

REAL-TIME PERFORMANCE MANAGEMENT FOR THE ENTERPRISE

**RtPM**



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**RtPM**

# Foundation

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# Survey the Audience



# Question 1

- What was the score when you left the baseball game last night?
  - 2 - 1
  - 4 - 1
  - 6 - 1
  - 8 - 1
  - What game?



# Question 2

- If you build displays or spreadsheets, how many PI servers do they connect to?
  - 1
  - 2
  - 3
  - 4
  - 5
  - More than 5

# Question 3

- Do you build applications using RtPM?:
  - Yes, through programming
  - Yes, through configuration
  - Yes, with both programming and configuration
  - I don't build applications



# Question 4

- When I build RtPM applications, I most frequently use:
  - Performance Equations and Totalizers
  - Advanced Computing Engine (ACE)
  - ProcessBook and VBA
  - DataLink (Excel)
  - AF Analysis Rules



# Last Question

- Do you link PI data to non-PI data today?
  - Yes, through ODBC DataSets in ProcessBook
  - Yes, through RtWebParts and RtBaseline Services
  - Yes, using PI OLEDB within SQL Server or Oracle
  - No
  - I want to, but I'm not sure how





# Results?

We will revisit the survey at the conclusion



# Outline

- Architecture
- Motivation
- Foundation solution approach
- Business solution example
- Summary

# What We Want You to Know

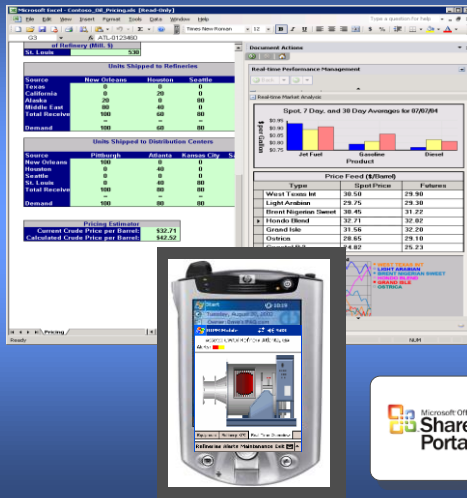
**An evolution of RtPM platform to help you provide more value from PI**

- Foundation is a configurable:
  - Logical enterprise asset model
    - Include relationships between the assets
  - Way to organize and access all data, whether stored in PI or not
- Foundation:
  - Facilitates agile, incremental projects
  - Extends reach of RtPM-based solutions to include external assets and data



# RtPM Platform Functional Description

## RtPortal



OSIsoft  
ProcessBook

Microsoft  
Office

OSIsoft  
DataLink

Microsoft  
SharePoint  
Portal Server 2003

Live Communications  
Server 2005

MapPoint WebService

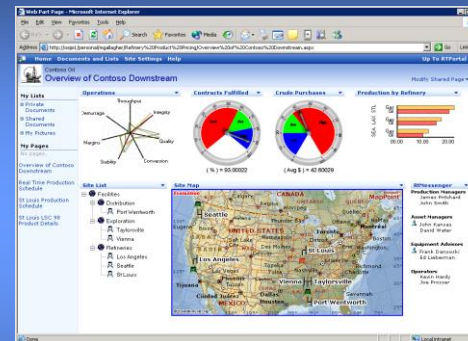
## RtAnalytics

Microsoft  
Visual Studio .net

OSIsoft  
ACE

SQL Server  
Analysis /BI

OSIsoft  
Sigmafine



## RtBaseline

### Foundation

Unified Aggregation for Time Series and Non Time Series Data  
Public Service Oriented Architecture

Microsoft  
.net

Enterprise Level

A single, unified  
data collection,  
reference, and  
storage platform

Microsoft  
Windows Server 2003



DATA INTEGRATION

Microsoft  
SQL Server 2000

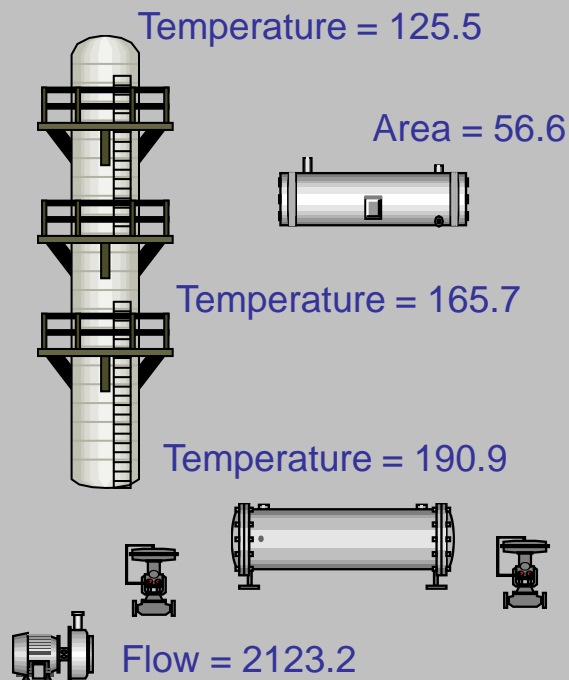
Real-time Data and Events

Context Database

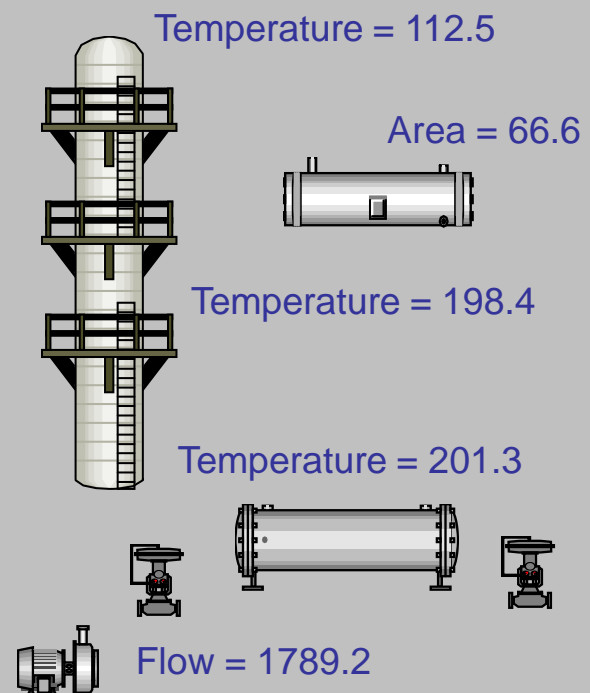
# Organizing a variety of data in a way that helps you solve problems

## Plant 1

### Tower 1



### Tower 2



# Motivations for Foundation

- PI System Scalability
- Context
- Foreign Data
- Logical Asset Model
- External Asset Models
- Unification of Data



# Motivation: Scalability

- PI scales to over 4 million points
  - This represents a huge accomplishment
  - Users can expand application of PI
  - Track more processes
  - Track more information about processes
- However:
  - How do you organize points?
  - How do you find information?
  - Do supporting functions scale accordingly?
    - Batch Database
    - Asset Database
  - How is this information ***put into context*** ?



# Motivation: Context

- A working definition of context:

*The set of information needed to define an appropriate subset of data from all available data to solve a business problem.*





# Motivation: Context

- A working definition of context:

*The set of information needed to define an appropriate subset of data from all available data to solve a business problem.*

- For a trivial problem, context may be simple
  - What was the temperature over the last shift?



# Motivation: Context

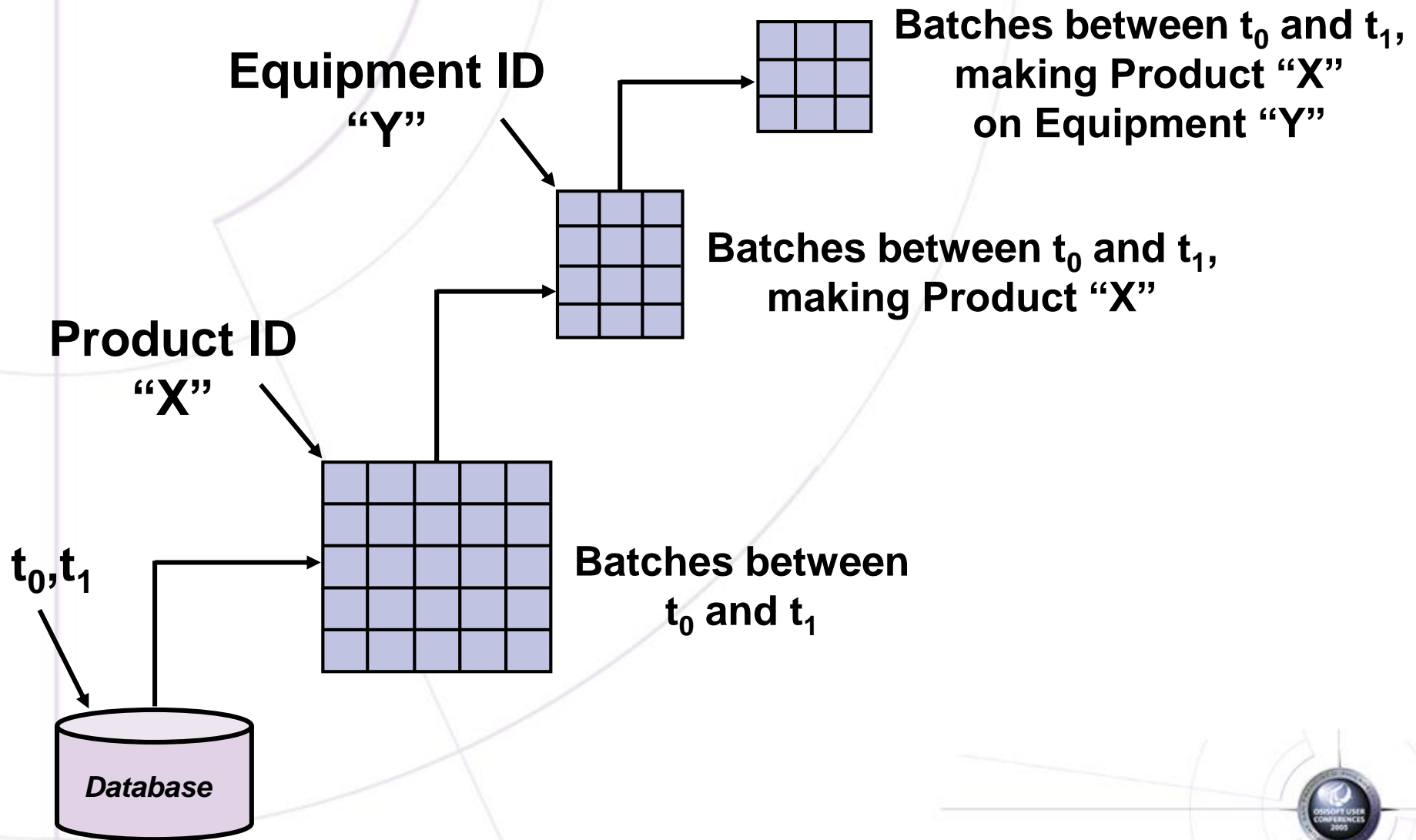
- A working definition of context:

*The set of information needed to define an appropriate subset of data from all available data to solve a business problem*

- For a simple problem, context may be simple
  - What was the temperature over the last shift?
- For a difficult problem, context might be significant and come from a variety of sources
  - Are we scrapping product “X” because of inadequate training of lab technicians?
    - Requires HR and LIMS data



# Applying Context



# Motivation: Data from Other Systems

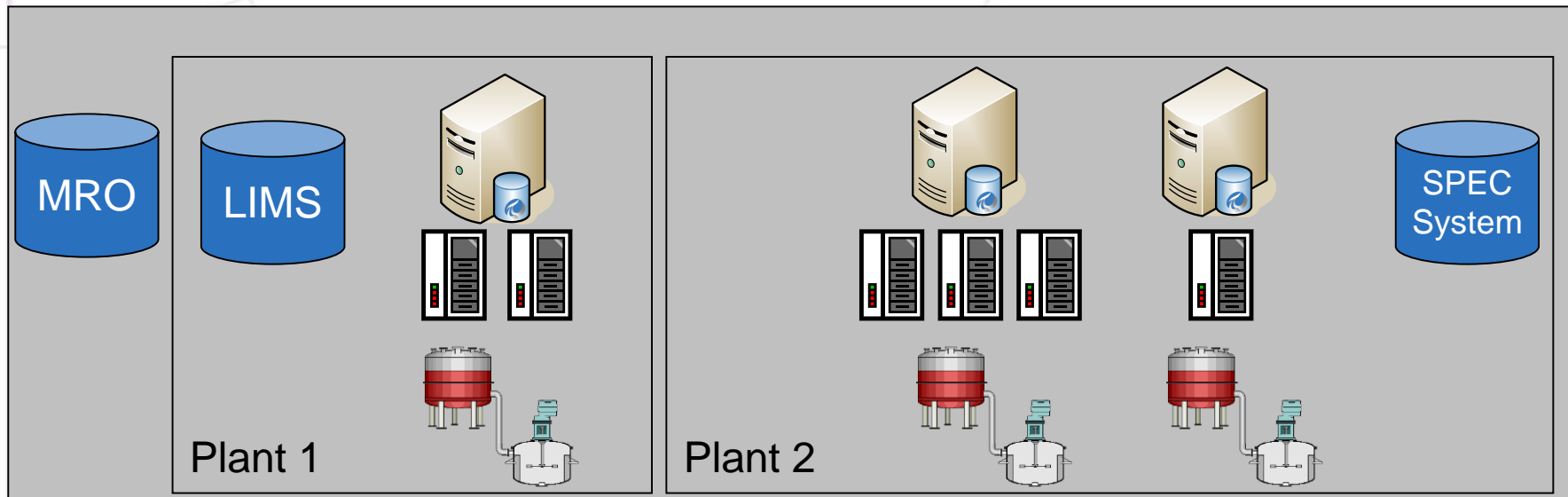
**Leveraging non-time series data provides value**

- ERP – HR
- ERP – Inventory
- Asset Management
- MES
- LIMS
- ProcessPoint
- Document Management
- Planning
- Inventory Management
- Supply Chain
- Other
  - Bill of Lading, Batches (e.g. from PI Batch)



# Motivation: System Data Model

- Model of the Data in the systems
- Focuses on where the data is stored within systems
  - What application server stores the data?
  - How does the application server store it?



