 - Alarms & Events
 - Batch

Library

- Table Categories
- Templates
 - Analysis Templates
 - Case Templates
 - Element Templates
 - Event Frame Templates**
 - BioReactor Downtime
 - Corrective Action
 - downtime
 - Incubator Downtime
 - Corrective Action
 - PI Campaign
 - PI Batch
 - PI Unit Batch
 - PI Sub Batch
 - S88 Procedure
 - S88 Unit Procedure
 - S88 Operation
 - S88 Phase
 - S88 Phase State
 - S88 Phasestep
 - Wave BioReactor Downtime
 - Condenser Downtime
 - Corrective Action
 - Down Time Template
 - Gas Turbine Downtime
 - HRSG Downtime
 - Steam Turbine Downtime
 - Model Templates
 - Transfer Templates

- Elements
- Event Frames
- Library**
- Unit of Measure
- Model Analyses

20 Event Frame Templates

Event Frame Templates

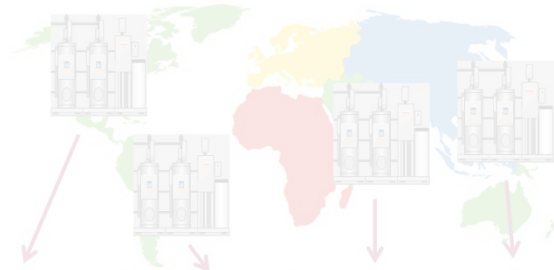
Filter

Name	Description	Type
Bio Equipment Downtime		
BioReactor Downtime		Event Frame
Incubator Downtime		Event Frame
Wave BioReactor Downtime		Event Frame
DownTime		
BioReactor Downtime		Event Frame
Down Time Template		Event Frame
PI DB Templates		
PI Batch		Event Frame
PI Campaign		Event Frame
PI Sub Batch		Event Frame
PI Unit Batch		Event Frame
PowerPlant Downtime		
Condenser Downtime		Event Frame
Gas Turbine Downtime		Event Frame
HRSG Downtime		Event Frame
Steam Turbine Downtime		Event Frame
S88 Batch Templates		
S88 Operation		Event Frame
S88 Phase		Event Frame
S88 Phase State		Event Frame
S88 Phasestep		Event Frame
S88 Procedure		Event Frame
S88 Unit Procedure		Event Frame



Enterprise Management – PI AF Unit of Measure

Enterprise Companies Work Collaboratively



B1:TI333A.p V	\\CalderaA\t emp	TE-BLR-996- R	\\BLR_N\MT R47
622 DegF	314 Deg C	611 K	288 Deg C

The process is the same ...

The instrumentation is different

- Automatic conversion of UOMs of the same class
- Enables cross site comparison
- UOMs are extensible (define your own through code)

AMIDemo2007 - PI System Explorer

File Edit View Go Help

Database Query Date Back Check In New Class New UOM

Unit of Measure

Search

Class

- Angular Velocity
- Area
- Density
- Dynamic Viscosity
- Electric Charge
- Electric Current
- Electric Potential
- Energy
- Energy Cost
- FOE Mass
- FOE Volume
- Force
- Frequency
- Heat Capacity
- Heat Transfer Coefficient
- Length
- Luminous Intensity
- Mass
- Mass Flow Rate
- Molar Flow Rate
- Molar Volume (Normal)
- Molar Volume (Standard)
- Molecular Weight
- Moles
- Money
- Plane Angle
- Power
- Pressure
- Pressure (Gauge)
- Quantity
- Ratio
- Specific Energy
- Specific Gravity
- Speed
- Temperature
- Temperature (Delta)

