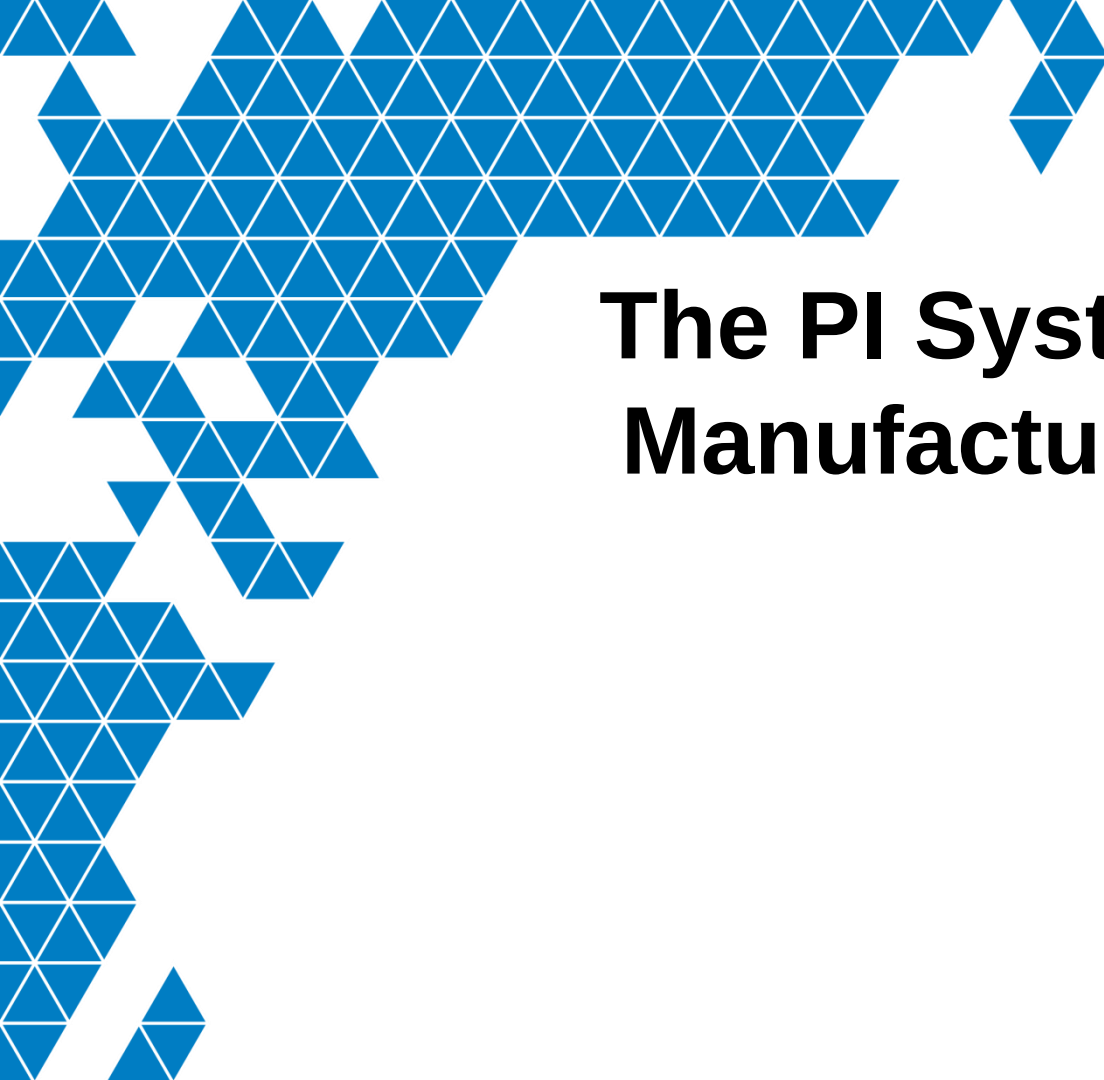




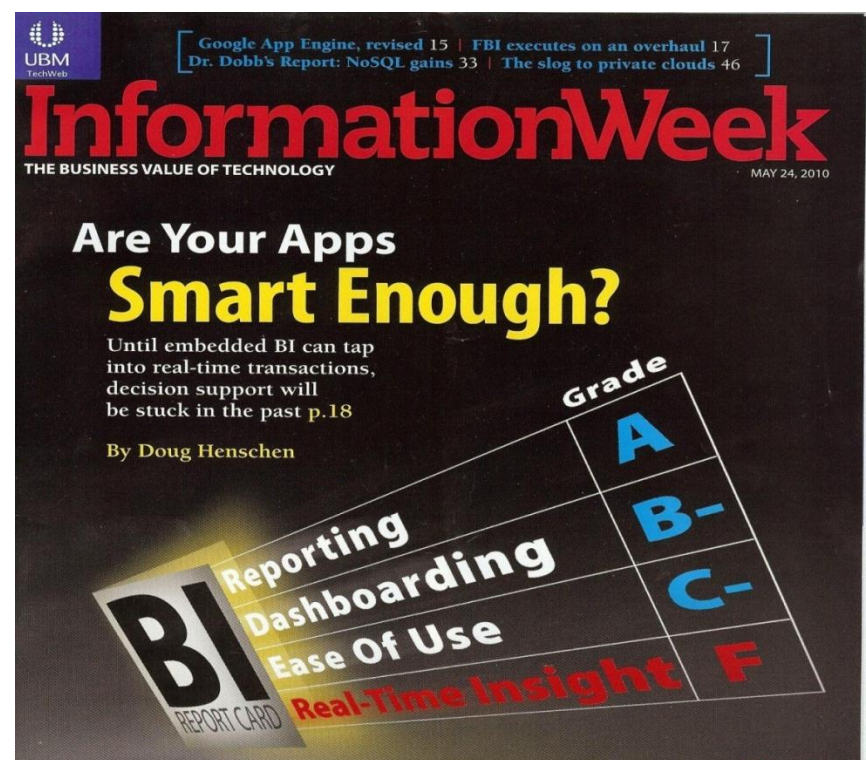
# **The PI System – Enterprise Manufacturing Intelligence Infrastructure**

