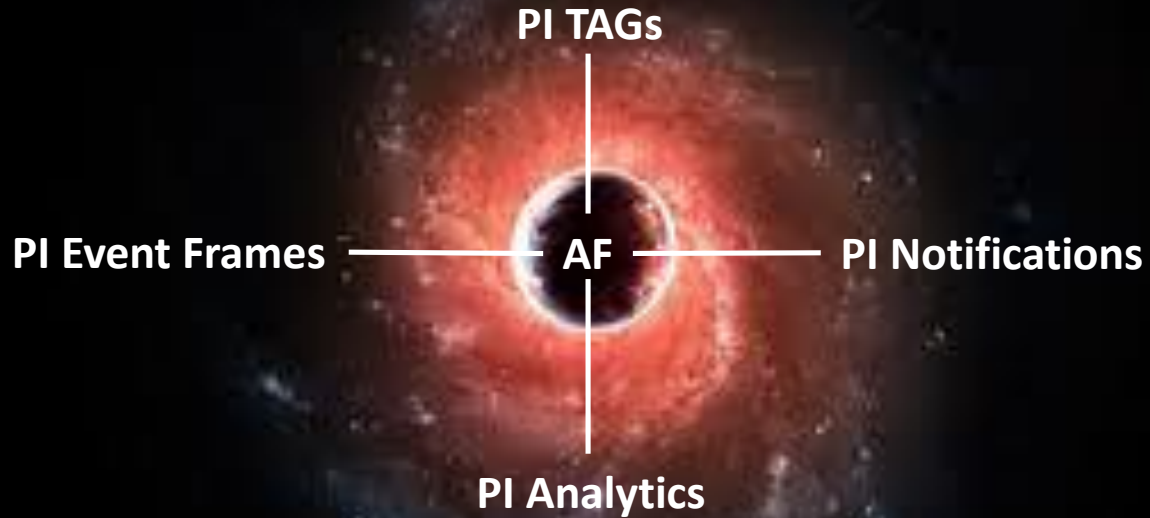


The Universe of Possibilities using AF

Presented by **Herbert Falk**



The Core of Future Applications

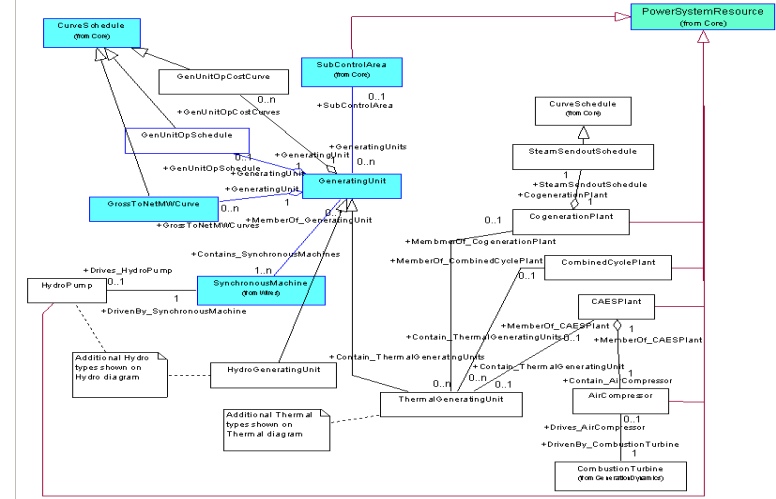
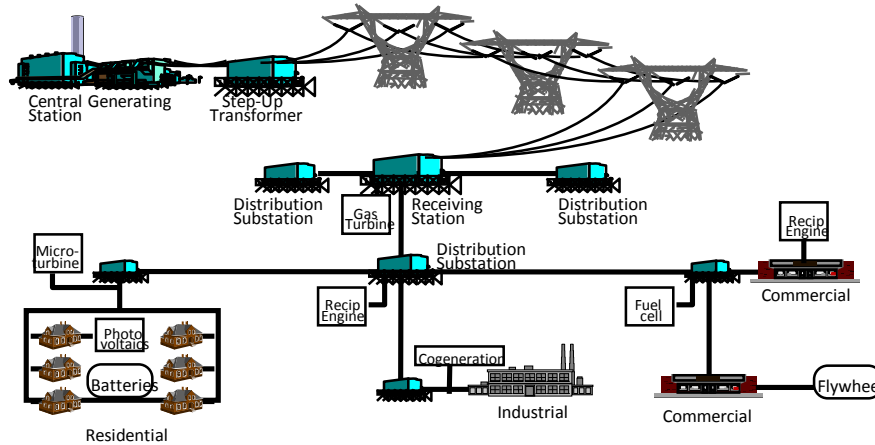


Application Considerations

- Think to the future, not only tactically
 - » Think out of the box
 - » Try to see synergies
 - » Use of standards
 - » Model Management
 - » What is an event?
 - » Analysis benefits
 - » Visualization

CIM and 61850

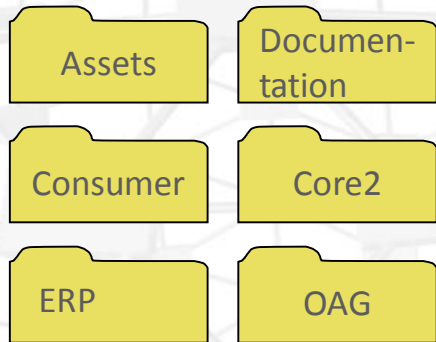
Common Information Model (CIM) is an Information Model of the Power System