Energy

Search

Name	Abbreviation	Class	Canonical	Reference
British thermal unit	Btu	Energy	1055.05585262 J	1055.05585262 J
calorie	cal	Energy	4.1868 J	4.1868 J
gigajoule	GJ	Energy	1000000000 J	1000000000 J
joule	J	Energy	1 J	1 J
kilocalorie	kcal	Energy	4186.8 J	1000 cal
kilojoule	kJ	Energy	1000 J	1000 J
kilowatt hour	kWh	Energy	3600000 J	3600000 J
mega watts hour	MWh	Energy	360 J	0.0001 kWh
megajoule	MJ	Energy	1000000 J	1000000 J
MegaWatts	MW	Energy	3600 J	0.001 kWh
million British thermal unit	MM Btu	Energy	1055055852.62 J	1000000 Btu
million calorie	MMcal	Energy	4186800 J	1000000 cal
TeraWh	TWh	Energy	3600000 J	1000 MW
Tons	Tons	Energy	0.08788615252...	8.33E-05 Btu
watt hour	Wh	Energy	3600 J	0.001 kWh
watt second	Ws	Energy	1 J	1 J

Unit of Measure Properties

General

Name:

Abbreviation:

Description:

Canonical UOM:

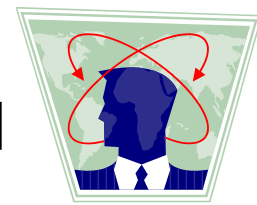
Reference UOM:

Method: ☒ Simple ☐ Formula

Factor:

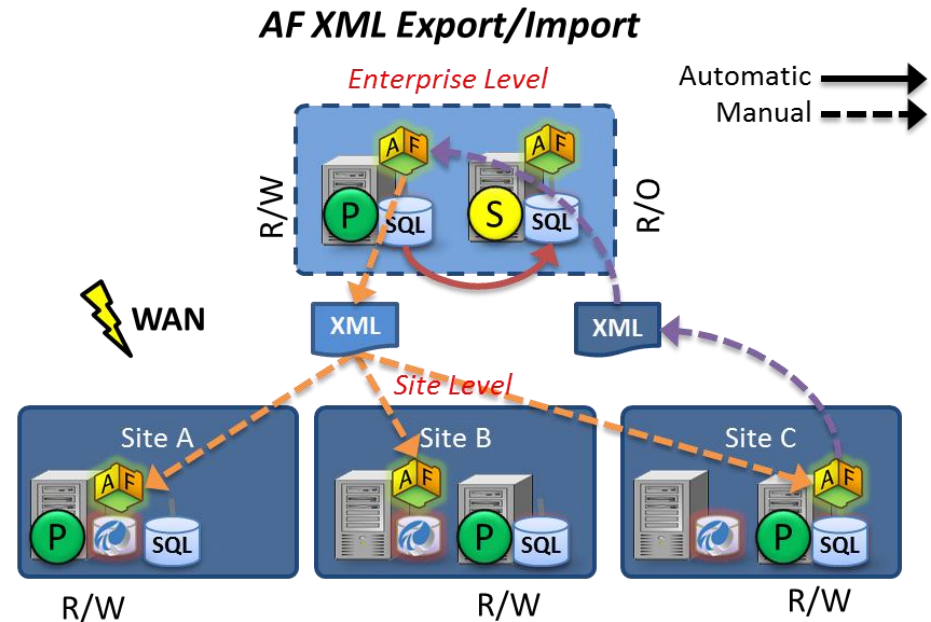
Offset:

Deploy PI AF with the Enterprise in Mind



- PI AF supports referencing data across multiple PI Servers & systems
- PI AF supports both central (Enterprise) and local (Site) deployments with several synchronization options
 - AF HA (Replication)
 - AF XML Export/Import
 - AF Builder Export/Import
 - AF Data Access Custom App
 - More options in the future