Presented by  
Curt Hertler

# 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**.”

*Source: Manufacturing Automation*

## 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



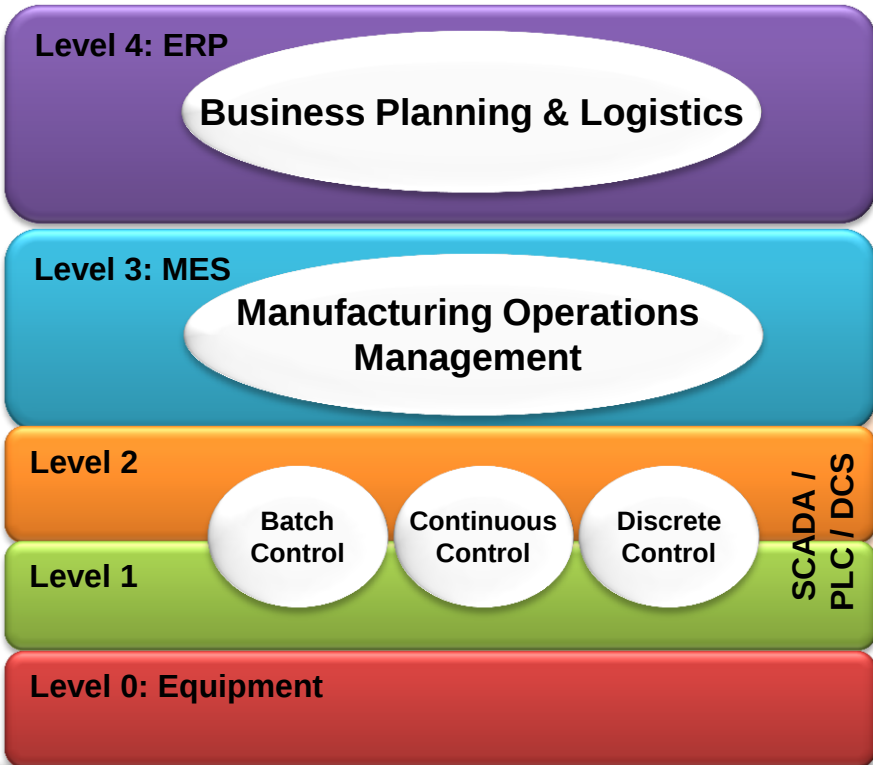
# Core Functions of EMI

- **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.