UML – Unified Modeling Language

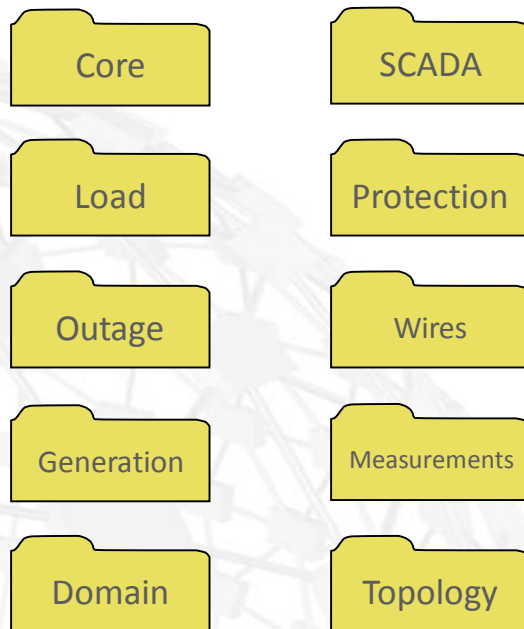
CIM is a Comprehensive Model for Utilities

IEC 61968 from IEC TC57 WG14

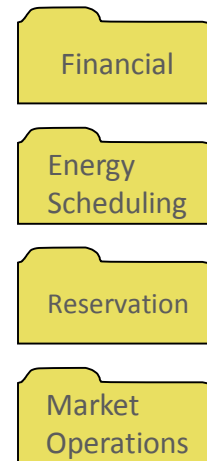


Distribution

IEC 61970 from IEC TC57 WG13



EMS, Transmission & Planning



IEC 62325
from
IEC TC57
WG16

Markets (Euro & NA)

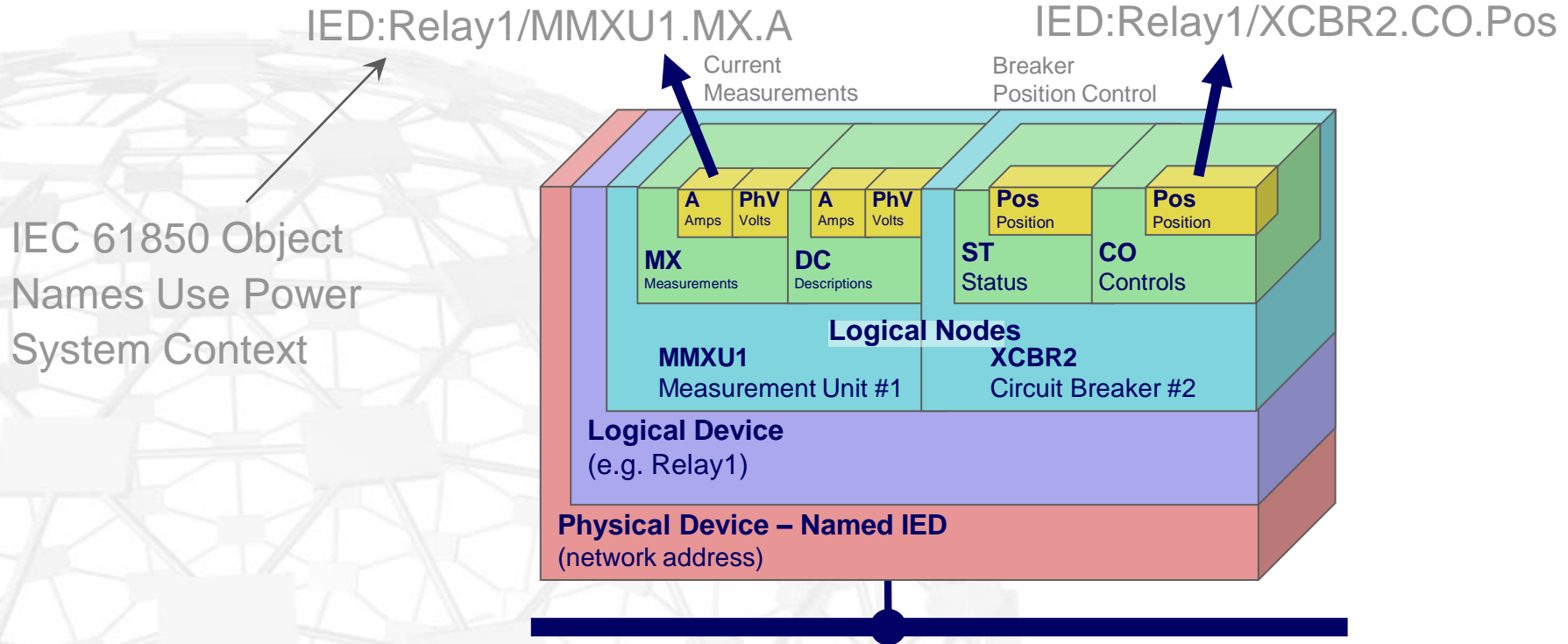
CIM Impact on European TSOs and DSOs

- EU Network codes are being established by ENTSO-E are CIM based
- Operational models, planning models, and state solution exchanges within ENTSO-E are all CIM based
- European Smart Grid projects and standards are being developed using CIM based solutions ¹