# Motivation: System Data Model

- System data model
  - How does the application retrieve the data?
    - Such as:
      - `\\north_pisvr\tmp125.hh`
    - Or:
      - `select value from limit where fkAttr in (select pk from attribute where name like 'temperature%' and limitttype = 3)`
  - An understanding of all necessary data access methods is required



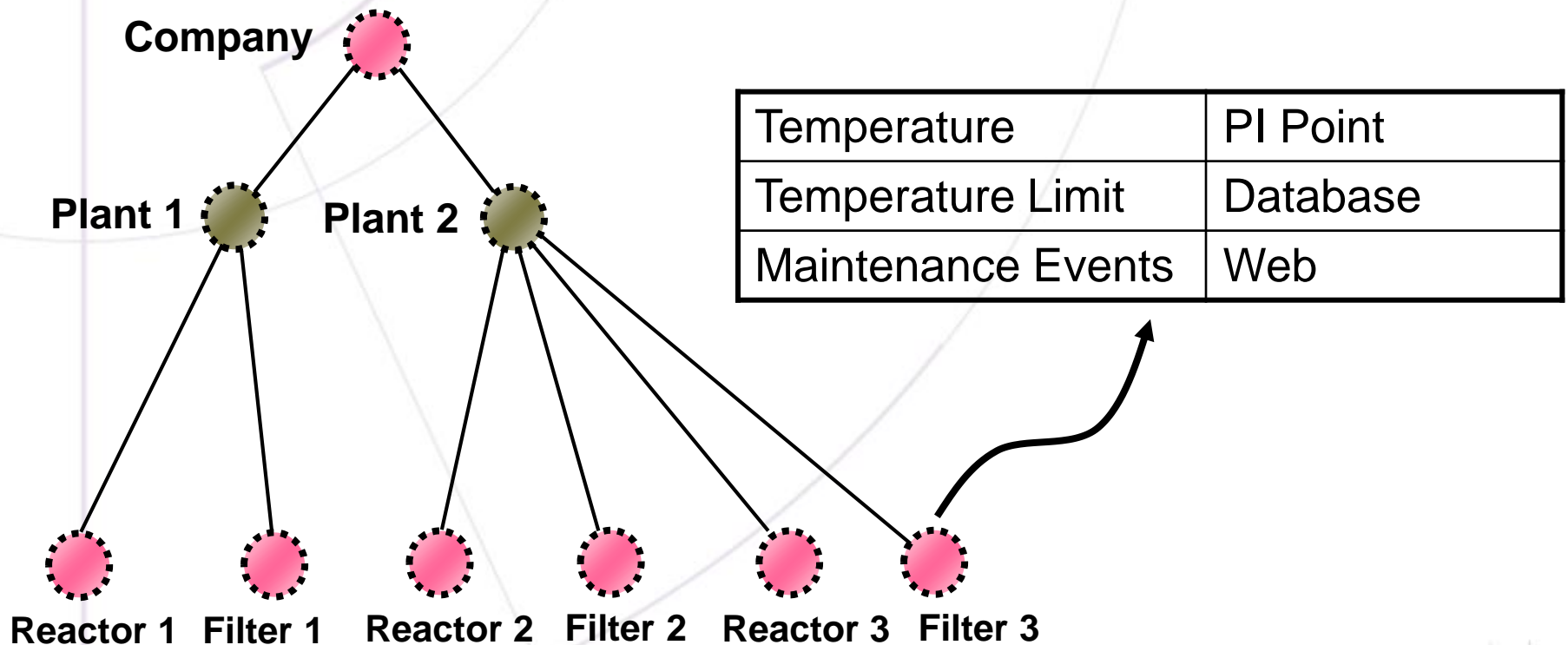
# Motivation: Logical Data Model

- Asset model
  - Assets are representations of physical resources
  - Allows association of data with a physical resource
    - To which tank is a level measurement logically associated?
  - For example:
    - **Plant1.Reactor1.Temperature.HighLimit**
  - An understanding of the process is required