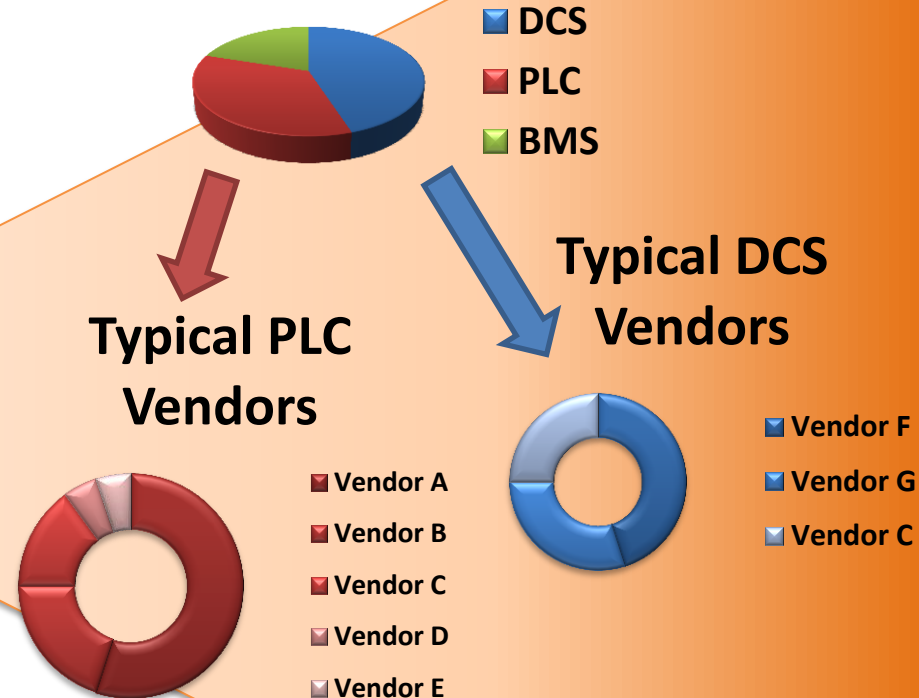
*Source: AMR Research*

# Aggregation – Enterprise Challenges

## ISA S95

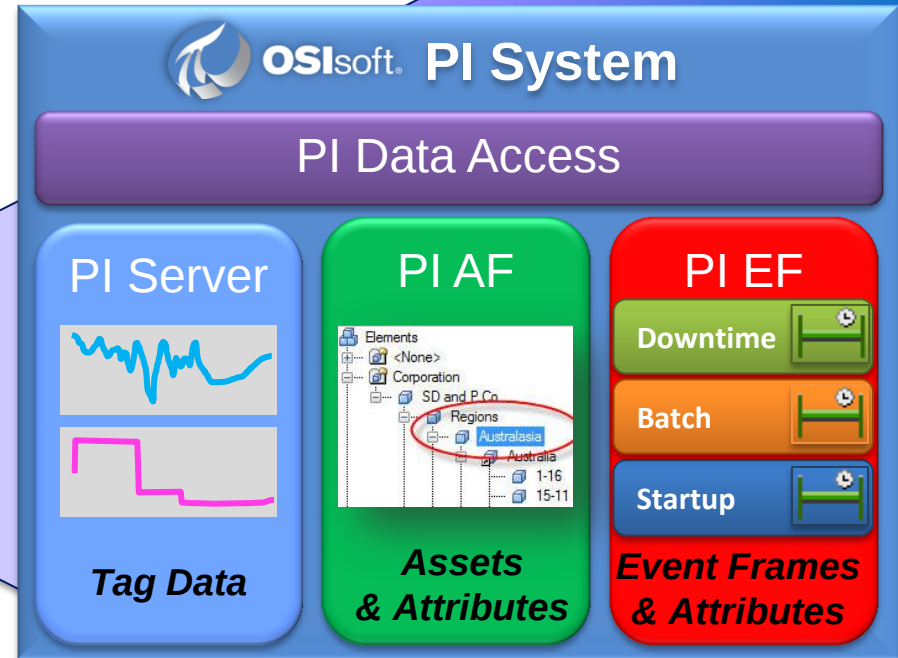
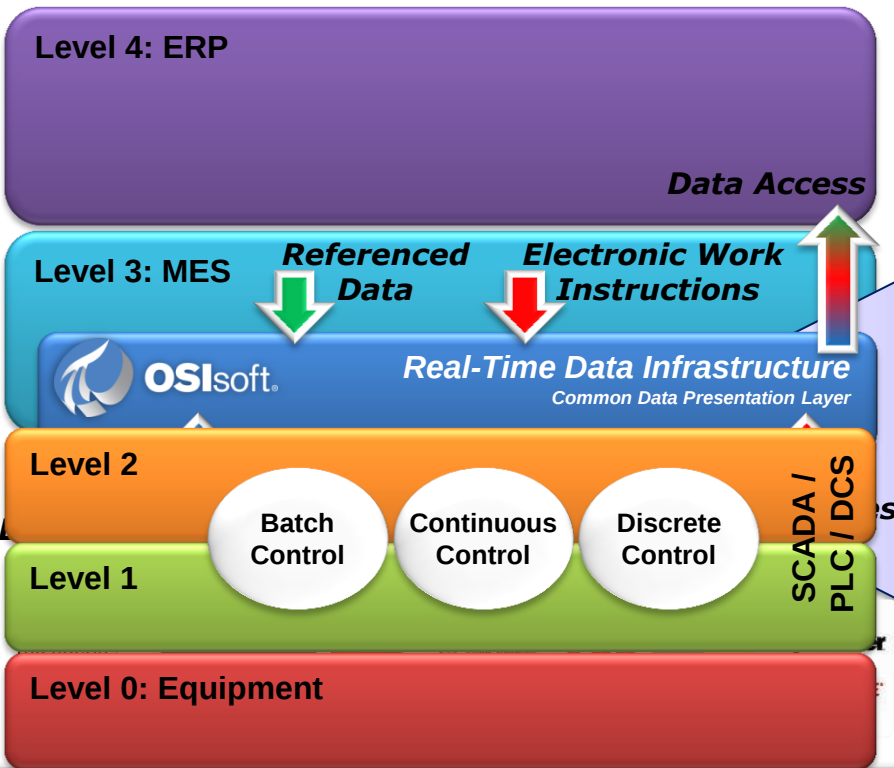


## Variable Process Control System Landscape



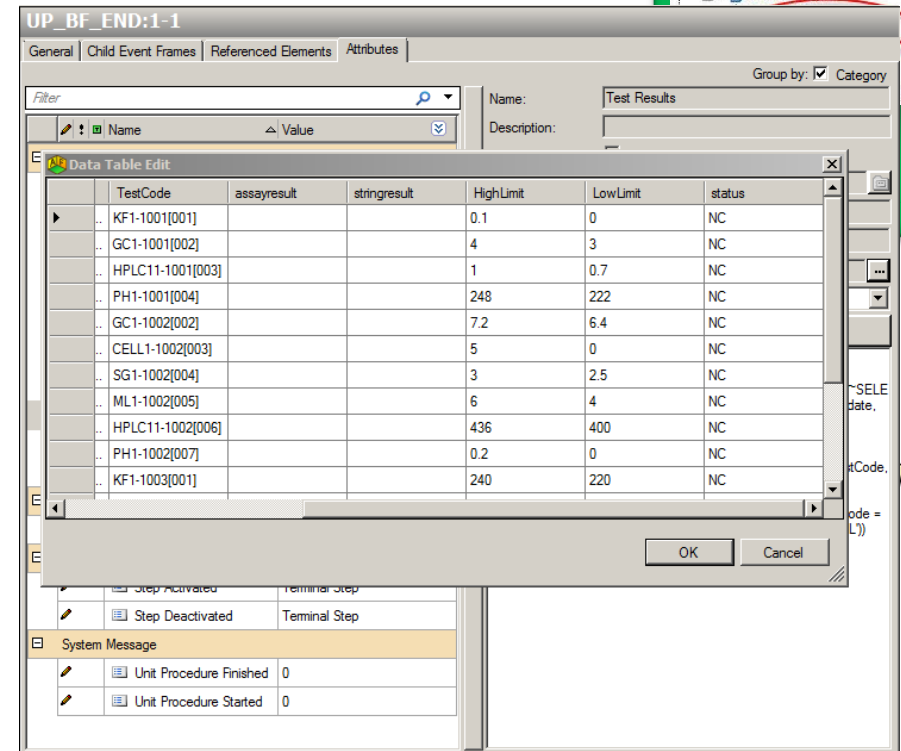
# Aggregation – PI System Data Infrastructure

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.