IEC 61850: A New Approach to Power System Communications

- IEC 61850 is much more than a protocol:
 - » Standardized **Device and Object Modeling**
 - › Logical Devices, Logical Nodes, Common Data Classes, etc.
 - › Extensions unique to specific applications (Hydro, Distributed Energy Resources (DER), Wind power, etc.)
 - » Standardized Service/Behavior Modeling
 - » Standardized **XML and a Design Process for System Description and Device Configuration**
 - » Standardized Communications Profiles (Protocols) for Many Use Cases
 - » Standardized Conformance Test Cases
- ENTSO-E is developing IEC 61850 user profiles for TSOs

IEC 61850 Data Model

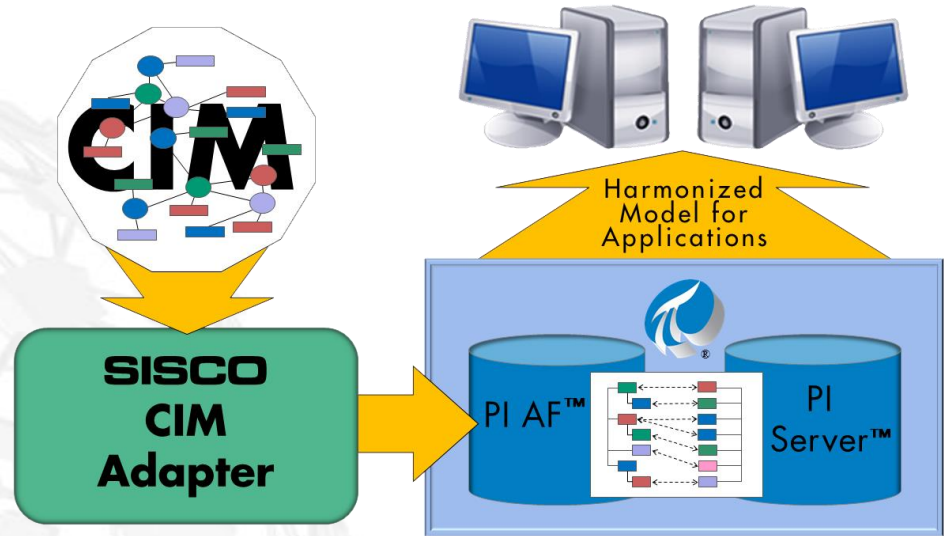


Impact of CIM and IEC 61850 on PI AF

- CIM and IEC 61850 have modeling information that can be leveraged by PI AF to provide context and meaning to PI data.
- Using data models to drive integration and application development is a proven method to manage the complexity of large scale systems.
- CIM and IEC 61850 provide a good starting point for most of a utilities modeling needs and a process for customizing it to meet your individual needs.
- Building custom models from the ground up is wasteful and can lead to many non-interoperable models for each functional requirement.

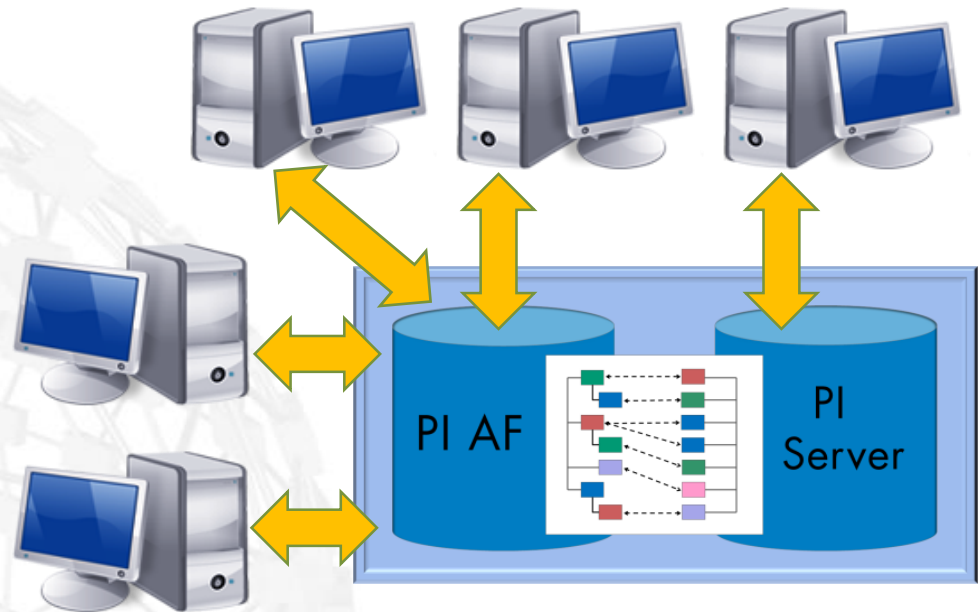
SISCO CIM Adapter Enables CIM & IEC 61850 for PI AF

- Enables **any** model in CIM-XML format to be imported into PI AF.
- Find data in the context of the power system.
- Supports a **Model-Driven Process** to manage all application models.



Typical Approach for Application Data Models?