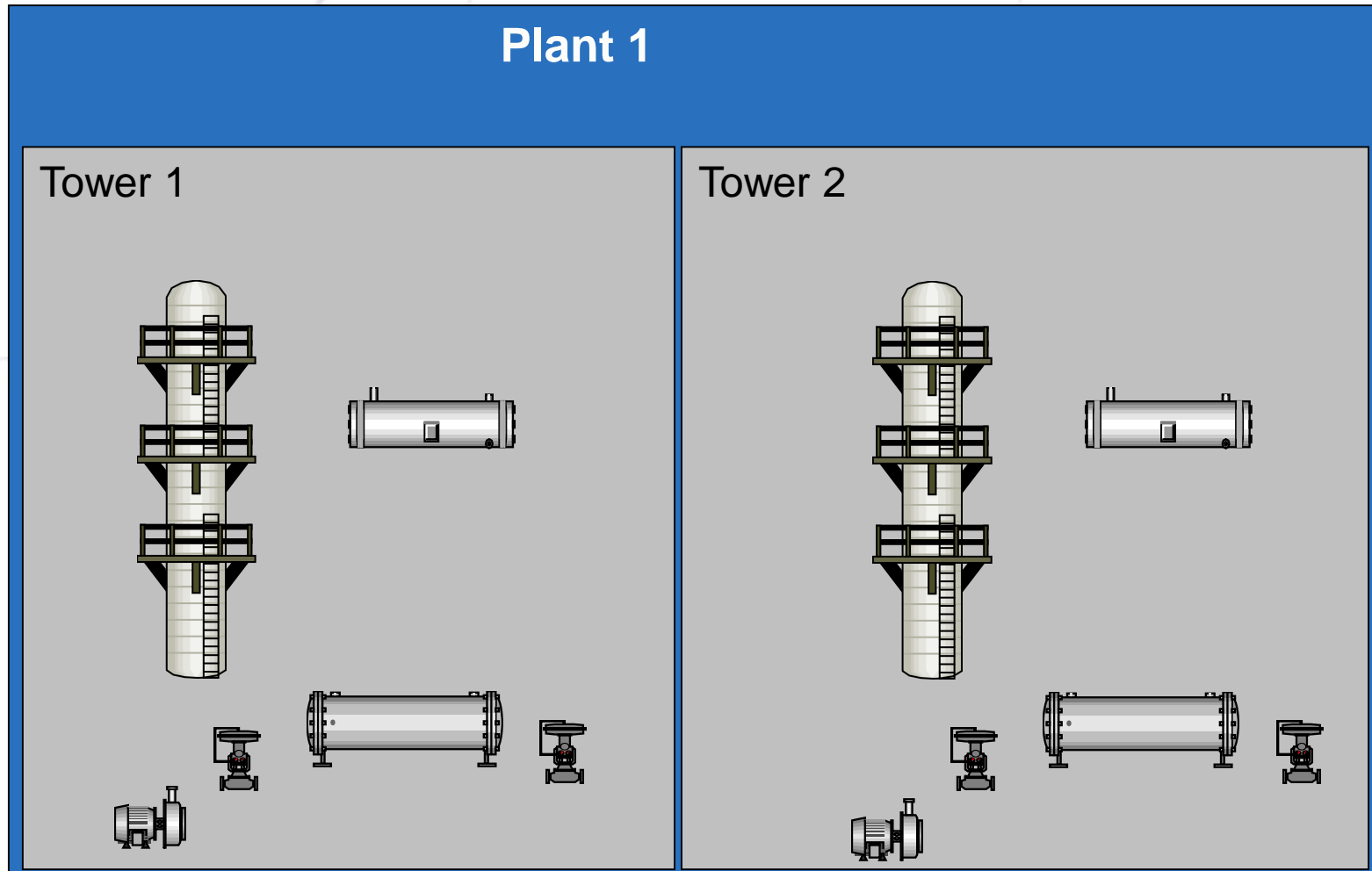
# Motivation: Logical Data Model

- A logical representation of physical assets



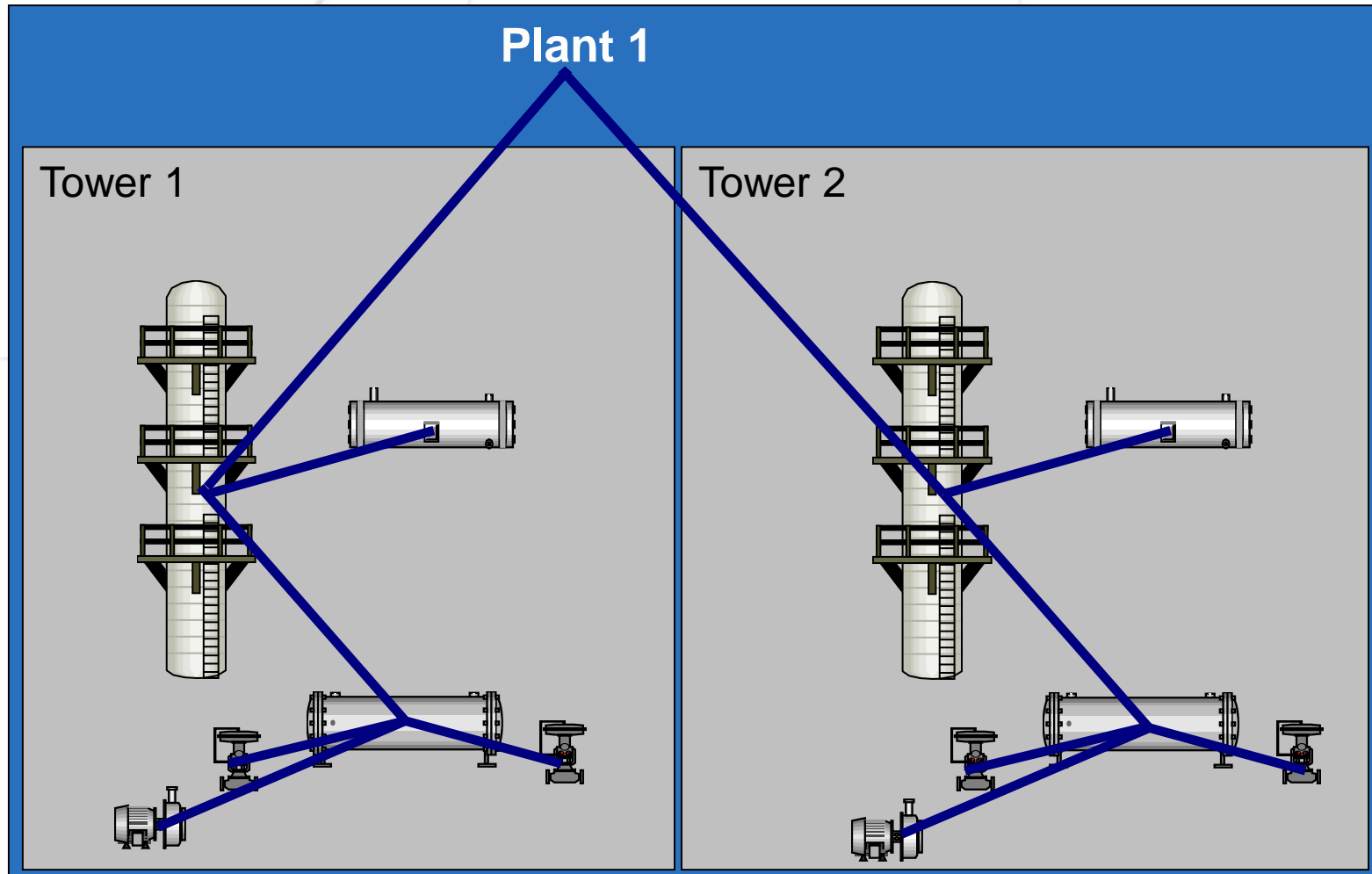


# Flexible Asset Model



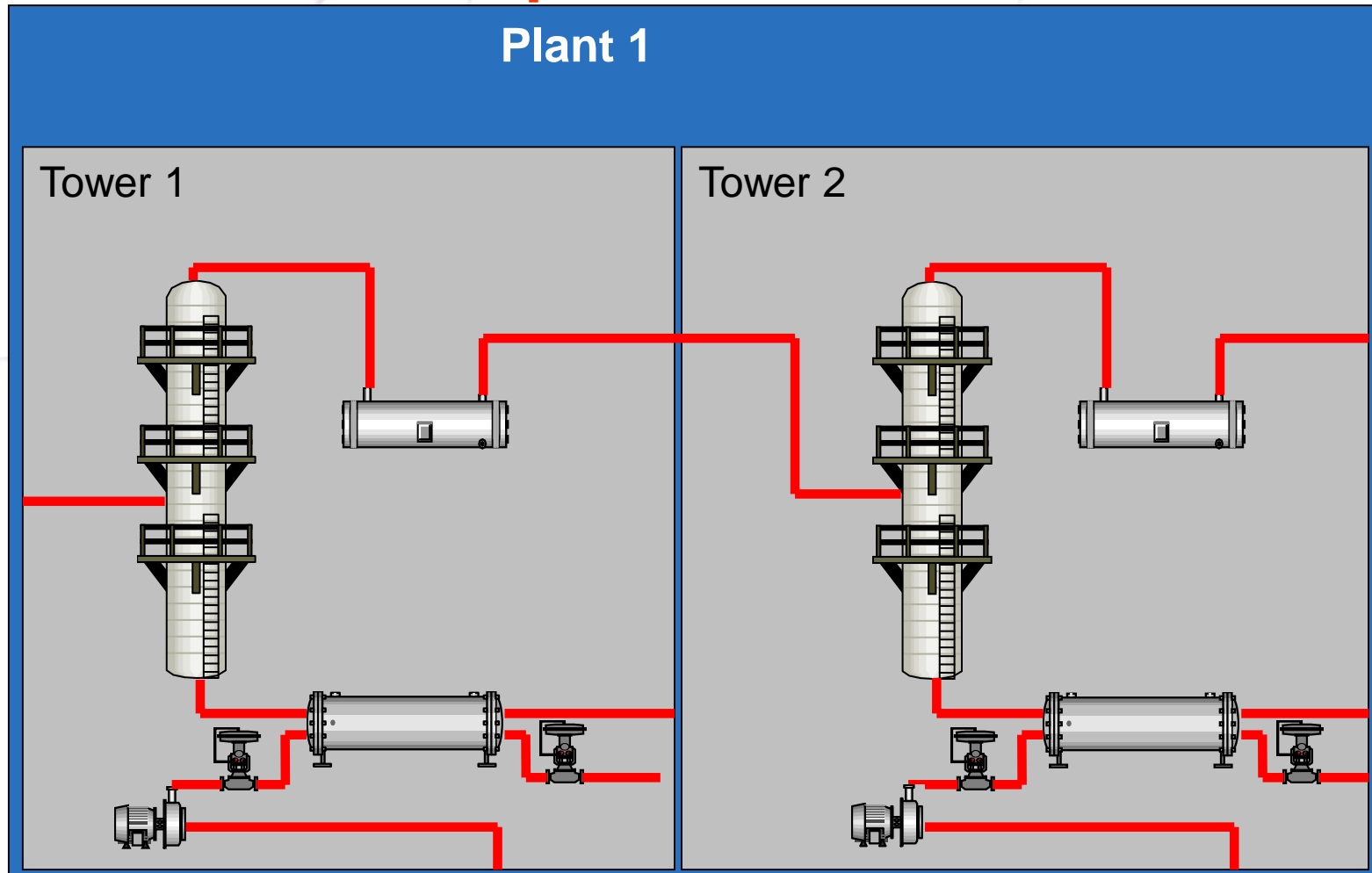
# Flexible Asset Model

## Hierarchical Relationships



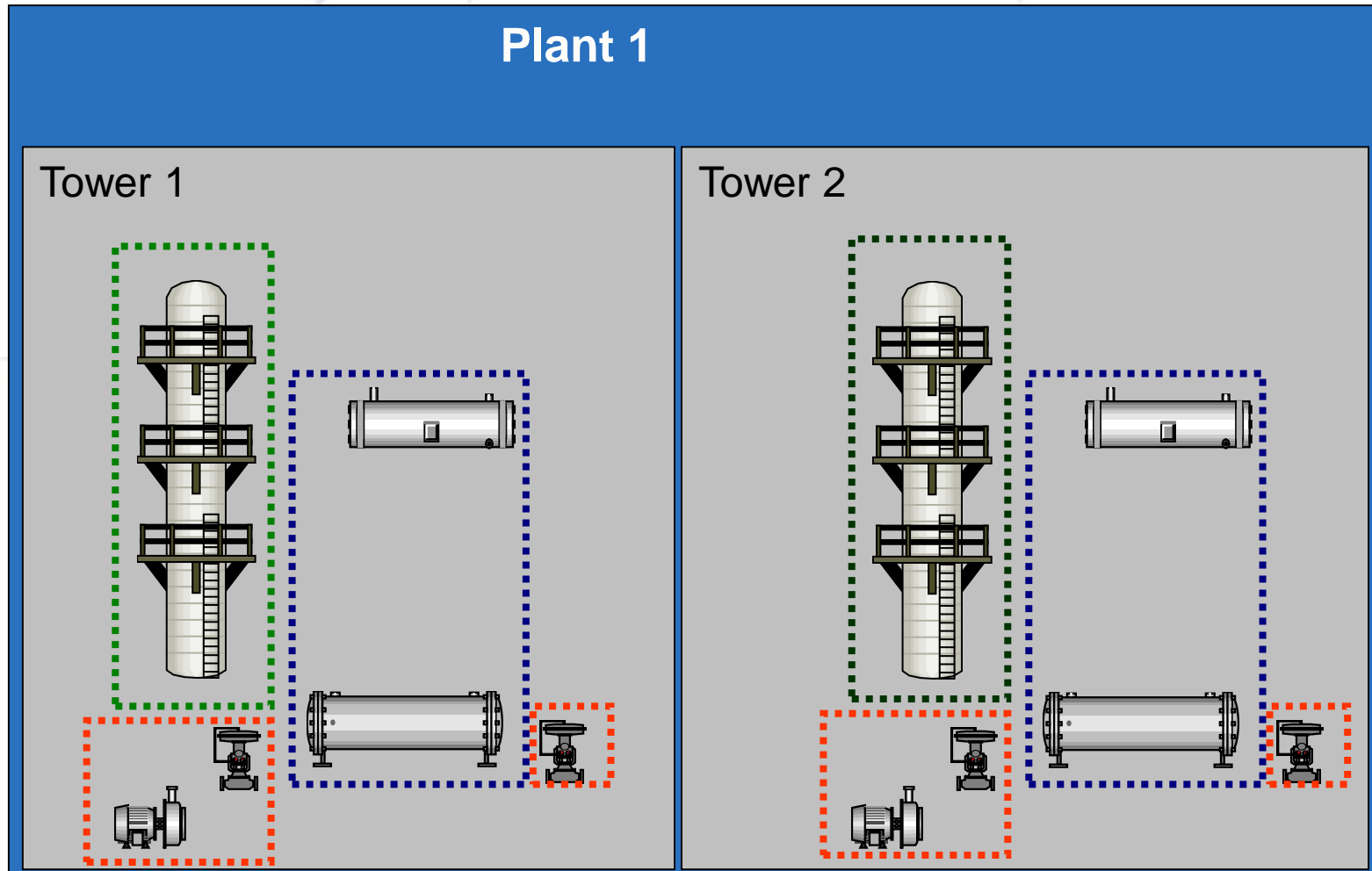
# Flexible Asset Model

## Flow Relationships



# Flexible Asset Model

## Role Relationships



# Foundation Is:

- A logical enterprise asset model
- Relationships between the assets
- Associations to
  - Data we own
  - Data we don't own



# Foundation Is:

- A logical enterprise asset model
- Relationships between the assets
- Associations to
  - Data we own
  - Data we don't own
- Includes powerful tools to enable creation of business solutions
- Visibility and exposure throughout our product line
- A way of achieving “one version of the truth”



# Motivation: Evolution of Existing Technologies

- OSIssoft has experience at creating asset models
  - Analysis Framework
    - Flow relationships
    - Strongly typed templates
    - Data references
  - Module Database
    - Hierarchical relationships
    - History
    - Flexible modeling



# Motivation: Evolution of Existing Technologies

- Merging and extending to an enterprise asset model
- Doing this in a way that protects your investment
  - Your data will be migrated
  - Your code will still run against existing SDKs
  - You can choose when to use Foundation





# Motivation: External Asset Models

- Other asset databases exist
  - SAP
  - Oracle/PeopleSoft/JD Edwards
  - MRO Maximo
- Each has a logical representation of physical assets
- Any of these may be authoritative in different locations



# Motivation: External Asset Models

- Standards exist to facilitate data exchange between asset databases
  - MIMOSA
    - Model of physical equipment
  - ISA S95
    - Model of information systems interaction
  - Both specify XML schema for exchange of data with other systems
- Moving XML documents not difficult
  - MS BizTalk, SAP XI, Vitria, etc.



# Motivation: External Asset Models

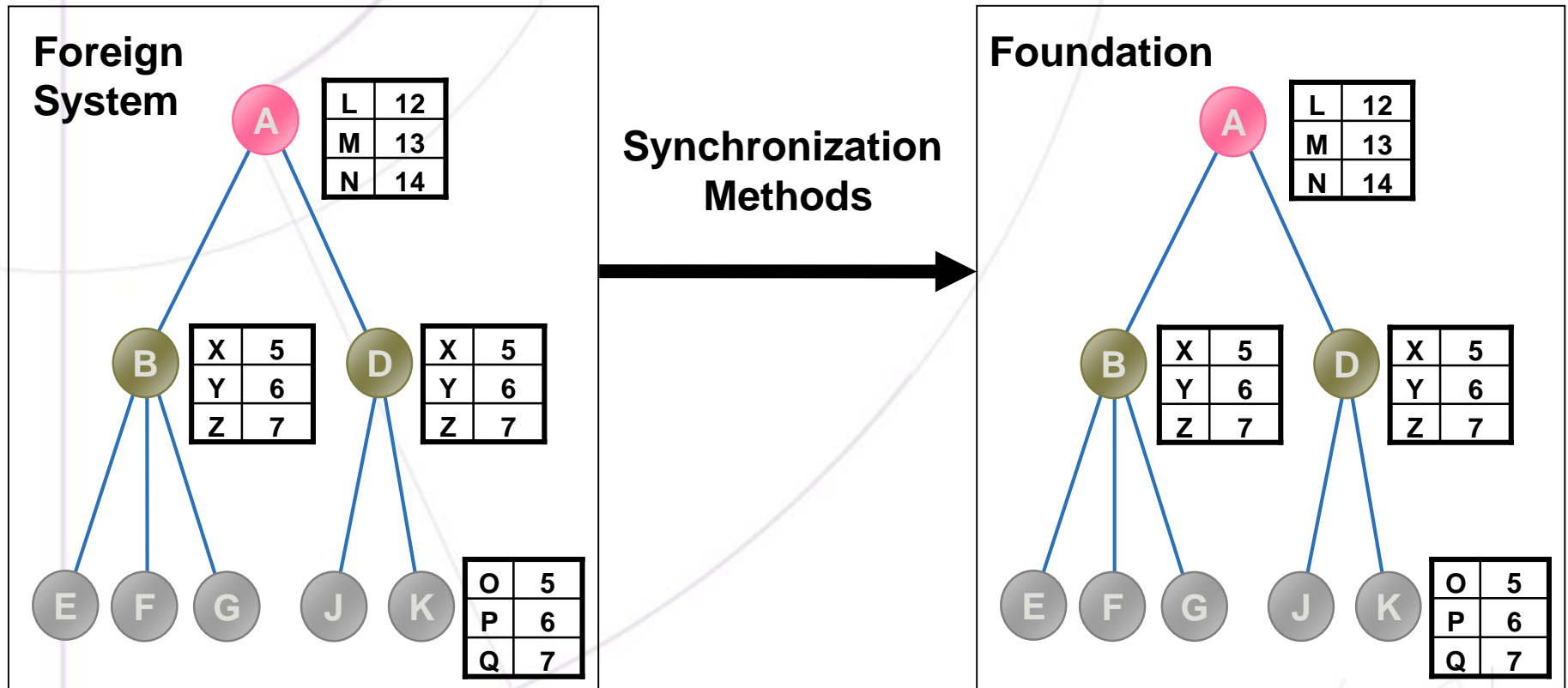
**OSIsoft has a history of supporting standards**