Think Globally, Implement Locally

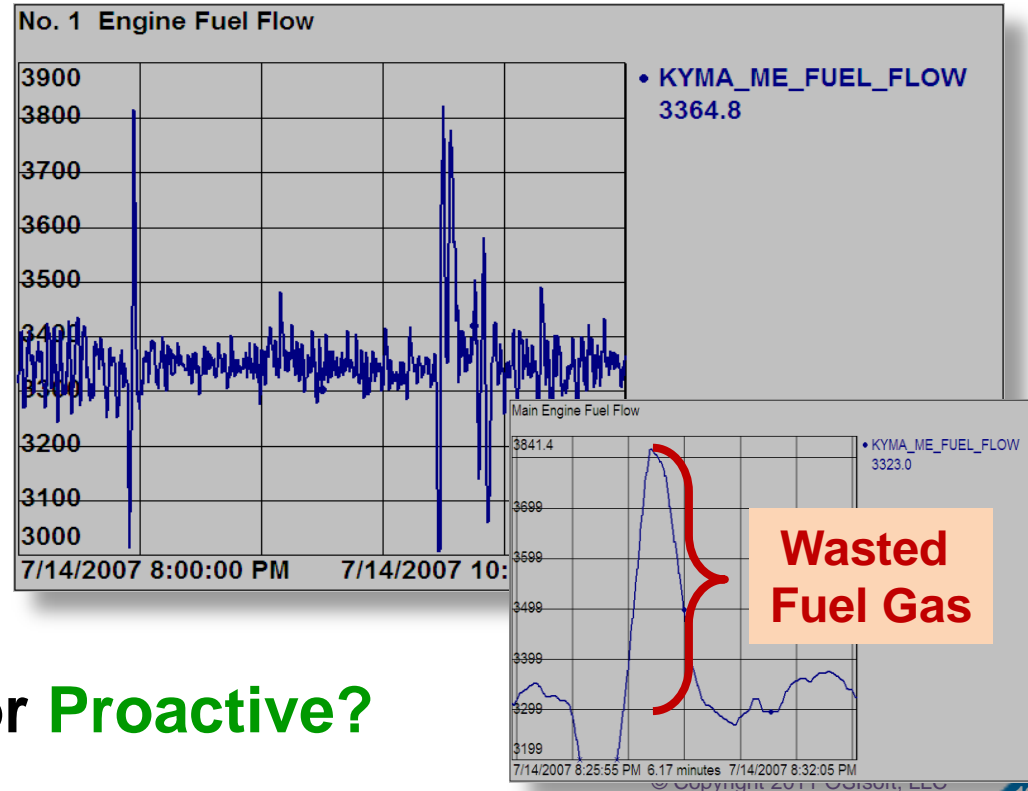


Infrastructure Approach to EMI

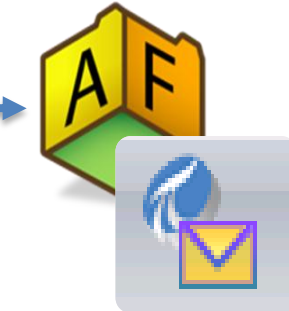
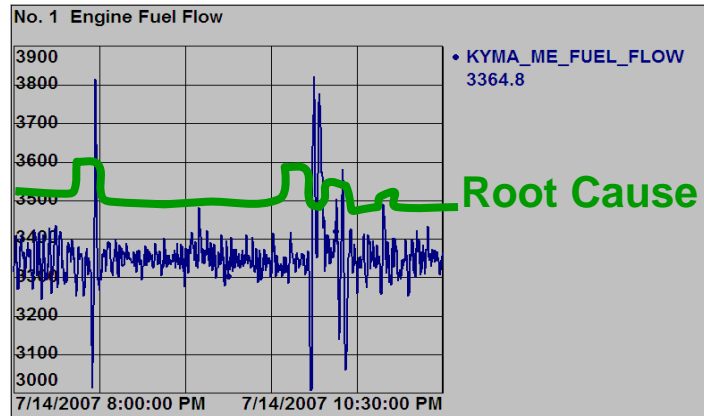
- Why did it take so long to notice?
- What did it take for the customer to find this trend and identify this problem?
- With tens of thousands of tags in a typical PI System, how many other opportunities are going unnoticed?