- Each group looks at its own application requirements and develops a data model that is optimized for its own use:
 - » Only data needed for its application is considered.
 - » New data model elements are added as needed based on immediate requirements of the individual applications.
- The “Ad-Hoc” Approach



Ad Hoc Approach for Line Rating Application

Line Rating Application

Control Area

Corridor

Line Segment 1

Line Segment 2

Ambient Temp

Wind Speed

Wind Direction

Current

A Line

LineTemp

Sag

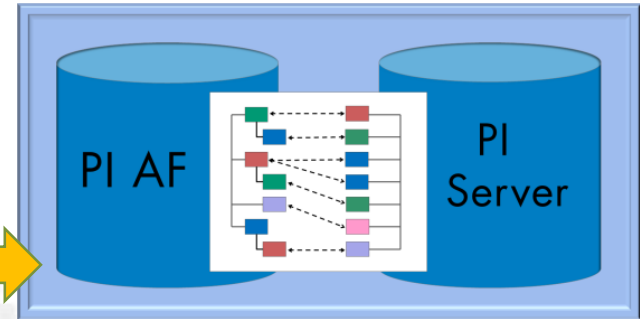
B Line

LineTemp

Sag



Line Rating App



Ad Hoc Approach for Remedial Action Schemes

Remedial Action Application

Corridor

North-South Interconnect

Line Trip RAS

Generator Trip RAS

Airport Substation

Sydney Sub

West Dam Sub

East Wind Sub

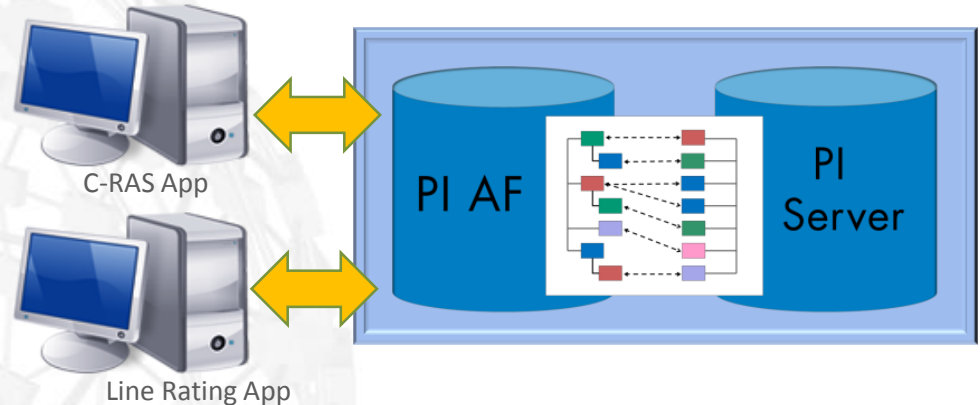
Line Status

Current

Margin

Line Rating

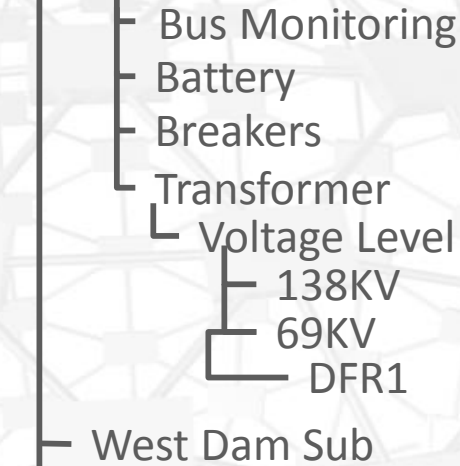
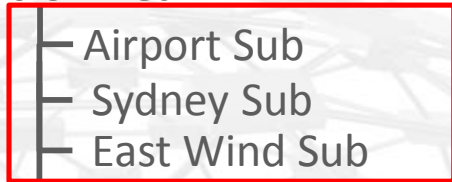
RAS Arming



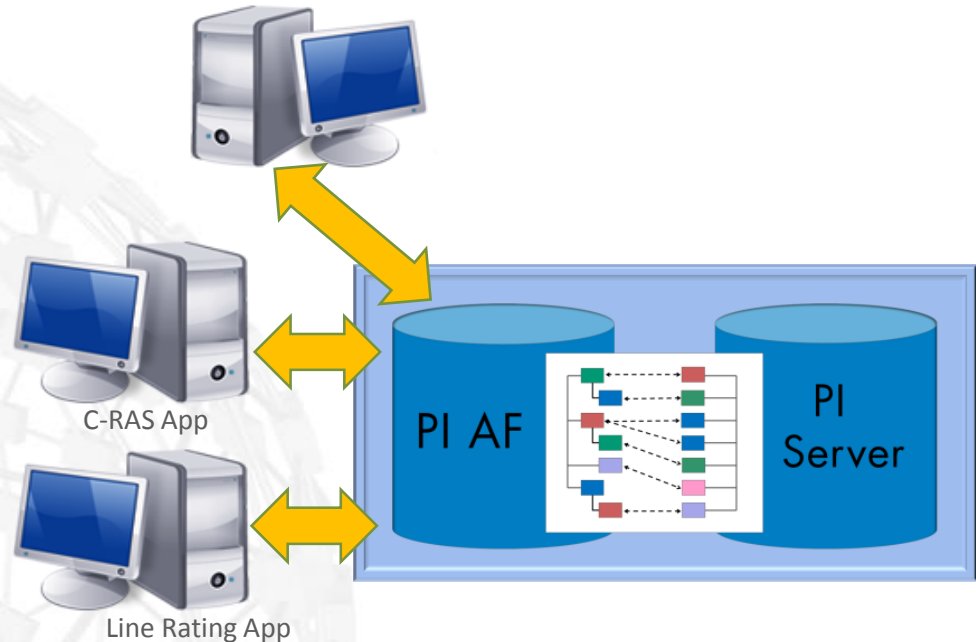
Ad Hoc Approach for Disturbance Monitoring