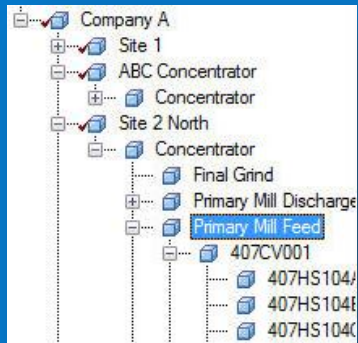
# Contextualization

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

## PI AF

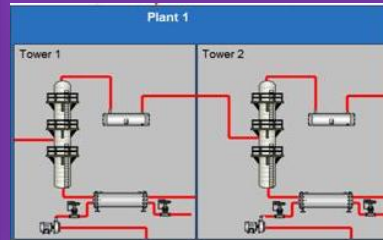


### Physical / Logical



### Element Hierarchy

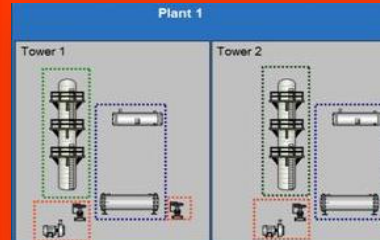
### Process Connectivity



### 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

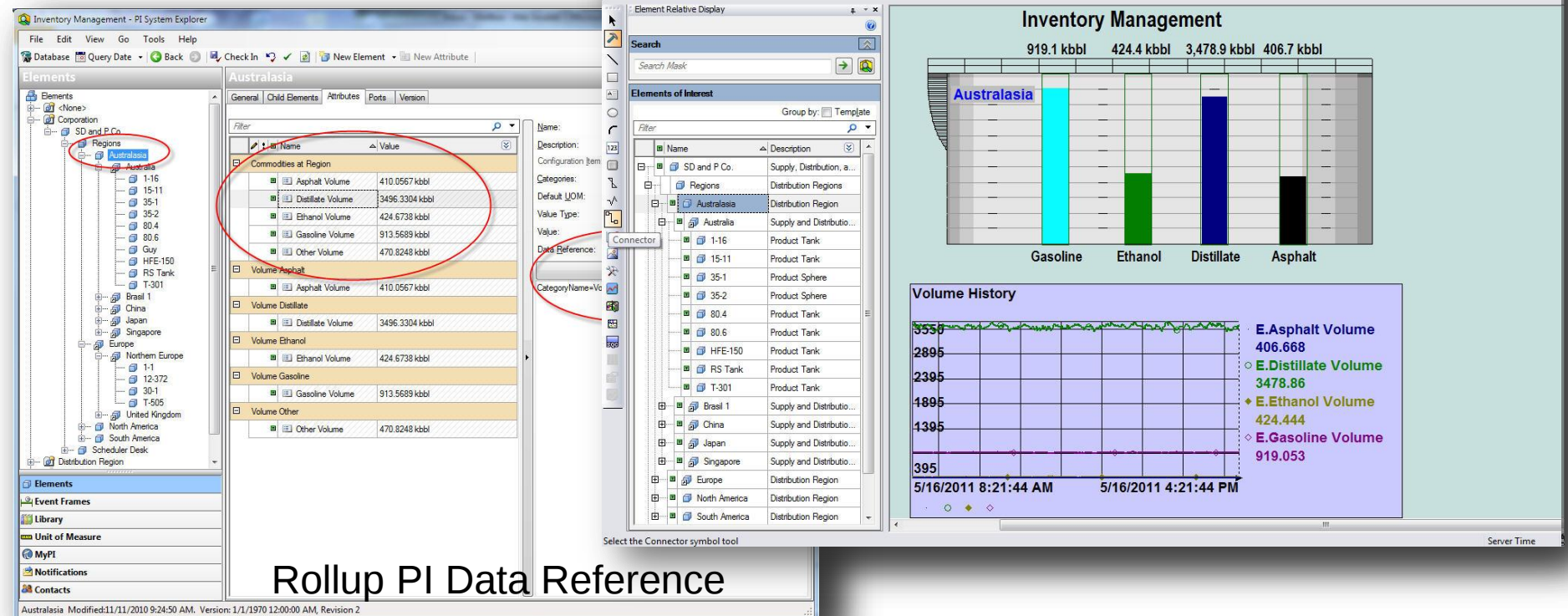