- OPC DA
- OPC HDA
- DDE
- ODBC
- OLE DB
- XML
- HTML
- SVG



# Goal: Asset Synchronization

- Either by XML data exchange or real-time mapping



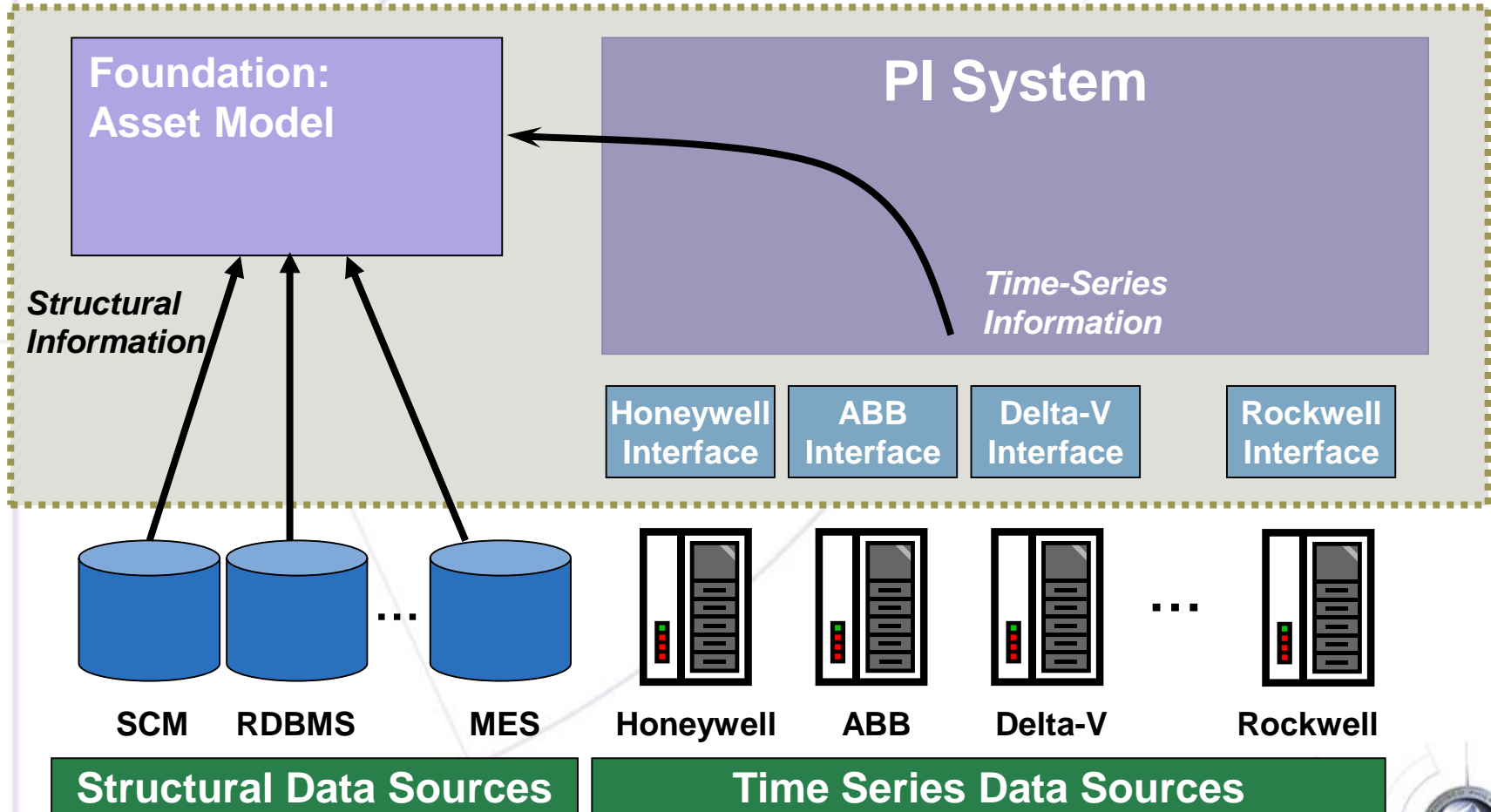
# Motivation: Data Integration

- Current capability:
  - Organize time-series data into an asset model
- Evolving to support:
  - Organize foreign and structured data into an asset model
  - Define and organize complex data
    - Row Sets
    - Structures
    - XML Documents
  - Synchronize from an asset model in a foreign system
  - Reference all data via the asset names



# Motivation: Unification of Data

## RtBaseline

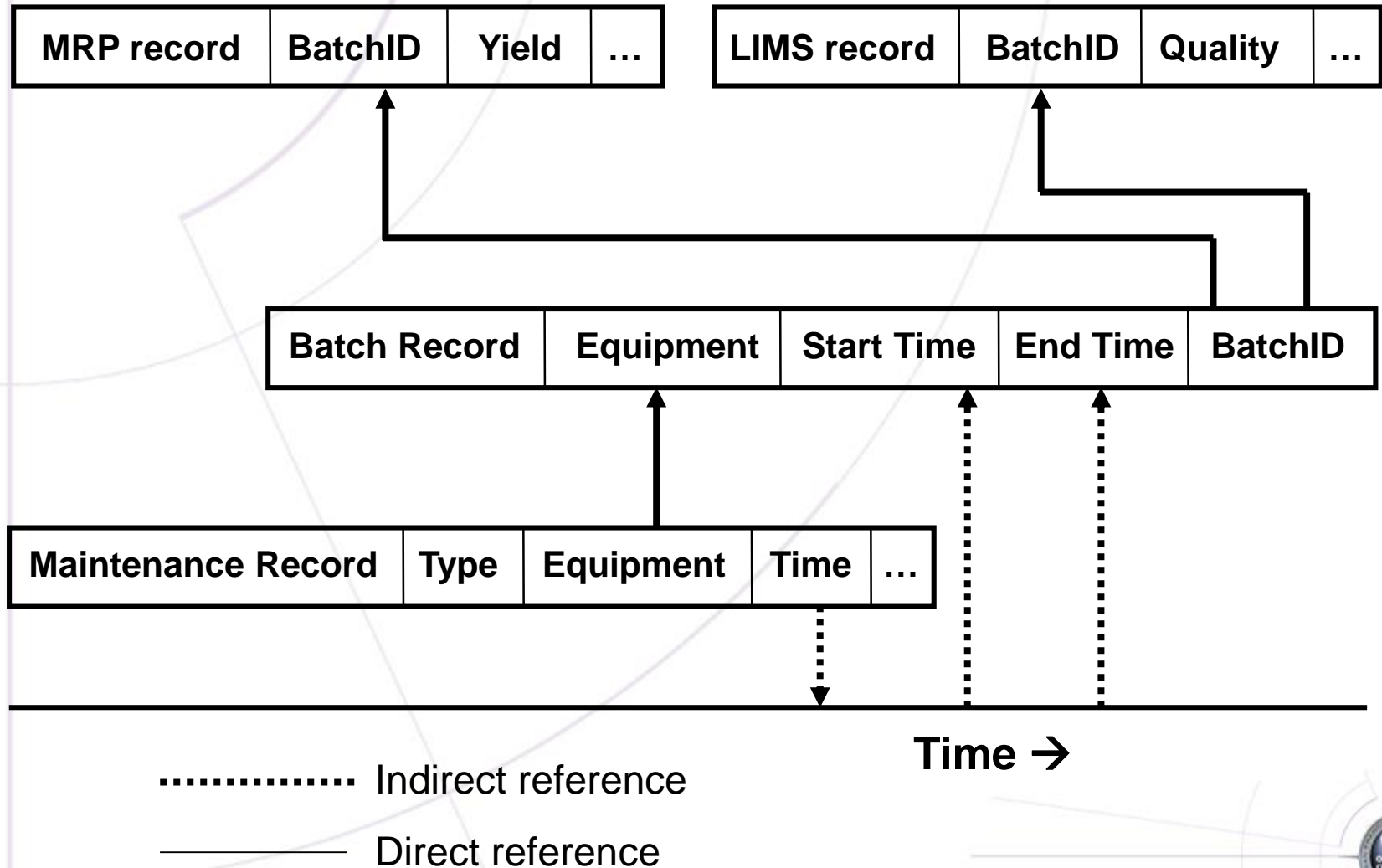


# Example Problem: Data Aggregation

- Prove or disprove a process theory
  - Frequency of maintenance affects yield or quality
- Sources of information
  - **PI Batch:** **time-batch relationship**
  - **MRP:** **yield**
  - **LIMS:** **quality**
  - **Maintenance system:** **maintenance events**
  - **PI Archive:** **process information**
- Issue
  - To assemble this information takes significant effort



# Example Problem: Data Aggregation





# Logical Asset Model

- Foundation provides the mapping from the data model to the asset model
- Primarily based upon existing technology (Analysis Framework)



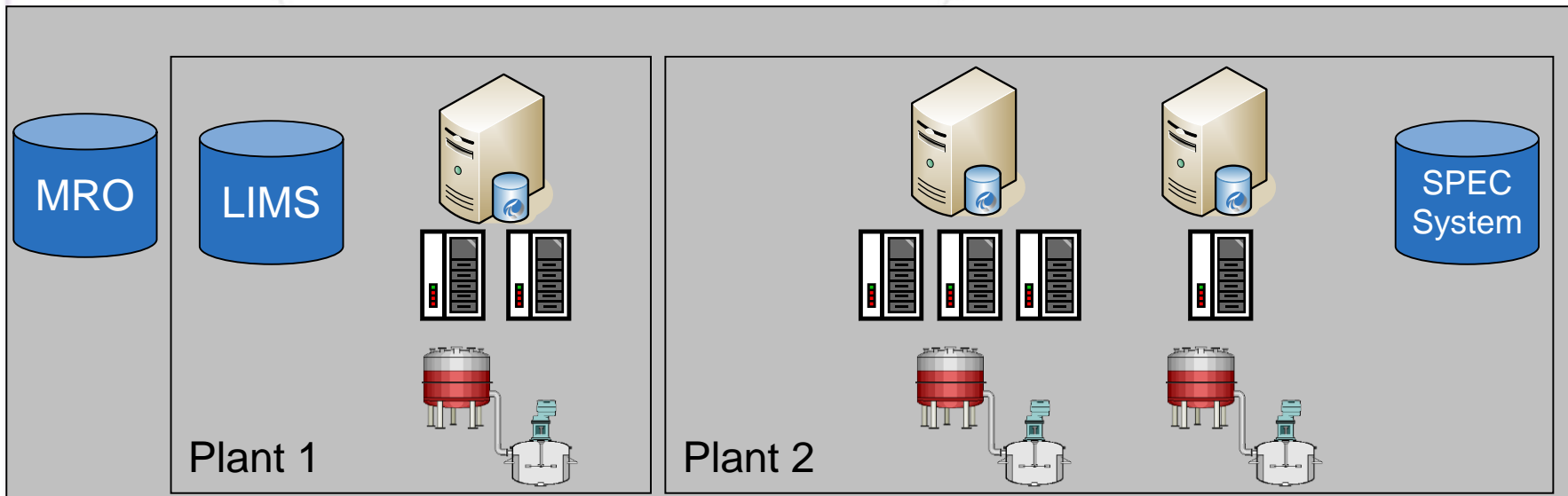
# Asset Model Exposes Data

- All data are exposed the same way
  - As attributes within the asset model
- Various rates of change
  - Time-series (changes often)
  - Configuration (changes infrequently)
- Varying complexity
  - Simple (real, string, etc.)
  - Complex (e.g. recordsets)
- Heterogeneous storage
  - OS/soft archive or asset model
  - From another system



# Enterprise-wide Scope

- Evolving the Asset Model to apply to one PI server or many
- Hides the differences
  - Control Systems are different
  - Inconsistent tag naming
  - Plant 1 has LIMS for managing quality specs
  - Plant 2 has a spec system for the same purpose
  - Maintenance system applies to all systems



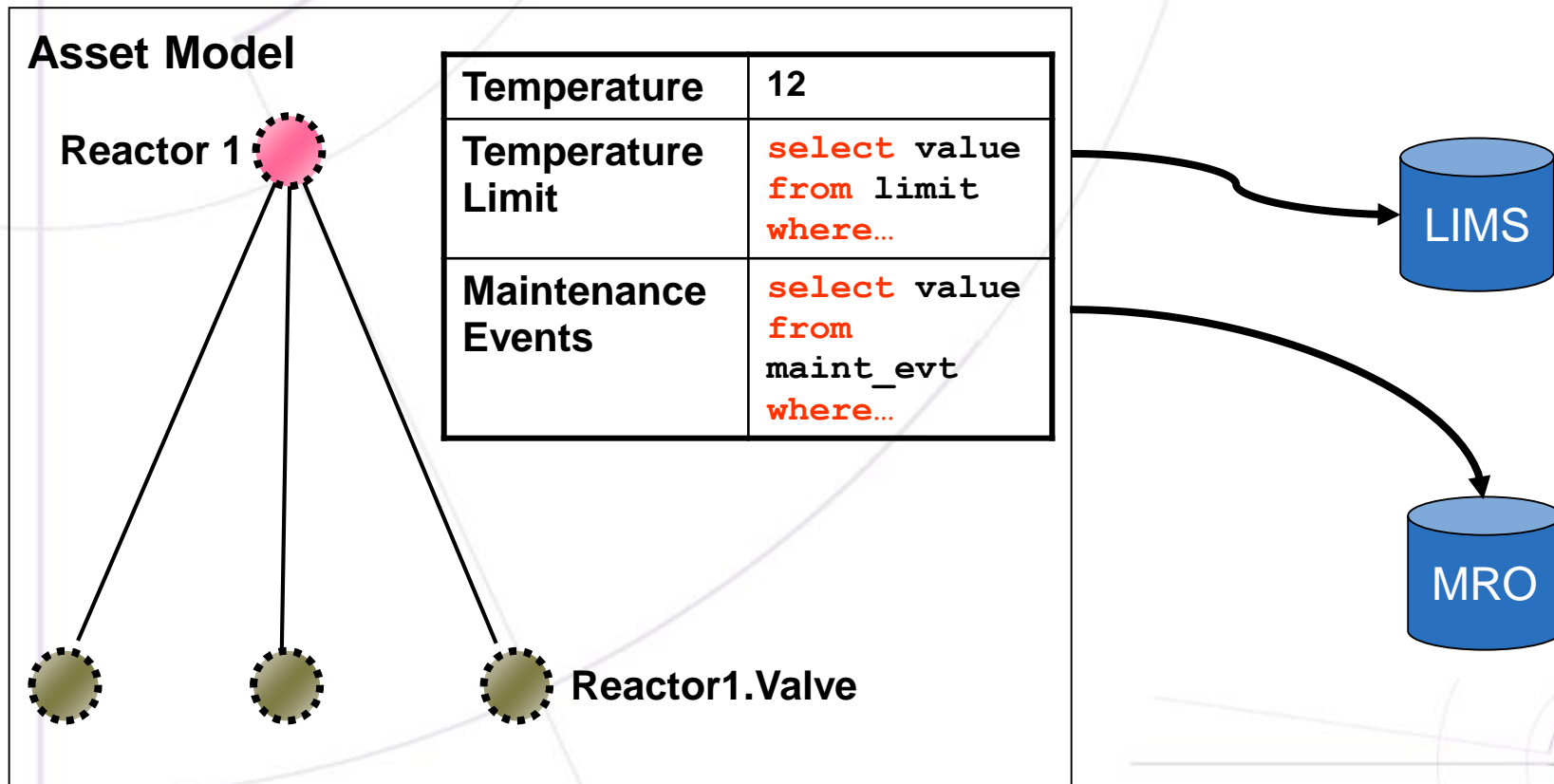
# Migrate User Interfaces to Asset Model