Disturbance Monitor App

└ Control Area

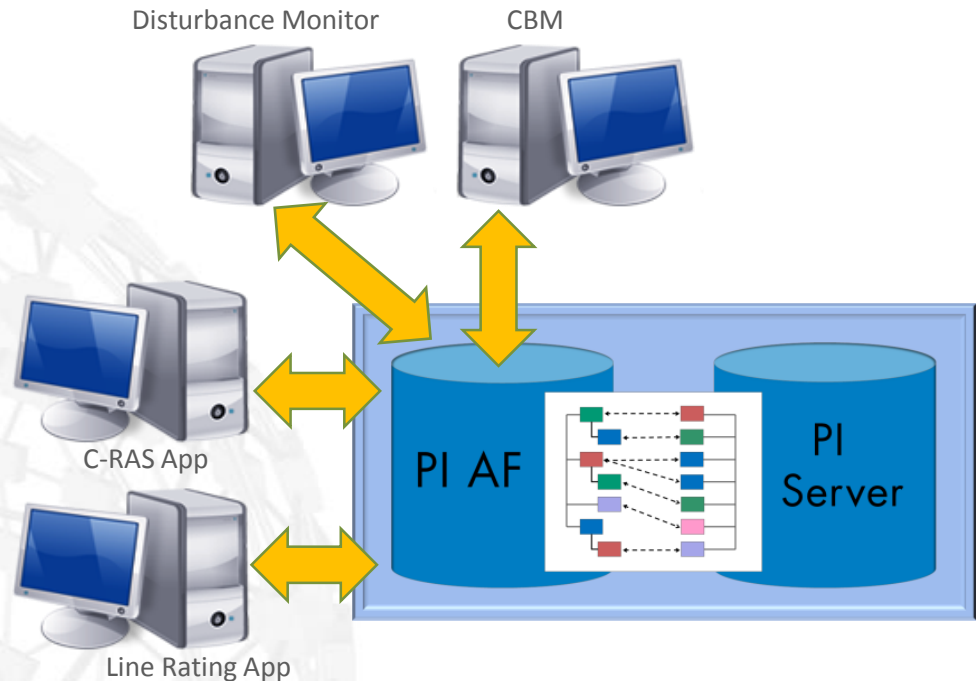
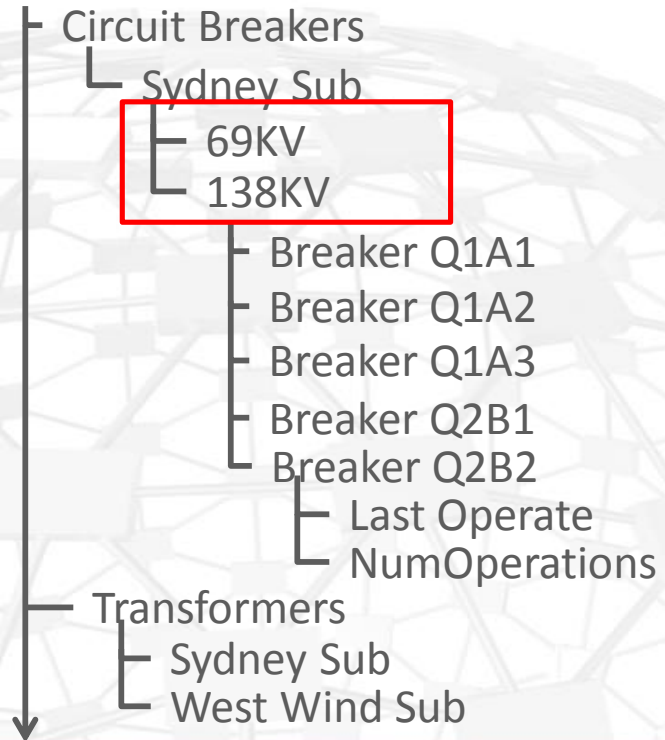