### Associated Info

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

### Attributes

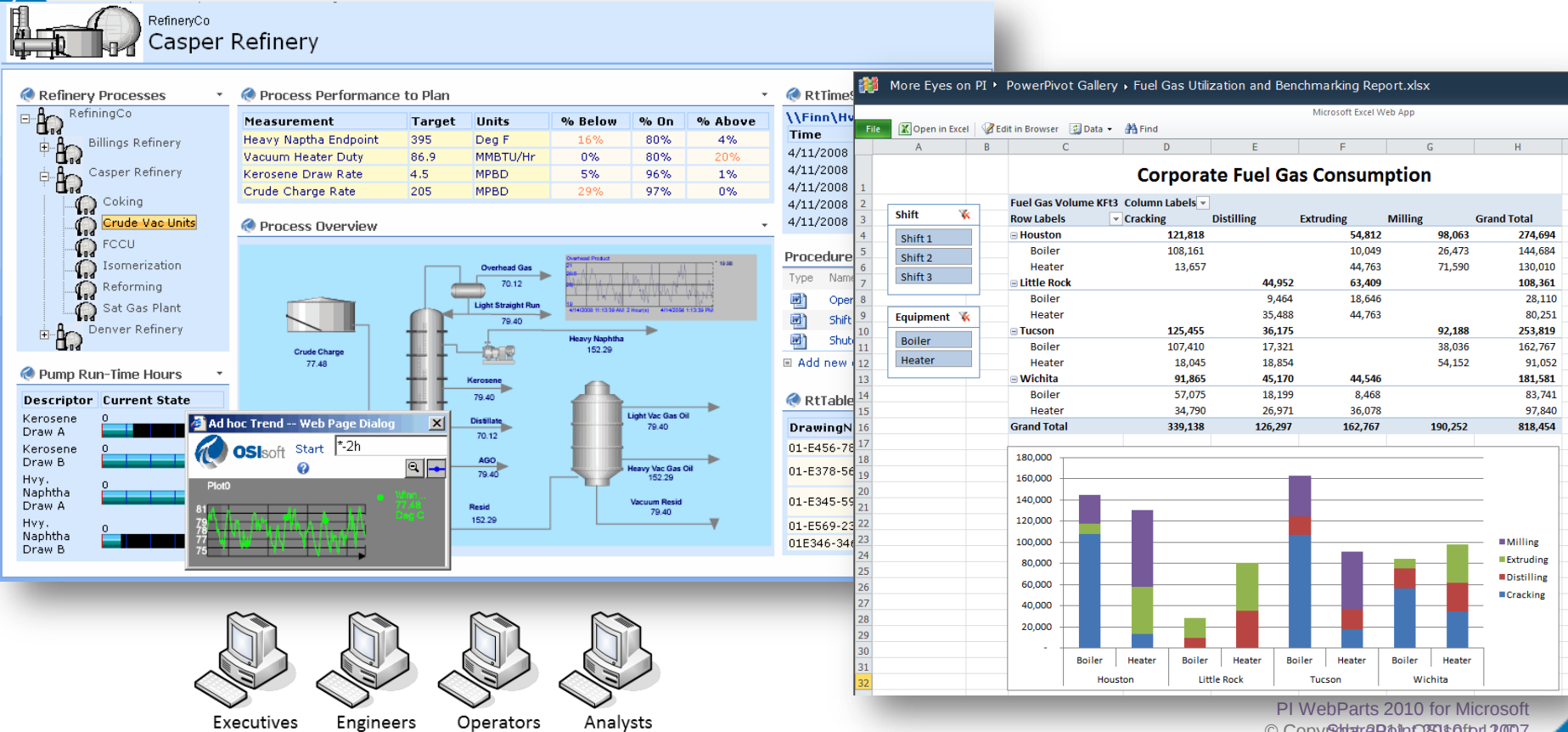
# Analysis

## Inventory – Region Level



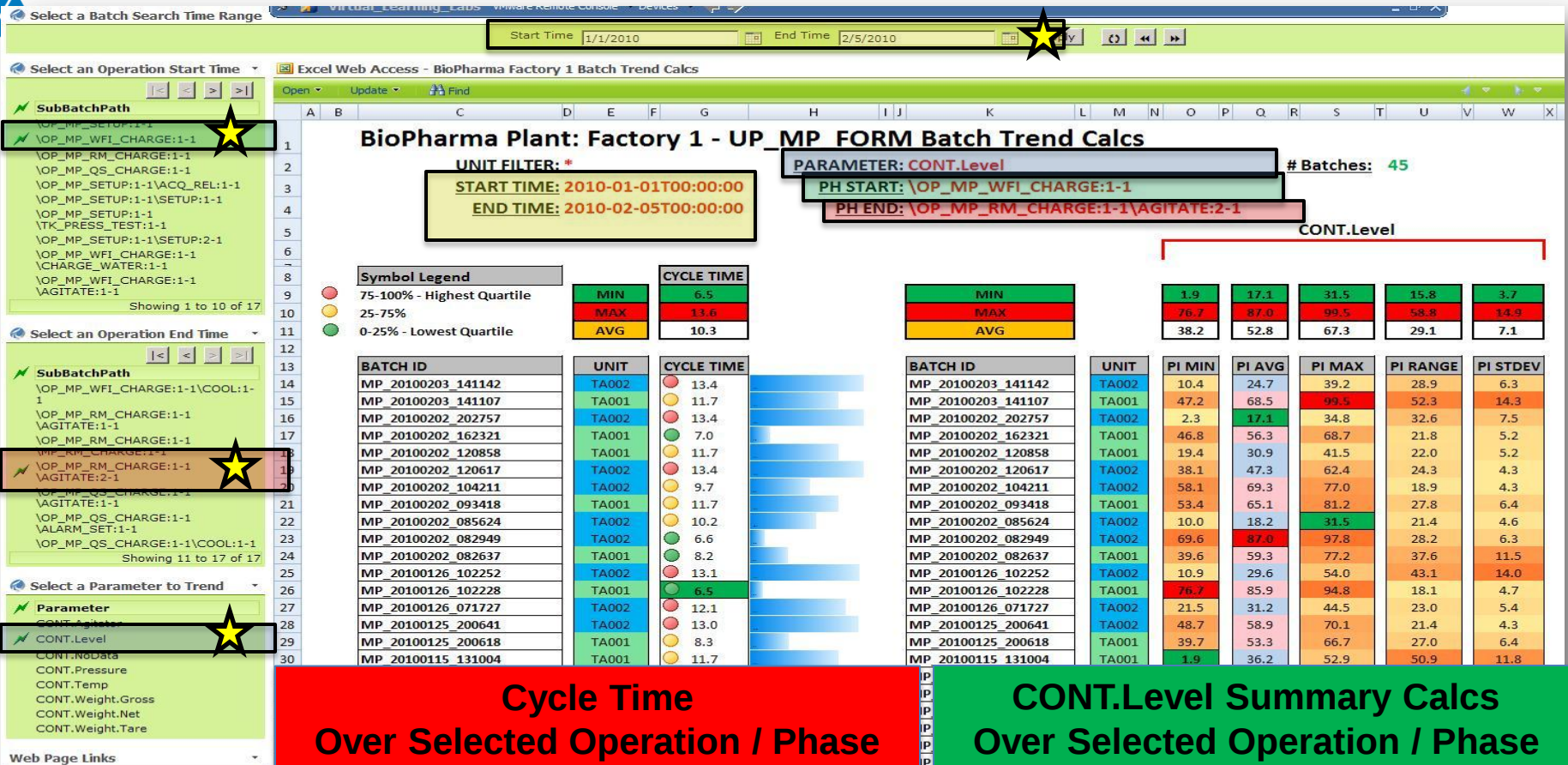
Providing tools to create visual summaries of the data to alert decision makers and call attention to the most important information of the moment.