- Access to data will be through the asset model
- For such user interface functions as:
  - Adding a value to a screen
  - Referencing a value in a calculation
  - Browsing the asset database
- Requires:
  - A very flexible asset model
  - Good tools for building the asset model
- Results:
  - You are not required to know source of data
  - Universal context engine for all data types



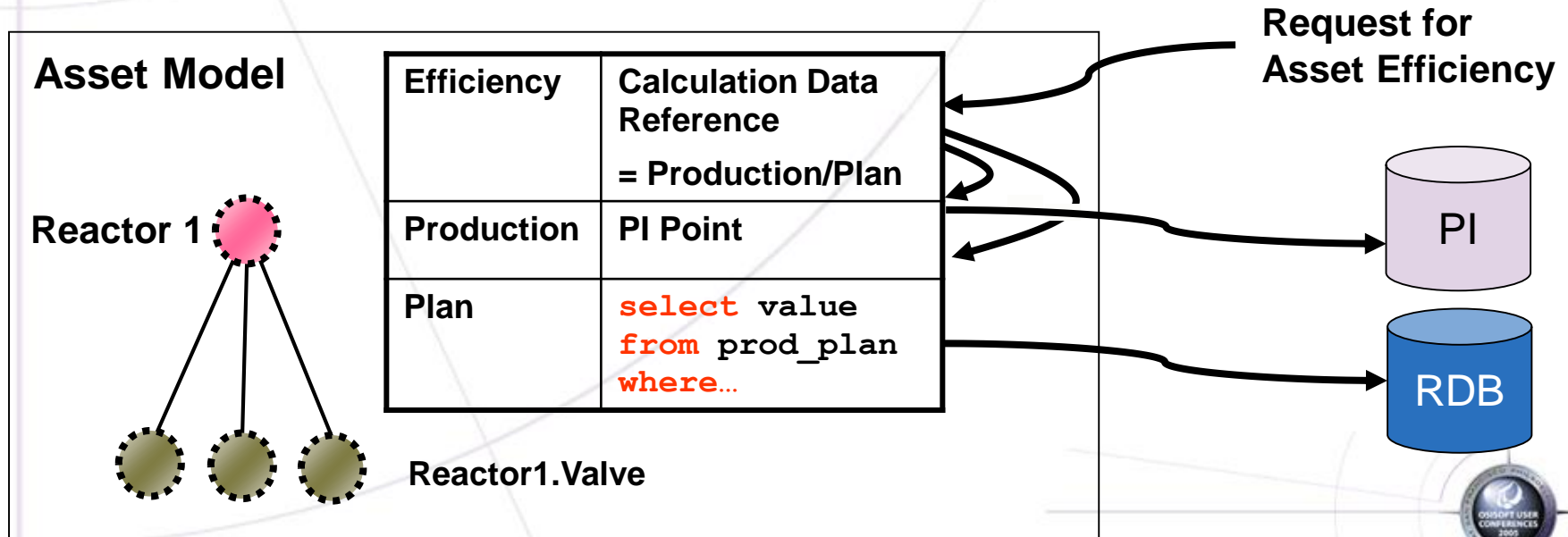
# Features: Data References

- Allows mapping of an attribute to a foreign system
- Honors other systems of reference



# Features: Data References

- Invoke a user-defined function on an asset
  - For example, an “asset efficiency” KPI
- Retrieve necessary asset attributes
  - Accessing attribute values can invoke user logic as well
  - Asset attributes are part of an asset template and apply to each instance of an asset



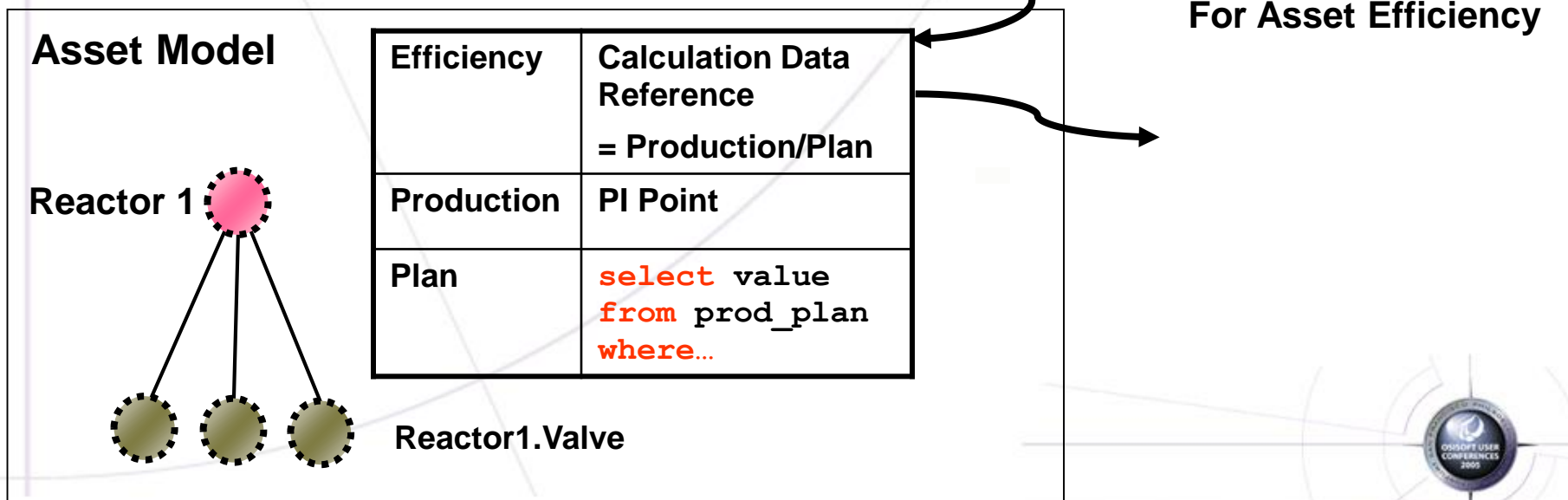
# Web Services: Technical Philosophy

- The services must:
  - Work well within an SOA
  - Serve useful functions within a business process
  - Minimize number of calls for a logical service
  - Perform well, even if service operation spans systems
- Application to OSIssoft:
  - Re-implementing our PI API on the Web is not appropriate
    - However using contextual information from Foundation to refine data from disparate sources does perform a useful function
  - Foundation will make it easier to create interesting functions



# Web Services: Example Service

- Invoke a user-defined function on an asset
  - For example, an “asset efficiency” KPI
- Retrieve necessary asset attributes
  - Accessing attribute values can invoke user logic as well
  - Asset attributes are part of an asset template and apply to each instance of an asset

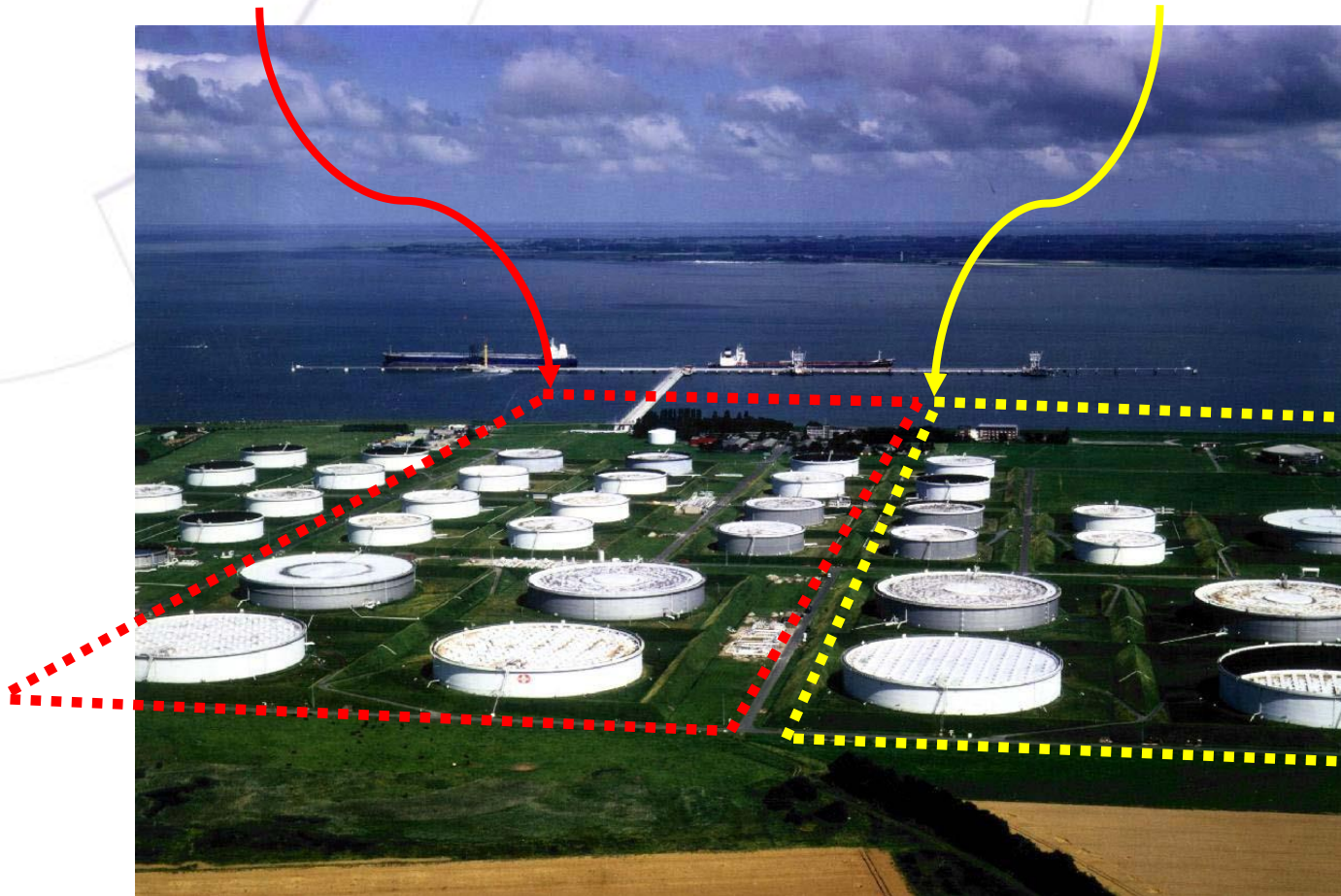




# Apply Services to Assets

TankFarm1.AvailableProducts





TankFarm2.AvailableProducts








# Features: Asset Type System

- The ability to create asset templates
  - For example, valves and pumps

## Class:

		Name 	Description	Configuration Item	Category	Value Type	Default Value	UOM	Data Reference
		Cargo Type	Type of Ship Truck's Cargo	False		String		<None>	<None>
		Empty Weight	Weight of the Ship Truck when Empty	False		Single	0 lb	pound (lb)	<None>
		License Number	License Number of Ship Truck	True		String		<None>	<None>
		Volume	Maximum Cargo Volume of Ship Truck	False		Single	0 US gal	US gallon (US gal)	<None>
				False			—		

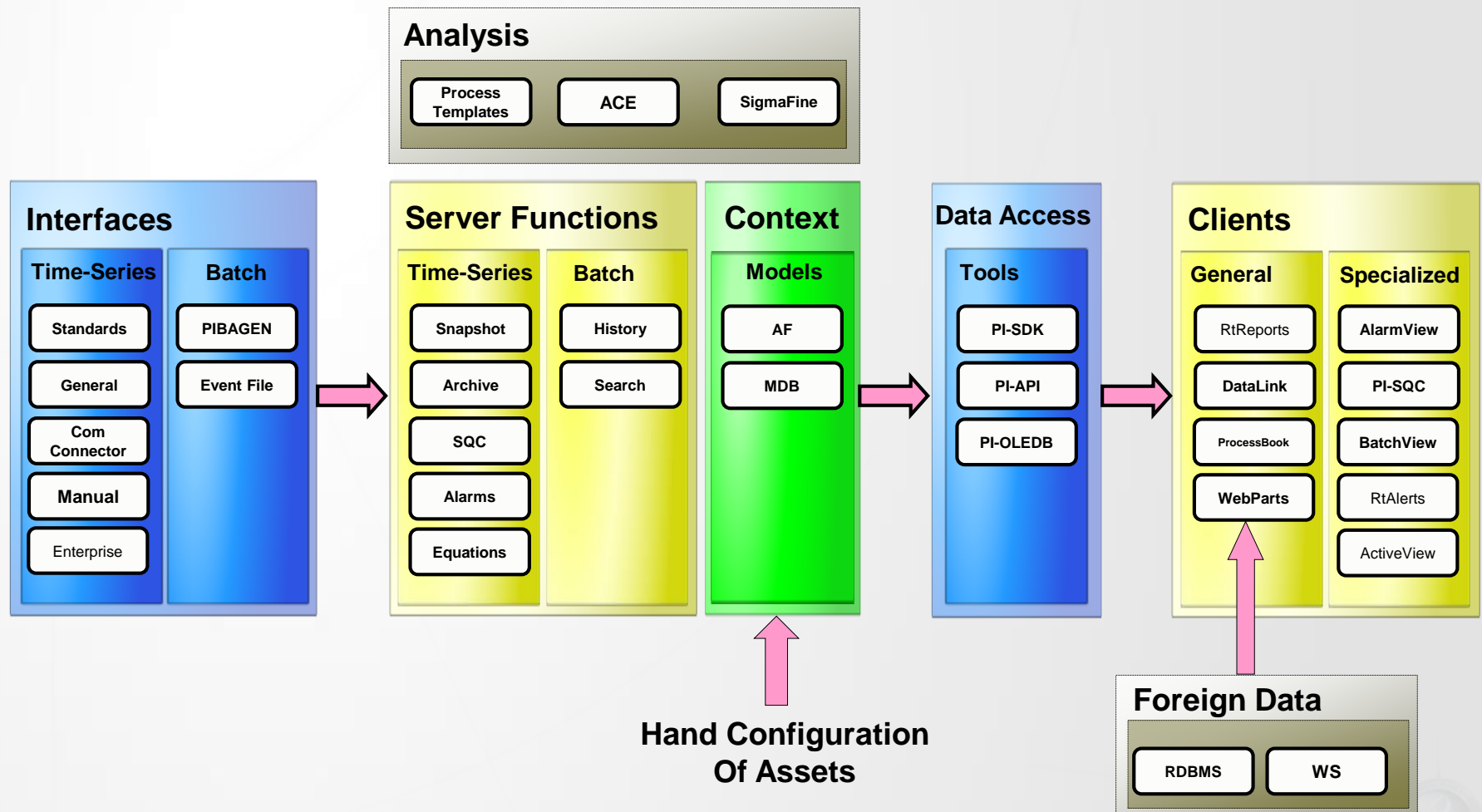
## Instance:

			Name 	Value	Value Type	Data Reference	Settings
			Cargo Type	Chocolate Milk	String	<None>	
			Empty Weight	2500 lb	Single	<None>	
			License Num...	JKL 217	String	<None>	
			Volume	1200 US gal	Single	<None>	

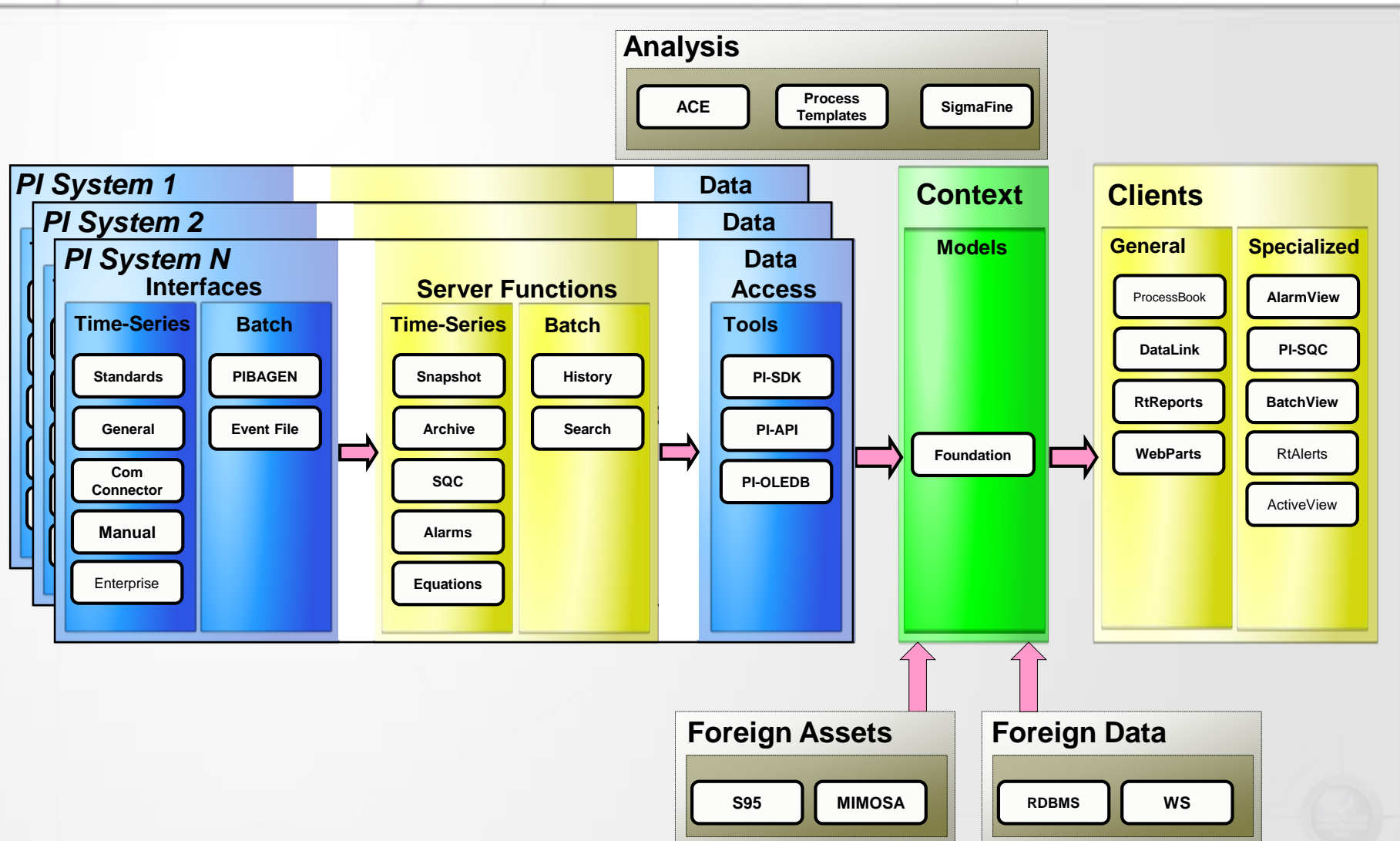
- Allows rapid deployment, easy management of the asset model



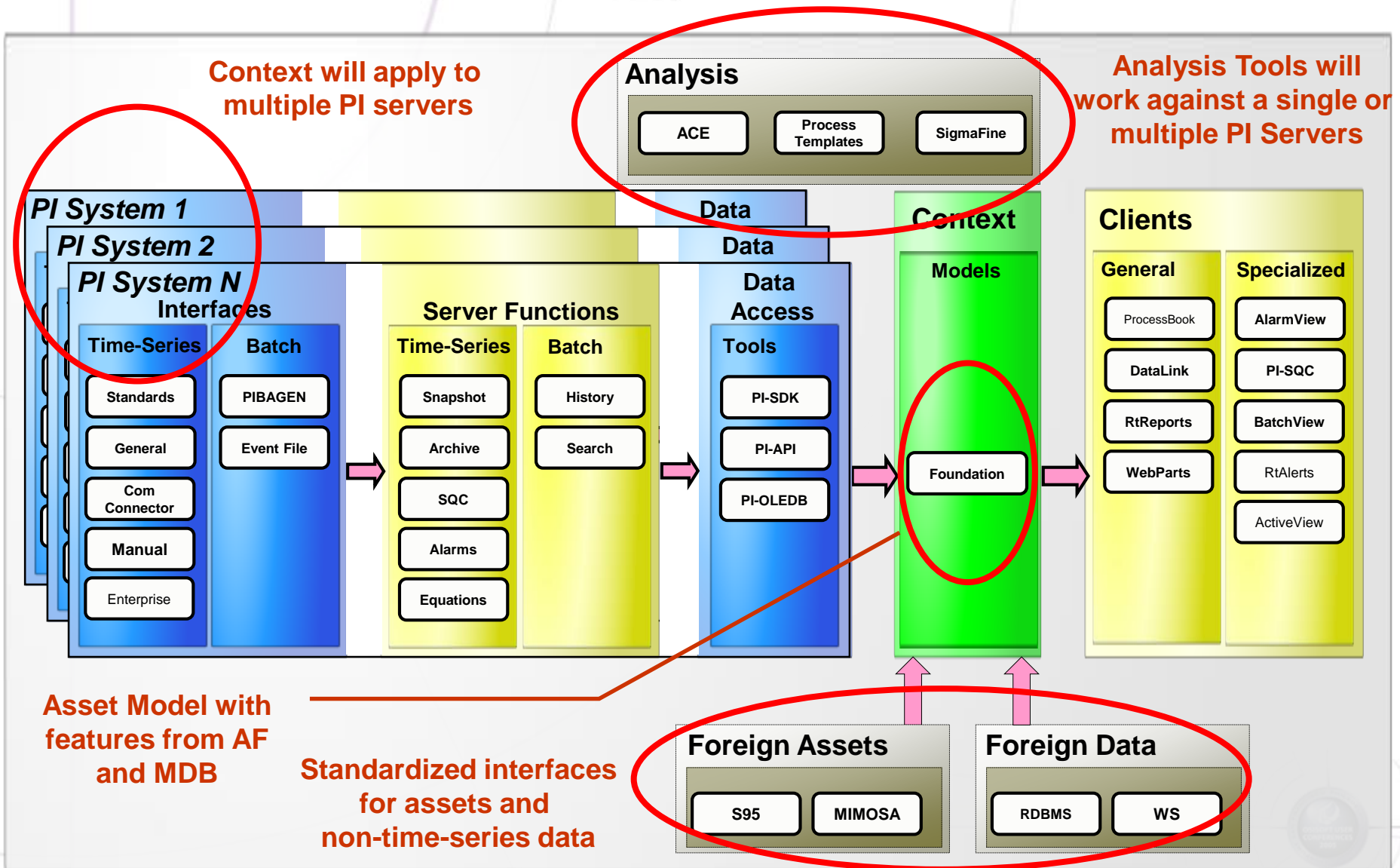
# RtPM Platform Review...Today



# RtPM Platform after Foundation



# RtPM Platform after Foundation



# RtPM Platform after Foundation

- This architecture achieves:
  - **“One version of the truth” across operations**
- Because rules are defined and deployed in templates
- Because it honors other systems of reference
  - External Asset models
  - External data
  - Structured data
- Because it exposes this data to a wide variety of client applications





# Business Solutions Example

- Example Problem: Standard Operating Conditions
  - Need a way to measure operating performance against expectations
  - Need to roll-up based upon asset hierarchy
  - Need to compare rolled-up performance vs. plan
    - For equipment and production
  - Need to visualize this for quick analysis
  - Need to compare against maintenance events
- Complications:
  - More than one “type” of asset
  - Production plan information in a planning system
  - Equipment is already defined in another system
    - And, this equipment is subject to change
  - Operating performance based upon limits from another system
  - We used actual schemas where applicable



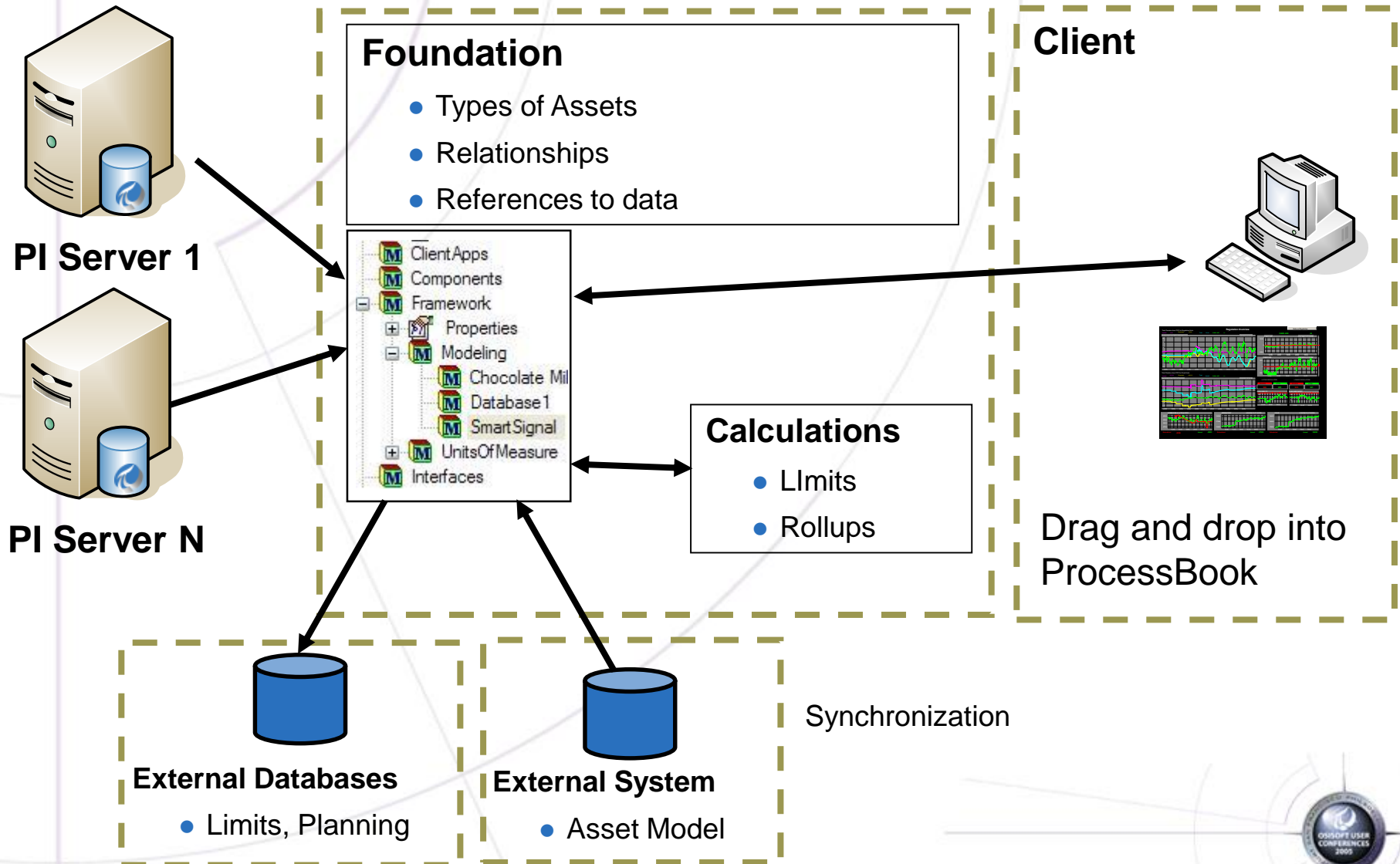
# Example: How to configure

- Starting Point
  - All the process values are in PI
  - Limit, Maintenance, Production Plan information in external systems
- Solution:
  - Asset “types” configured as Templates in Foundation
  - Asset Model copied from the external system
  - Limits configured as data references to the external system
  - Configured calculations
    - equipment performance
    - performance roll-up
    - production performance
  - Process Book to display summary and detail information from the assets