Disturbance Monitor



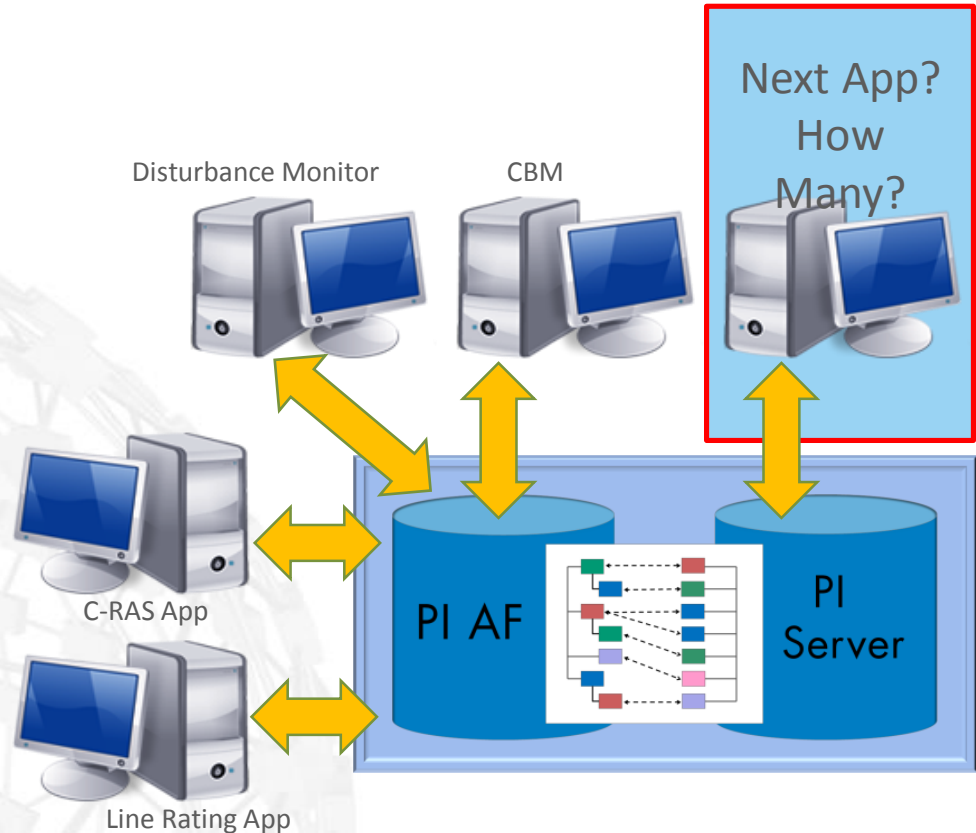
Ad Hoc Approach for CBM Applications

Condition Based Maintenance



Impact of Ad Hoc Approach for Application Data Models

- PI AF can accept as many models as you have space for.
- Impact of cross-organizational integration and data sharing ignored.
- Each group is individually satisfied with their own custom view until.....

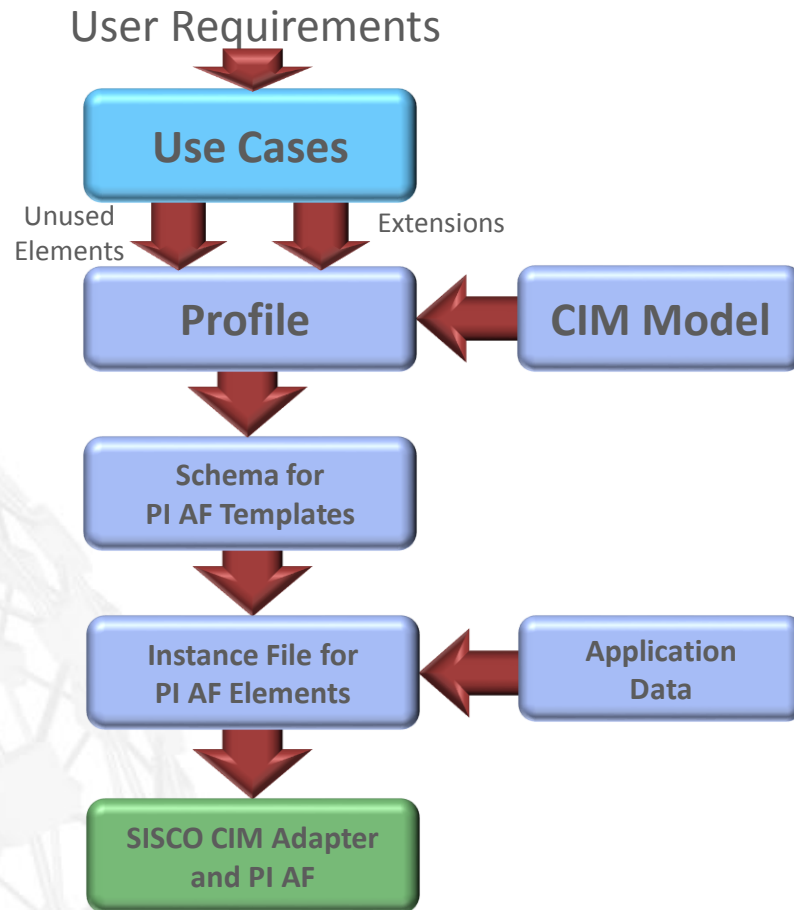


Change Happens

- Addressing change becomes too difficult when each application uses its own incompatible data modeling:
 - » Business needs demand organizational changes and new levels of data sharing and integration.
 - » New technology must be addressed (e.g. renewables, DER, “deregulation”, etc.
- Result: **Application rewrites, reintegration, project delays, barriers to data sharing.**

The CIM Model-Driven Process

- CIM is flexible to accommodate:
 - » Extensions for non-standard business needs
 - » Eliminate the complexity of unused models
- Profiles are created based on use cases to address your specific needs
- Instances created to relate existing data to the CIM Profile schema
- SISCO CIM Adapter used to configure PI AF Templates and Elements
- User applications use models to access data eliminating tag name dependency.