# Visualization – PI WebParts & Microsoft SharePoint

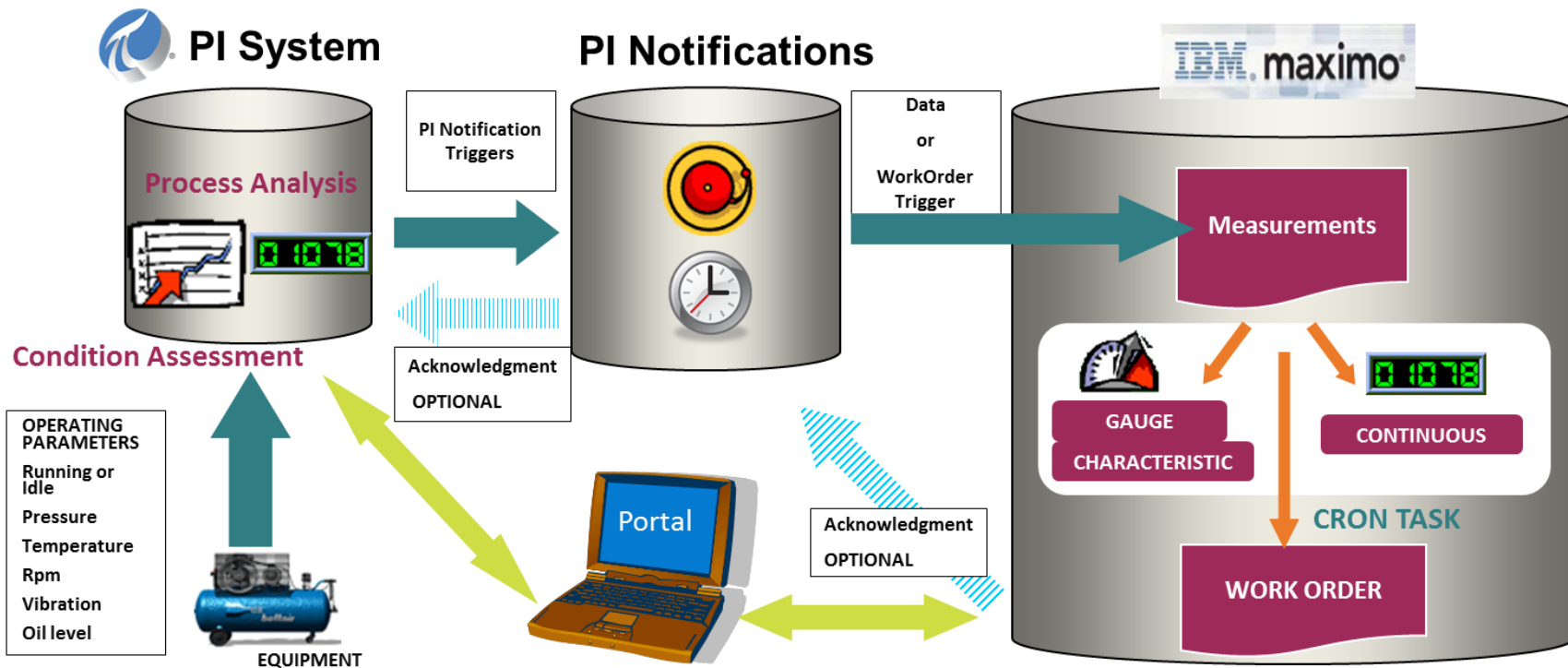


Providing tools to create visual summaries of the data to alert decision makers and call attention to the most important information of the moment.

# 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



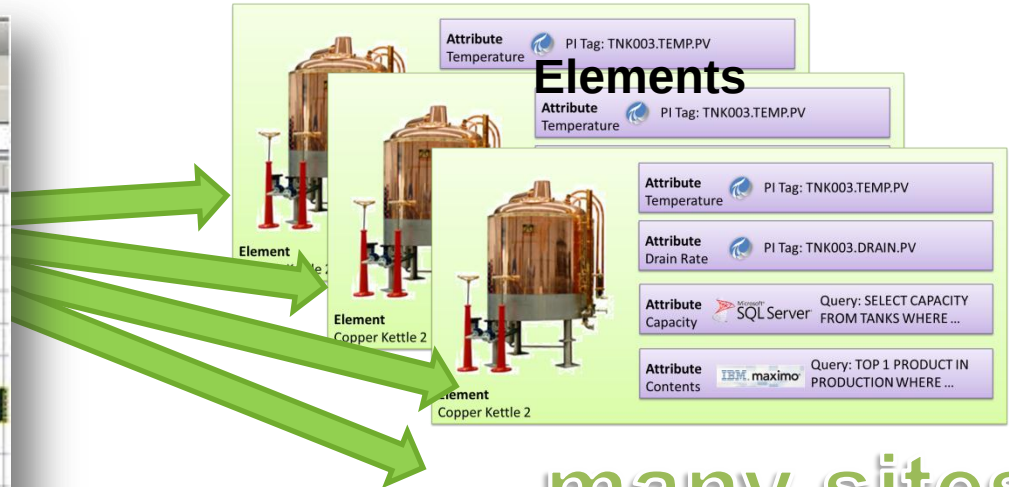
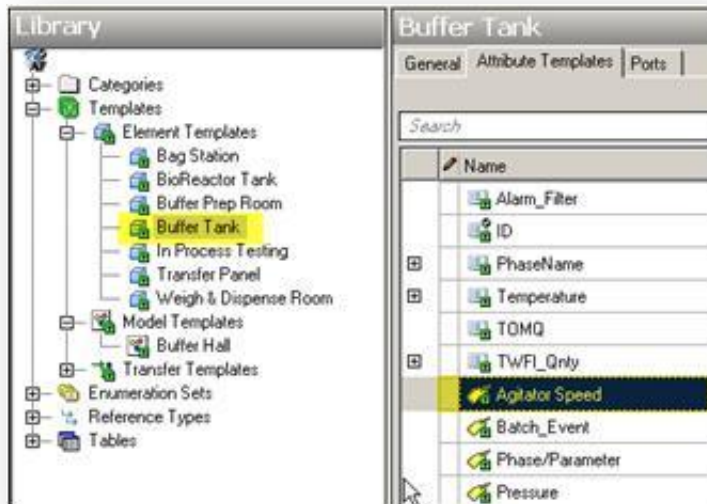
Propagation