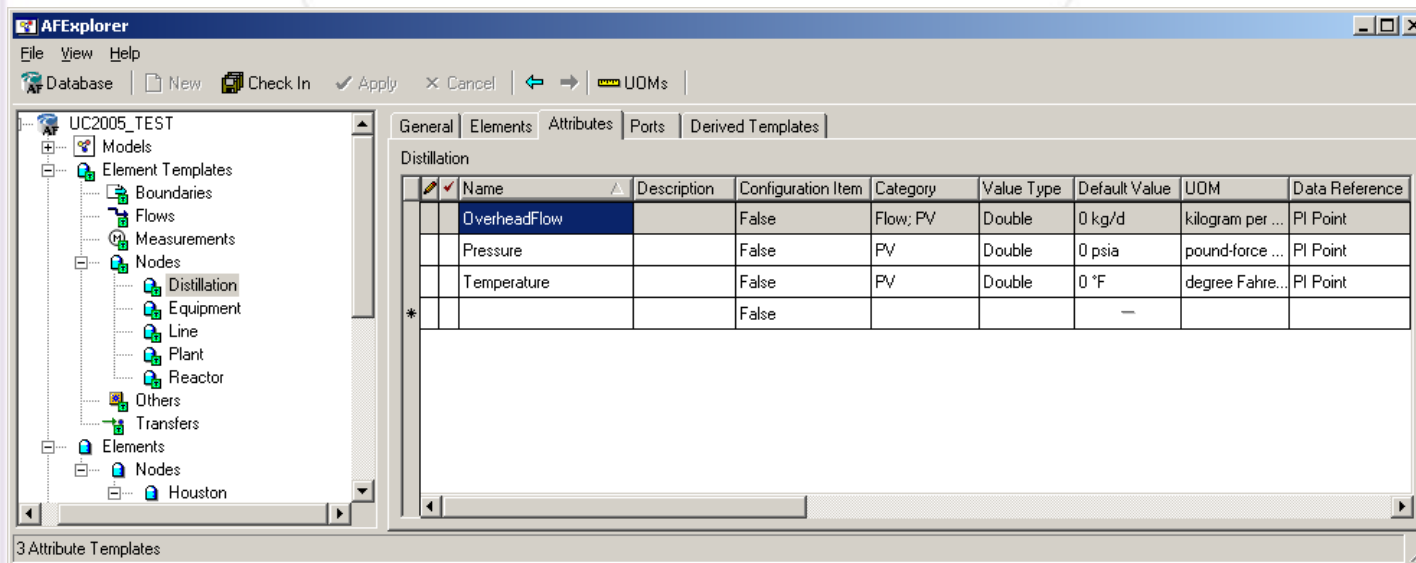


# Example: How to configure



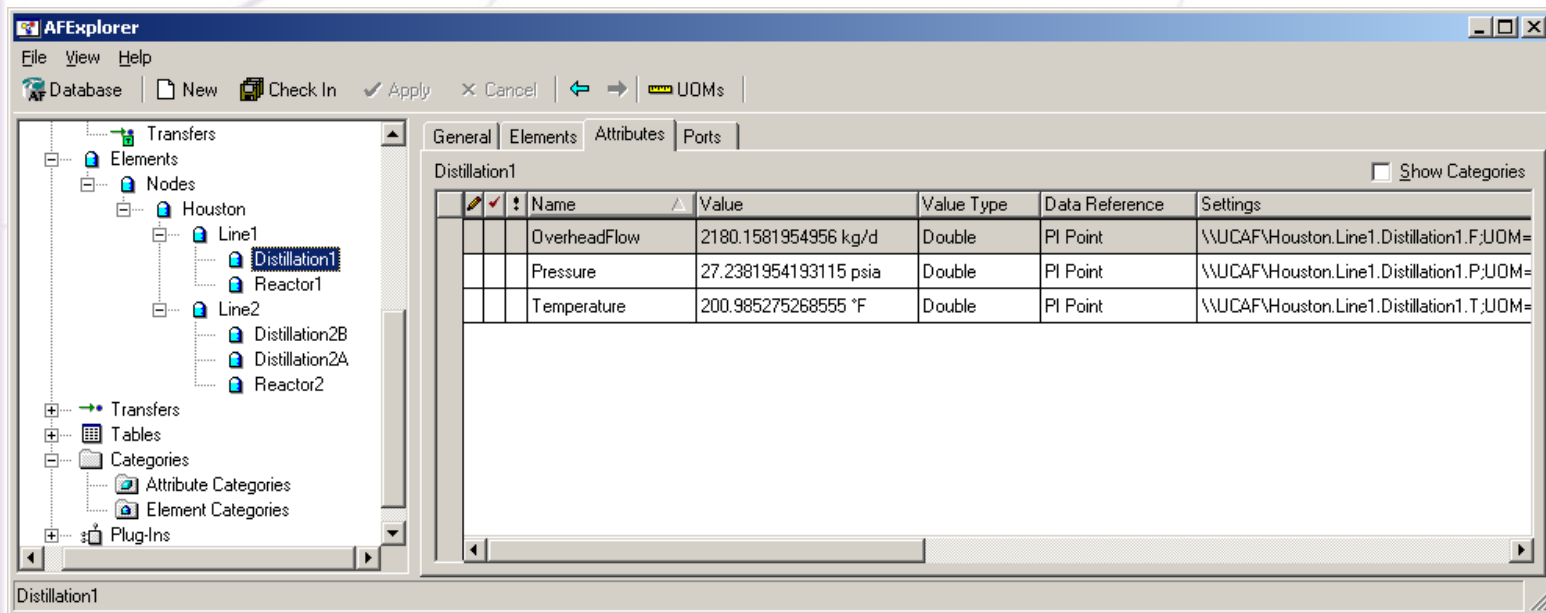
# Step 1: Model the PI Data

- Configuration of Templates
  - Reactor
  - Distillation
  - Line
  - Plant



# Step 2: Model the PI Data

- Configuration of Houston plant:

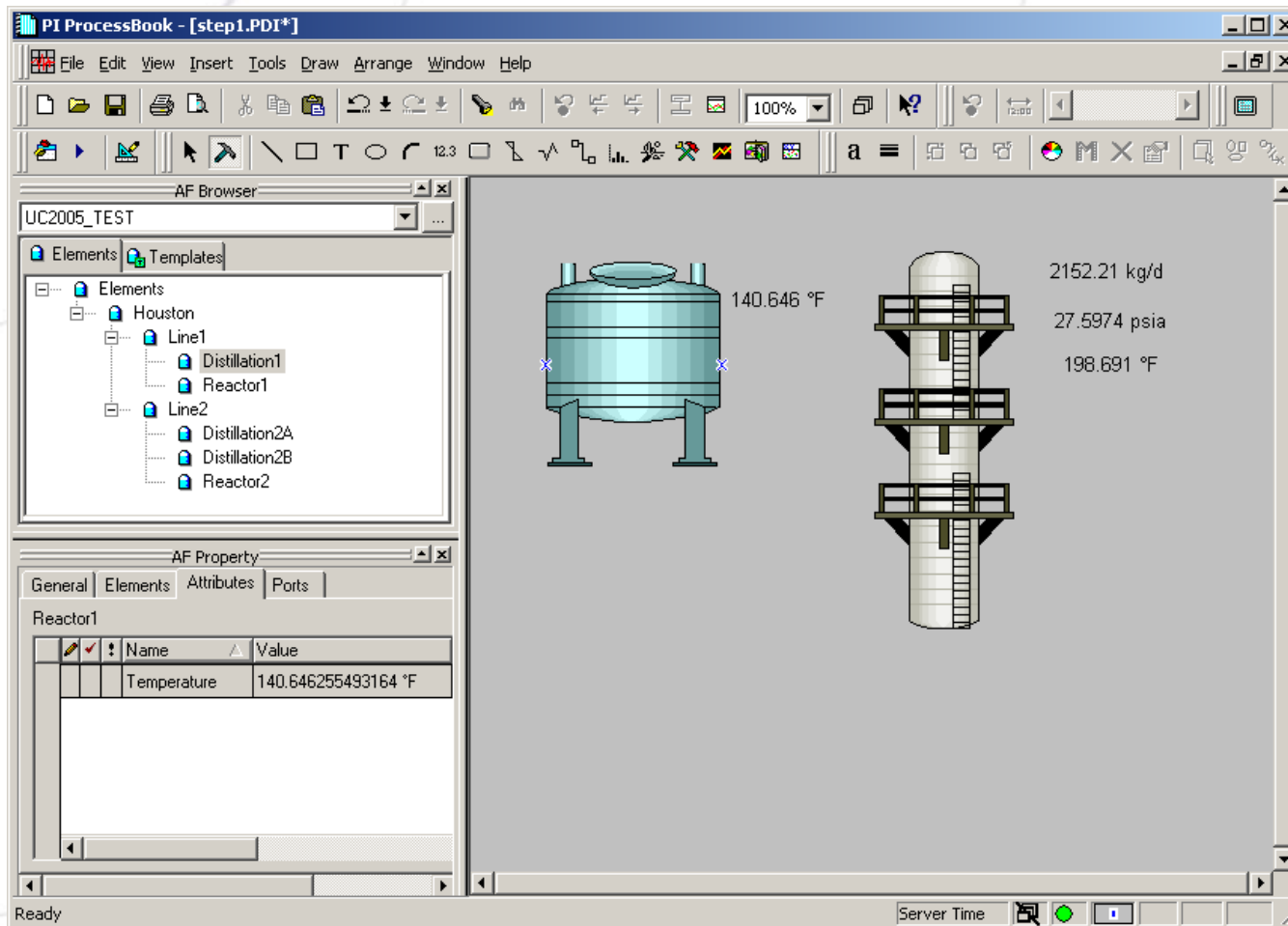


The screenshot displays the AFExplorer application window. The left-hand tree view shows the project structure, with 'Distillation1' highlighted under the 'Line1' node. The right-hand pane is set to the 'Attributes' tab for 'Distillation1'. It features a table with the following data:

	Name	Value	Value Type	Data Reference	Settings
	OverheadFlow	2180.1581954956 kg/d	Double	PI Point	\\UCAF\Houston.Line1.Distillation1.F;UOM=
	Pressure	27.2381954193115 psia	Double	PI Point	\\UCAF\Houston.Line1.Distillation1.P;UOM=
	Temperature	200.985275268555 °F	Double	PI Point	\\UCAF\Houston.Line1.Distillation1.T;UOM=

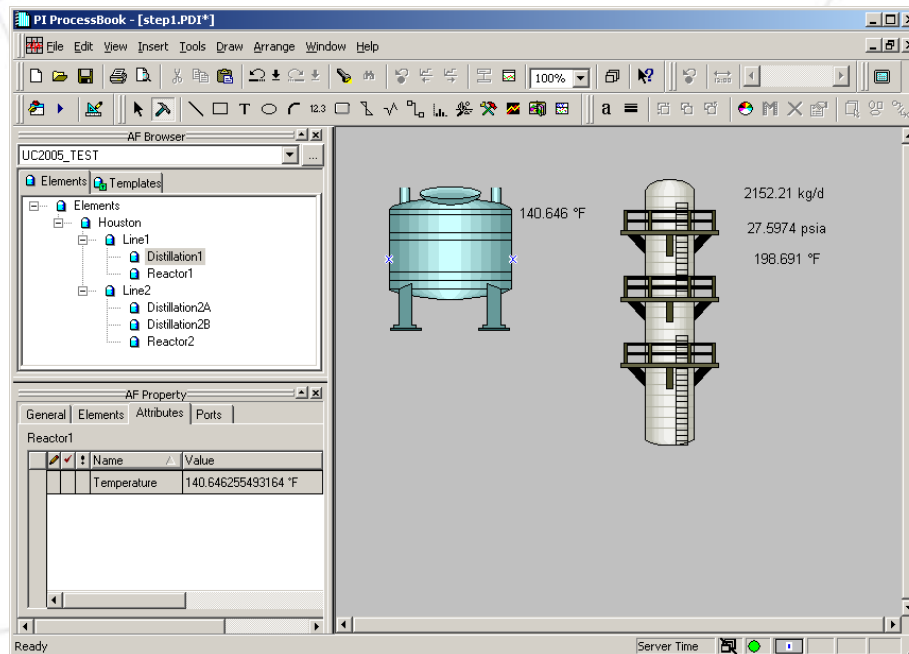
# Step 2: Model the PI Data

- Display in ProcessBook:



# What you just saw...

- Creating templates
- Creating instances
- Drag and drop of the reactor onto ProcessBook
- Drag and drop of attributes onto ProcessBook



# Step 3: Configure data references to external data

The screenshot shows the AFE Explorer application window. The left pane displays a tree view of the project structure, with 'Reactor' selected under 'Elements'. The right pane shows the 'Reactor' element's configuration table. The 'Table Lookup Data Reference' dialog box is open, showing the 'Limits' table with the 'HighLimit' column selected. The 'Where' clause is configured to filter data by Equipment and ProcessVariable.