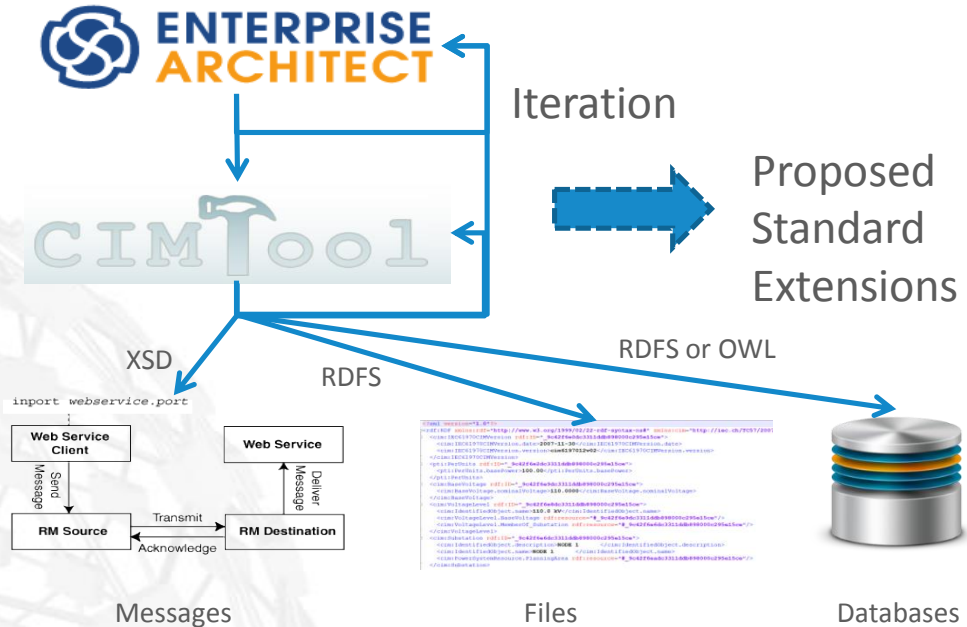


The Process of Profiling: Defining Information to be Exchanged

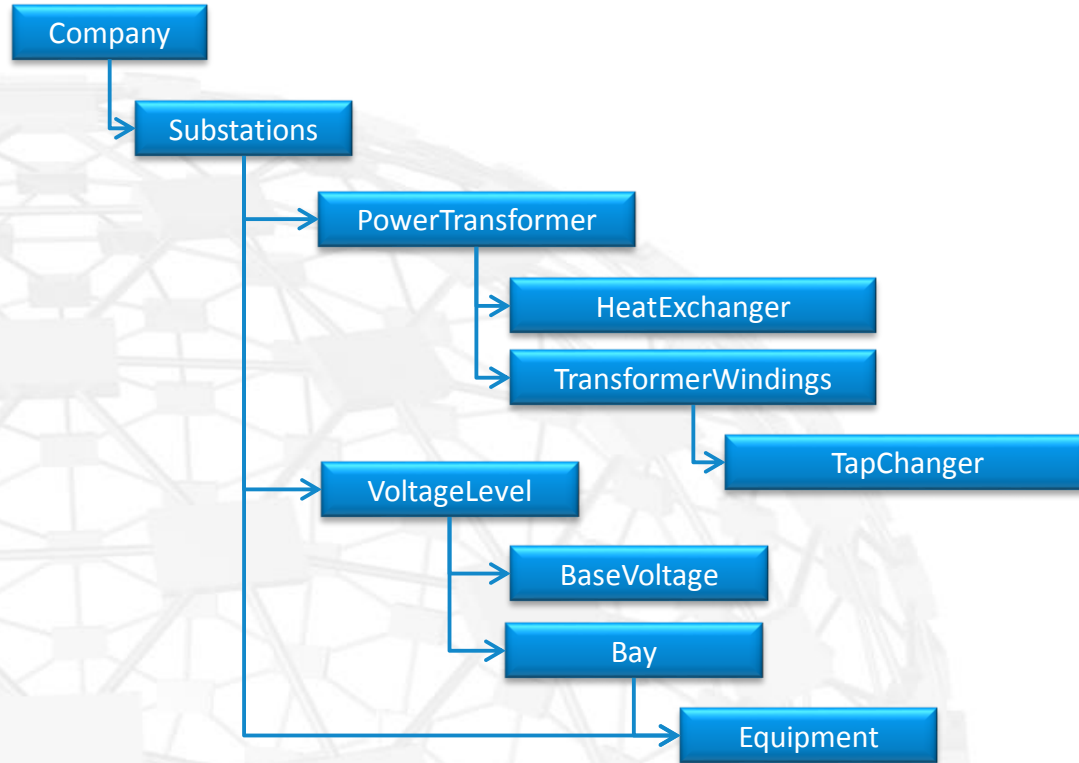
Step 1: Develop model

Step 2: Develop profile

Step 3: Implementation:
Create adapters /configuration



What can be created



CBM Modeling with CIM in PI AF

The screenshot displays the 'CBM - PI System Explorer' application window. The interface includes a menu bar (File, Edit, View, Go, Help), a toolbar with icons for Database, Query Date, Back, Check In, and New Element, and a search bar. The main window is divided into two panes. The left pane, titled 'Elements', shows a hierarchical tree structure under 'SISCO Managed Models' > 'Layers' > 'SDGE_CBM' > 'Layers' > 'ClassView'. The right pane, also titled 'Elements', shows a table of assets under the 'SDGE_CBM' element. The table has columns for Name, Description, Category, Type, and Template. The 'ClassView' element is selected in the left pane, and its contents are displayed in the right pane. Below the main panes, there is a status bar showing 'ClassView Modified: 10/28/2008 3:09:05 PM. Version: 1/1/1970 12:00:00 AM, Revision 1' and a taskbar with the 'Start' button and the application icon.