Reactive or **Proactive?**

Fuel flow spikes
discovered costing
\$93,000 / year



Infrastructure Approach to EMI

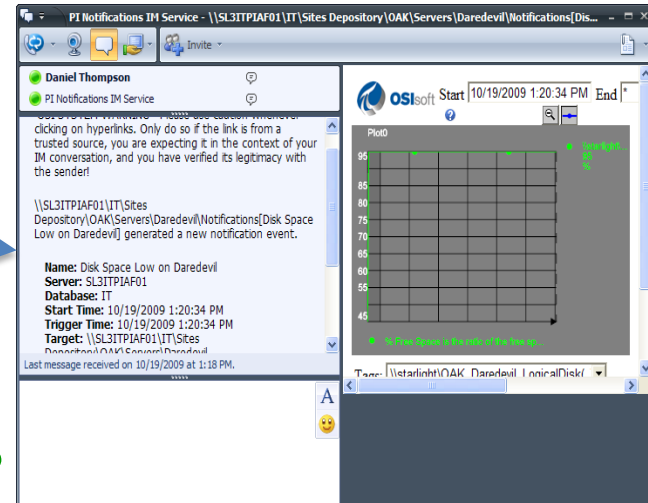


PI Notifications

Web Service



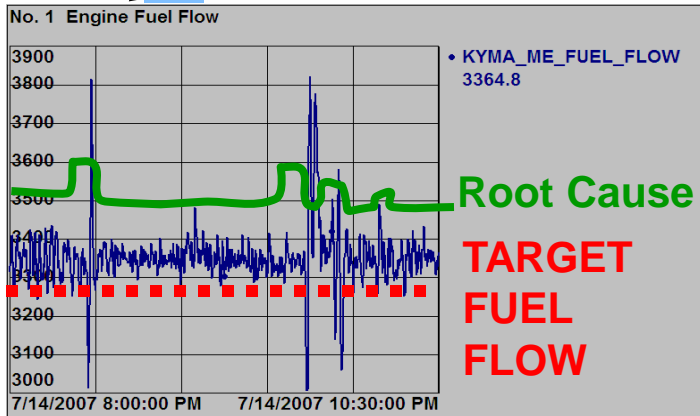
Reactive or Proactive?



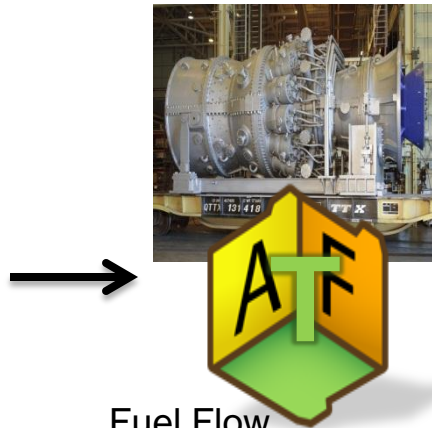
Infrastructure Approach to EMI



How many solutions are implemented at a single site but the 'best practice' is never formalized and replicated to other sites?



**Process Knowledge,
Transparent Accountability**



Fuel Flow
Fuel Flow.Target
Fuel Flow.[Root Cause]
Fuel Flow.[KPIs]

**Articulated, Defined, &
Standardized**



**Scalable Across
Enterprise**



Reduced Information Management Infrastructure

- The “E” in *EMI* is **Enterprise**
 - How many Manufacturing Intelligence applications enable you to spread your ‘intelligence’ across the Enterprise?
- The PI System enables you to scale the EMI Infrastructure across the Enterprise.
 - Replication of solutions/applications/analytics/displays/reports/BI
 - Rollup and Enterprise views
 - Ease of accessibility to information for ALL users
- Reduced ...
 - Cost of Ownership & Maintenance
 - Cost of Curiosity that enables Value Discovery across the Enterprise

Conclusions

- Value from Manufacturing Intelligence (and BI) requires Real-Time Insight
- The PI System fulfills all the required functions of Enterprise Manufacturing Intelligence

“If application vendors succeed in delivering real-time transactional insight with reduced information management infrastructure, it would be a game changer.”

The PI System:

- Delivers real-time information about manufacturing processes
- Gathers and analyzes production data
- Provides role-based visualization
- Reduces the information management infrastructure for EMI



Delivered Value:

- Optimize process performance and manufacturing yields
- Reduce waste
- Improve manufacturing processes
- Identification of best practices
- Respond to exceptions and events
- Game changer!!!



Thank you