**Table Lookup Data Reference**

Table: Limits

Result column: HighLimit

Unit of Measure: <Default> (\*F)

Where

Column: Equipment Operator: = Attribute or Value: Temperature Add And Add Or

Complete WHERE Clause:

Plant = '%.\.\Element%' And Line = '%.\Element%' And Equipment = '%Element%' And ProcessVariable = 'Temperature'

OK Cancel



# Step 3: Configure data references to external data

The top screenshot shows the AFE Explorer interface with the 'Reactor' element template selected. The 'Attributes' tab is active, displaying a table of configuration items.

Name	Description	Configuration Item	Category	Value Type	Default Value	UOM	Data Ref
Temperature		False	PV	Double	0 °F	degree Fahre...	PI Point
TemperatureHi		False	Limit	Double	0 °F	degree Fahre...	Table Loc
TemperatureLo		False	Limit	Double	0 °F	degree Fahre...	Table Loc
TemperatureSP		False	Limit	Double	0 °F	degree Fahre...	Table Loc
*		False			-		

The bottom screenshot shows the AFE Explorer interface with the 'Reactor1' instance selected. The 'Attributes' tab is active, displaying a table of data references.

Name	Value	Value Type	Data Reference	Settings
MaintenanceR...	<Data Table>	Object	Table	Connection~Provider=SQLOLEDB.1;Passw
SerialNum		String	<None>	
Temperature	158.830703735352 °F	Double	PI Point	\\UCAF\Houston.Line1.Reactor1.T;UOM=
TemperatureHi	200 °F	Double	Table Lookup	SELECT HighLimit FROM Limits WHERE P
TemperatureLo	150 °F	Double	Table Lookup	SELECT LowLimit FROM Limits WHERE PI
TemperatureSP	170 °F	Double	Table Lookup	SELECT Target FROM Limits WHERE Plar

# Step 3: Display the attributes in ProcessBook

PI ProcessBook - [step3.PDI\*]

File Edit View Insert Tools Draw Arrange Window Help

100%

AF Browser

UC2005\_TEST

Elements Templates

Elements

- Houston
  - Line1
    - Distillation1
    - Reactor1
  - Line2
    - Distillation2A
    - Distillation2B
    - Reactor2

AF Property

General Elements Attributes Ports

Reactor1

Name	Value
MaintenanceR...	<Data Table>
SerialNum	
Temperature	159.905944824219 °F
TemperatureHi	200 °F
TemperatureLo	150 °F

200 °F 159.906 °F 150 °F

2447.29 kg/d

45 psi 33.1558 psia 30 psi

270 °F 189.228 °F 200 °F

WorkOrder	Description	Status
WLM-00006	inspect sens	COMPLETE

WorkOrder	Description	Status
WLM-00025	Change purr	COMPLETE

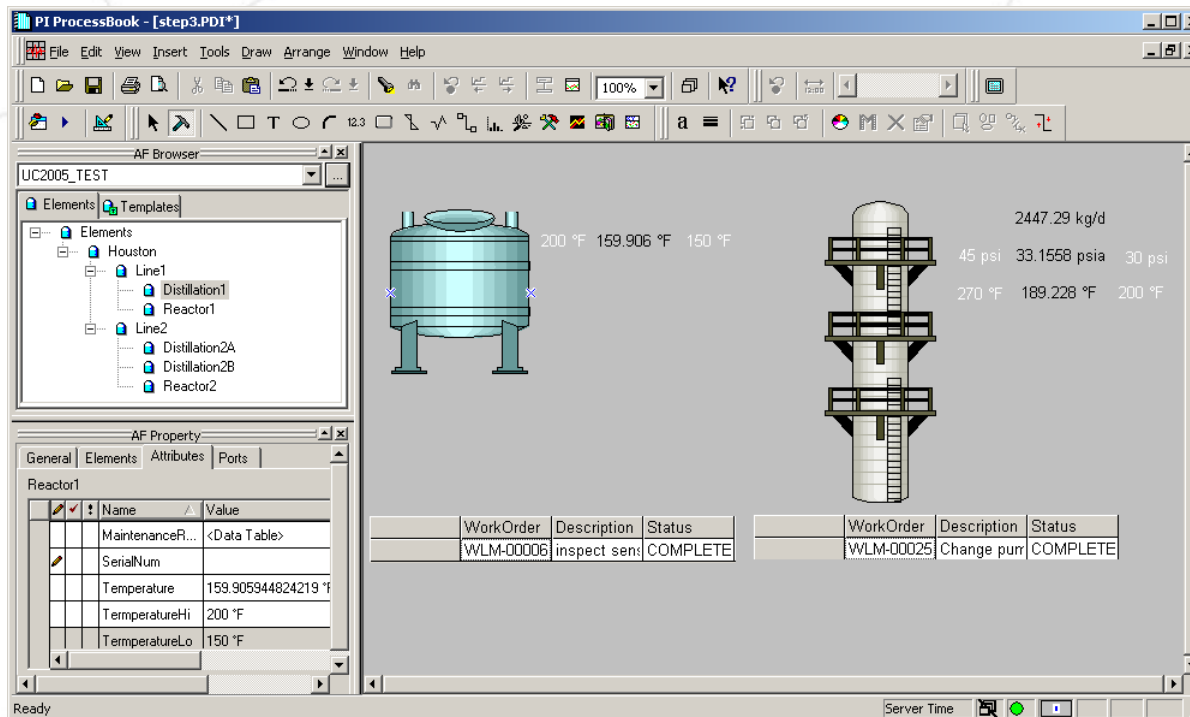
Ready

Server Time



# What you just saw....

- Creating references to other systems of reference
- Drag and drop of the simple attributes onto ProcessBook
- Drag and drop of data tables onto ProcessBook



# Step 4: Configure Calculation, Rollups

**Formula Configuration**

Data Reference Configuration

Variable: E Attribute: Temperature Unit of Measure: <Default> (°F)

Add to Definitions

A=TemperatureSP  
C=TemperatureHi  
D=TemperatureLo  
B=Temperature

Remove Selected Remove All

☐ Default Values Allowed

Result

Unit of Measure: <None>

Minimum:

Maximum:

OK Cancel

Formula Configuration

Click available buttons or operators.

Variables: A B C D E

Operators: = + - \* /

Functions: abs acos asin atan ceiling

Formula:

Add Formula to Calculation Sequence

Calculation Sequence:

1-abs((B-A)/(C-D))

Remove Selected Remove All Edit Selected

Evaluate

**Rollup Data Reference**

Category: Performance

Calculation: Avg

☐ Recurse sub-children

OK Cancel



# Step 4: Configure Calculation, Rollups

The screenshot displays two instances of the AFExplorer application. The top window shows the configuration for 'UC2005\_TEST' with the 'Line' table. The bottom window shows the configuration for 'UC2005\_TEST' with the 'Line1' table. Both windows show a tree view on the left with 'UC2005\_TEST' selected.

**Top Window: UC2005\_TEST - Line**

Line	Name	Description	Configuration Item	Category	Value Type	Default Value	UOM	Data Reference
	ActualRate		False	Flow	Double	0 kg/d	kilogram per ...	Rollup
	Performance		False	Performance	Double	0	<None>	Rollup
*			False			-		

**Bottom Window: UC2005\_TEST - Line1**

Line1	Name	Value	Value Type	Data Reference	Settings
	ActualRate	2536.16638183593 kg/d	Double	Rollup	CategoryName=Flow;Calculation=Sum;Recursive
	Performance	0.435840470450267	Double	Rollup	CategoryName=Performance;Calculation=Avg;R

# Step 4: Configure Calculation, Rollups

The image displays two instances of the AFExplorer application. The top instance shows the configuration for the 'Plant' element, and the bottom instance shows the configuration for the 'Houston' element.

**Top Window: AFExplorer - Plant**

General | Elements | Attributes | Ports | Derived Templates

Plant

Name	Description	Configuration Item	Category	Value Type	Default Value	UOM	Data Ref
ActualRate		False		Double	0 kg/d	kilogram per ...	Rollup
OrderQuantity		False		Double	0 kg	kilogram (kg)	Table Loc
Performance		False		Double	0	<None>	Rollup
PlannedRate		False		Double	0 kg/d	kilogram per ...	Table Loc
*		False			—		

**Bottom Window: AFExplorer - Houston**

General | Elements | Attributes | Ports

Houston

☐ Show Categories

Name	Value	Value Type	Data Reference	Settings
ActualRate	7357.84263610838 kg/d	Double	Rollup	CategoryName=Flow;Calculation=Sum;Recursive
OrderQuantity	25000 kg	Double	Table Lookup	SELECT OrderQuantity FROM ProcessOrder W/H
Performance	0.606028394244969	Double	Rollup	CategoryName=Performance;Calculation=Avg,R
PlannedRate	5000 kg/d	Double	Table Lookup	SELECT PlannedRate FROM ProcessOrder W/H

# Step 4: Configure in ProcessBook

PI ProcessBook - [step4.PDI\*]

File Edit View Insert Tools Draw Arrange Window Help

100%

AF Browser

UC2005\_TEST

Elements Templates

Elements

- Houston
  - Line1
    - Distillation1
    - Reactor1
  - Line2

AF Property

General Elements Attributes Ports

Reactor1

	Name	Value
	MaintenanceR...	<Data Table>
	Performance	0.79109130859376
	SerialNum	
	Temperature	159.554565429688 °F
	TemperatureHi	200 °F
	TemperatureLo	150 °F
	TemperatureSP	170 °F

Plant Performance = 0.58286

Line Performance = 0.36347

200 °F 157.487 °F 150 °F

Relative Performance Metric = 0.74974

WorkOrder	Description	Status
WLM-00006	inspect sens	COMPLETE

2582.68 kg/d

45 psi 26.1627 psia 30 psi

270 °F 197.127 °F 200 °F

Relative Performance Metric = 0.3634

WorkOrder	Description	Status
WLM-00025	Change pur	COMPLETE

Ready

Server Time



# Deployment: Creating a second plant

AFExplorer

File View Help

Database New Check In Apply Cancel UOMs

Others  
Transfers  
Elements  
Nodes  
Houston  
Line1  
Distillation1  
Reactor1  
Line2  
Distillation2A  
Distillation2B  
Reactor2  
BatonRouge  
Line1  
Distillation1  
Reactor1  
Line2  
Distillation2  
Reactor2  
Line3  
Distillation3  
Reactor3  
Transfers  
Tables  
Limits  
ProcessOrder

General Elements Attributes Ports

Distillation1

☐ Show Categories

	Name	Value	Value Type	Data Reference	Settings
	MaintenanceR...	<Data Table>	Object	Table	Connection~Provider=SQLOLEDB.1;Password=
	OverheadFlow	2457.46702194213 kg/d	Double	PI Point	\\UCAF\BatonRouge.Line1.Distillation1.F;UOM=
	Performance	0.548225157601489	Double	Formula	A=PressureSP;B=Pressure;C=PressureHi;D=Pres
	Pressure	29.1771831512451 psia	Double	PI Point	\\UCAF\BatonRouge.Line1.Distillation1.P;UOM=
	PressureHi	45 psi	Double	Table Lookup	SELECT HighLimit FROM Limits WHERE Plant =
	PressureLo	30 psi	Double	Table Lookup	SELECT LowLimit FROM Limits WHERE Plant =
	PressureSP	35 psi	Double	Table Lookup	SELECT Target FROM Limits WHERE Plant = %
	SerialNum		String	<None>	
	Temperature	208.924667358398 °F	Double	PI Point	\\UCAF\BatonRouge.Line1.Distillation1.T;UOM=
	TemperatureHi	270 °F	Double	Table Lookup	SELECT HighLimit FROM Limits WHERE Plant =
	TemperatureLo	200 °F	Double	Table Lookup	SELECT LowLimit FROM Limits WHERE Plant =
	TemperatureSP	245 °F	Double	Table Lookup	SELECT Target FROM Limits WHERE Plant = %

Distillation1



# Maintenance: Changing the Equipment

The screenshot shows the AFExplorer application window. The left sidebar displays a hierarchical tree structure of the process model. The main pane shows the configuration for 'Line2'.

**AFExplorer**  
File View Help  
Database New Check In Apply Cancel UOMs

**Line2** ☐ Show Categories

	Name	Value	Value Type	Data Reference	Settings
	ActualRate	2580.99832534789 kg/d	Double	Rollup	CategoryName=Flow;Calculation=Sum;Recursive
	Performance	0.818535003662107	Double	Rollup	CategoryName=Performance;Calculation=Avg;R

Line2

# Demonstration Summary:

- An interesting application can be quickly configured
- The data comes from many sources
  - PI and external systems (Limits, Maintenance, Planning)
- Application includes configured calculations
  - Performance, Production vs. Plan
  - Logic is applied through the asset relationships
- The model information was applied to ProcessBook
  - Time-Series and relational data from business systems
- Simple deployment and maintenance
- Ensures one version of the truth across your operations





# Foundation is...

## An evolution of RtPM platform to help you provide more value from PI

- Like Mission Control, Foundation organizes a variety of data in a way that helps you solve problems
- Foundation is a configurable:
  - Logical enterprise asset model
    - Include relationships between the assets
  - Way to organize and access all data, whether stored in PI or not
- Foundation:
  - Facilitates agile, incremental projects
  - Extends reach of RtPM-based solutions to include external assets and data