- 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 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

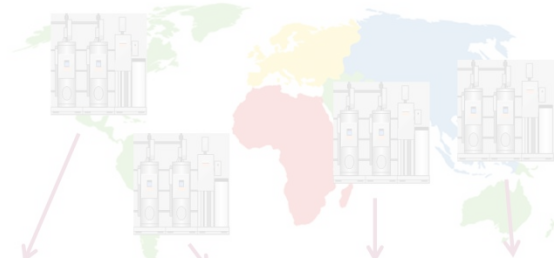
**Event Frame Templates**

| Name                          | Description | Type        |
|-------------------------------|-------------|-------------|
| <b>Bio Equipment Downtime</b> |             |             |
| BioReactor Downtime           |             | Event Frame |
| Incubator Downtime            |             | Event Frame |
| Wave BioReactor Downtime      |             | Event Frame |
| <b>DownTime</b>               |             |             |
| BioReactor Downtime           |             | Event Frame |
| Down Time Template            |             | Event Frame |
| <b>PIBDB Templates</b>        |             |             |
| PI Batch                      |             | Event Frame |
| PI Campaign                   |             | Event Frame |
| PI Sub Batch                  |             | Event Frame |
| PI Unit Batch                 |             | Event Frame |
| <b>PowerPlant Downtime</b>    |             |             |
| Condenser Downtime            |             | Event Frame |
| Gas Turbine Downtime          |             | Event Frame |
| HRSG Downtime                 |             | Event Frame |
| Steam Turbine Downtime        |             | Event Frame |
| <b>S88Batch Templates</b>     |             |             |
| 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 – AF Unit of Measure

Enterprise Companies Work Collaboratively



|                  |                     |                  |                   |
|------------------|---------------------|------------------|-------------------|
| B1:TI333A.p<br>V | \\CalderaA\t<br>emp | TE-BLR-996-<br>R | \\BLR_N\MT<br>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:

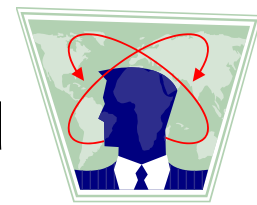
Reference UOM:

Method: ☒ Simple ☐ Formula

Factor:

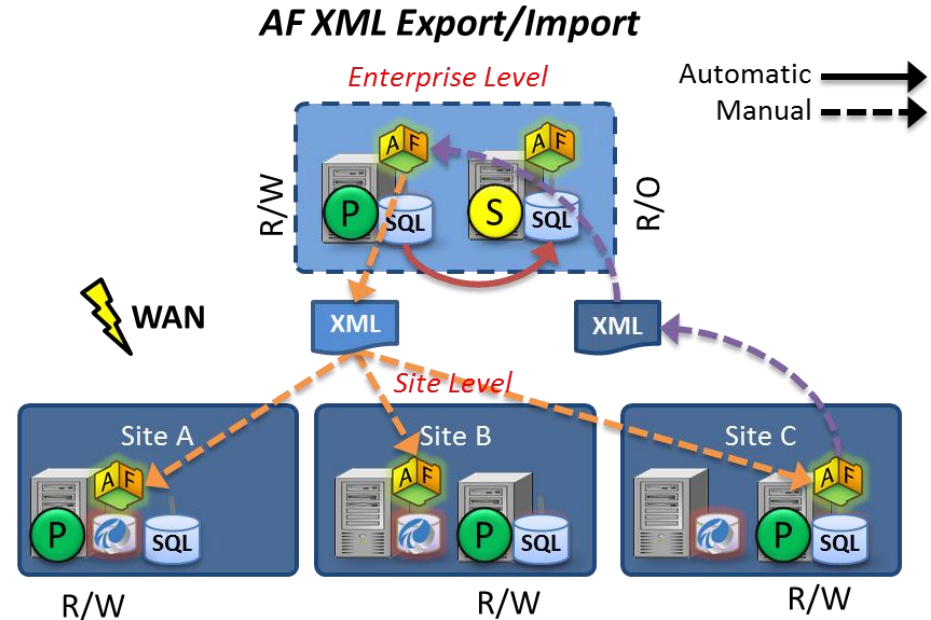
Offset:

# 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*

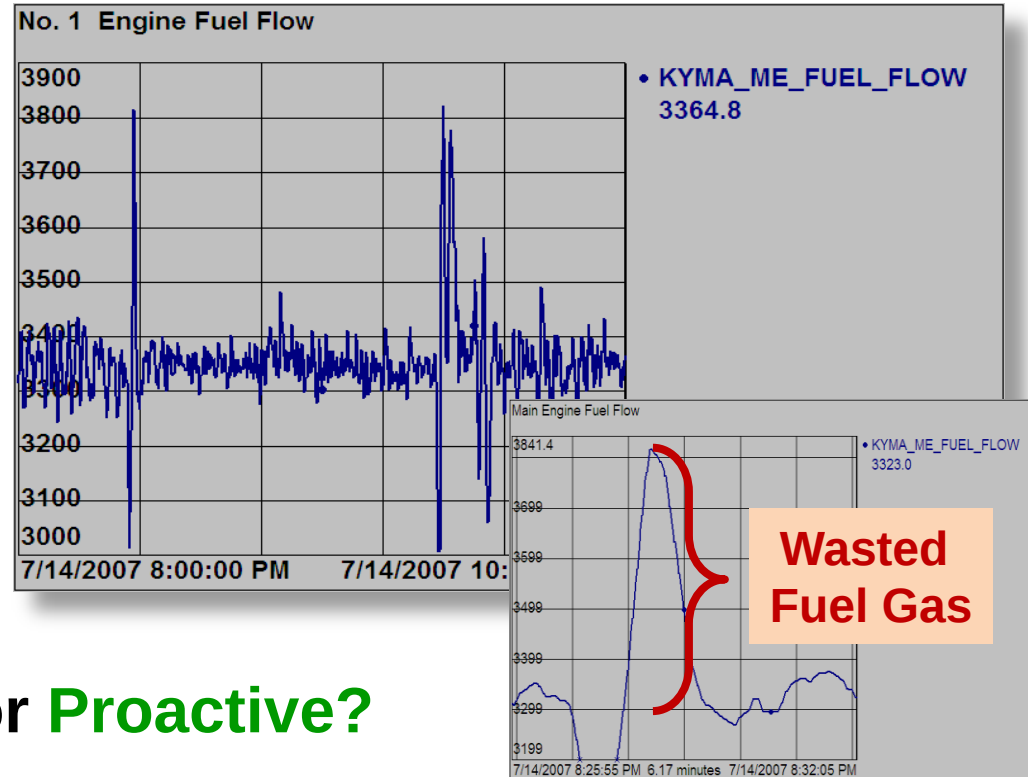


# Infrastructure Approach to EMI

- 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?

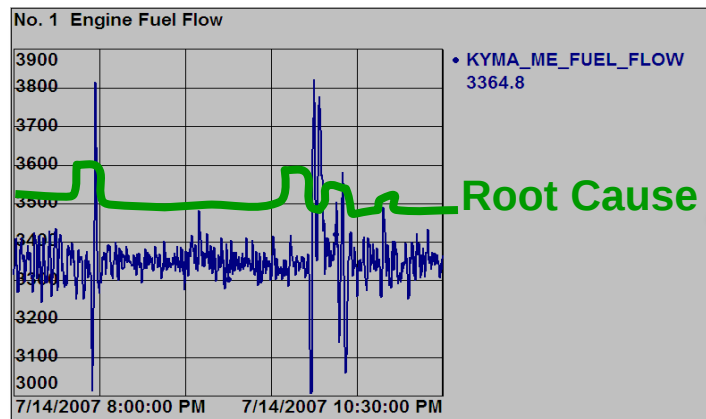
**Reactive** or **Proactive?**

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





**In**

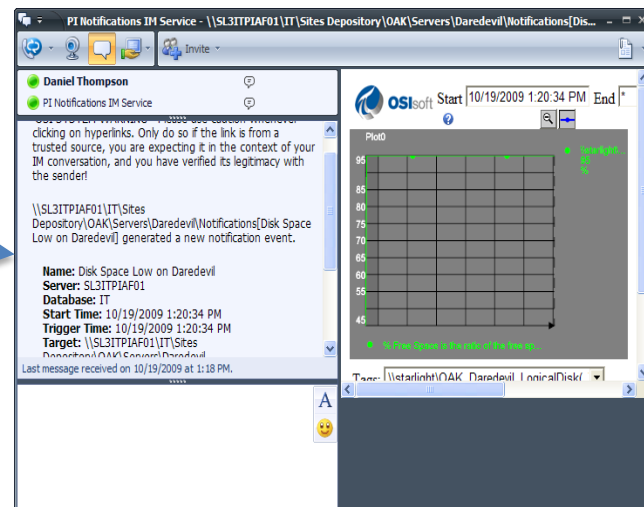
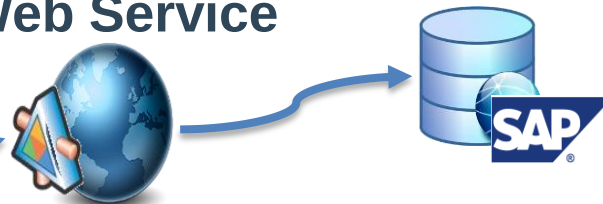


## Root Cause



## PI Notifications

## Web Service

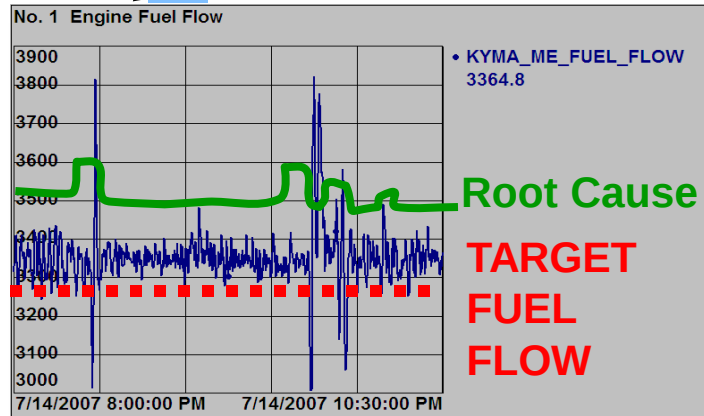


# Reactive or Proactive?

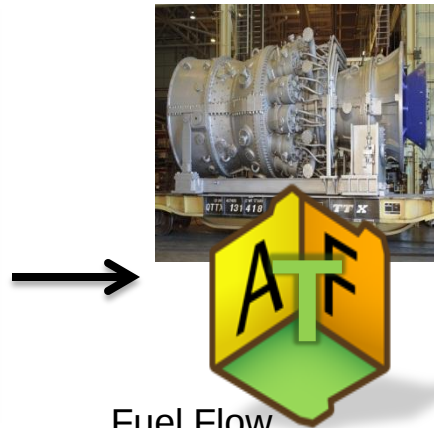
# Infrastructure Approach to EMI



*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