Elements

- Elements
 - SISCO Managed Models
 - Layers
 - SDGE_CBM
 - Layers
 - ClassView
 - breakerAssets
 - breakerType
 - bushing
 - CBMSystem
 - DGA
 - distributionTransmission
 - LTC
 - LTCTransformer
 - predictiveAnalysis
 - report
 - SF6GasBreaker
 - Substation
 - systemReports
 - systemStatus
 - thermal
 - transformerAssets
 - transformerType
 - voltageLevel
 - InstanceView

Elements

CBM Group by: ☐ Category ☐ Template

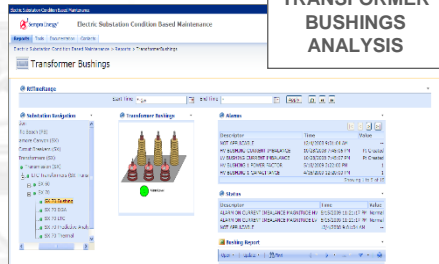
Search

Name	Description	Category	Type	Template
SISCO Managed Mo...			None	SISCO Model Template
SDGE_CBM	Created from R...		None	SDGE_CBM
ClassView			None	
breakerAssets		SDGE_CBM: S...	None	SDGE_CBM:breakerAssets
breakerType		SDGE_CBM: S...	None	SDGE_CBM:breakerType
bushing		SDGE_CBM: S...	None	SDGE_CBM:bushing
CBMSystem		SDGE_CBM: S...	None	SDGE_CBM:CBMSystem
DGA		SDGE_CBM: S...	None	SDGE_CBM:DGA
distributionTran...		SDGE_CBM: S...	None	SDGE_CBM:distributionTransmission
LTC		SDGE_CBM: S...	None	SDGE_CBM:LTC
LTCTransformer		SDGE_CBM: S...	None	SDGE_CBM:LTCTransformer
predictiveAnalysis		SDGE_CBM: S...	None	SDGE_CBM:predictiveAnalysis
report		SDGE_CBM: S...	None	SDGE_CBM:report
SF6GasBreaker		SDGE_CBM: S...	None	SDGE_CBM:SF6GasBreaker
Substation		SDGE_CBM: S...	None	SDGE_CBM:Substation
systemReports		SDGE_CBM: S...	None	SDGE_CBM:systemReports
systemStatus		SDGE_CBM: S...	None	SDGE_CBM:systemStatus
thermal		SDGE_CBM: S...	None	SDGE_CBM:thermal
transformerAssets		SDGE_CBM: S...	None	SDGE_CBM:transformerAssets
transformerType		SDGE_CBM: S...	None	SDGE_CBM:transformerType
voltageLevel		SDGE_CBM: S...	None	SDGE_CBM:voltageLevel
InstanceView			None	

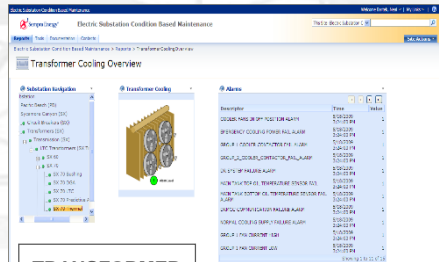
ClassView Modified: 10/28/2008 3:09:05 PM. Version: 1/1/1970 12:00:00 AM, Revision 1

Start | CBM - PI System Expl... 8:06 AM

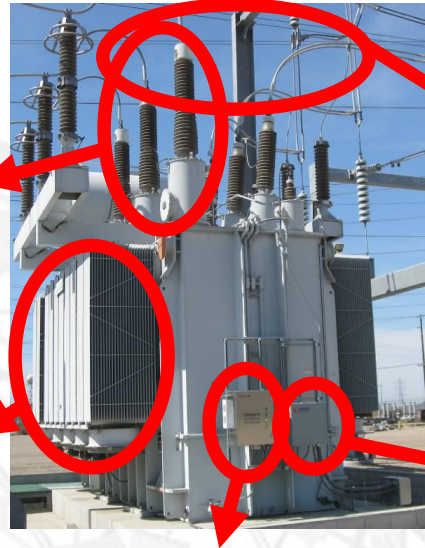
CBM Model-Based Analysis, Notifications and Reporting



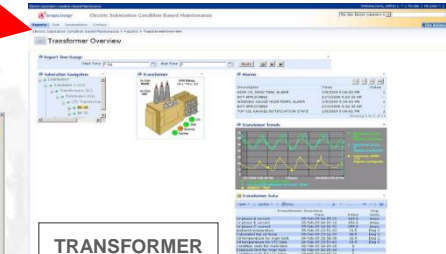
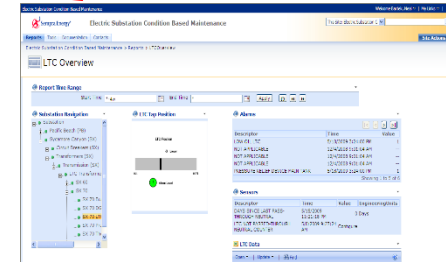
TRANSFORMER
BUSHINGS
ANALYSIS



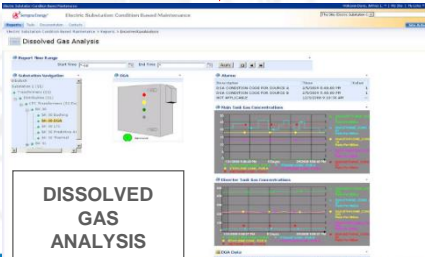
TRANSFORMER
COOLING
ANALYSIS



LTC energy is measured at
the control cabinet on the
other side of the bank

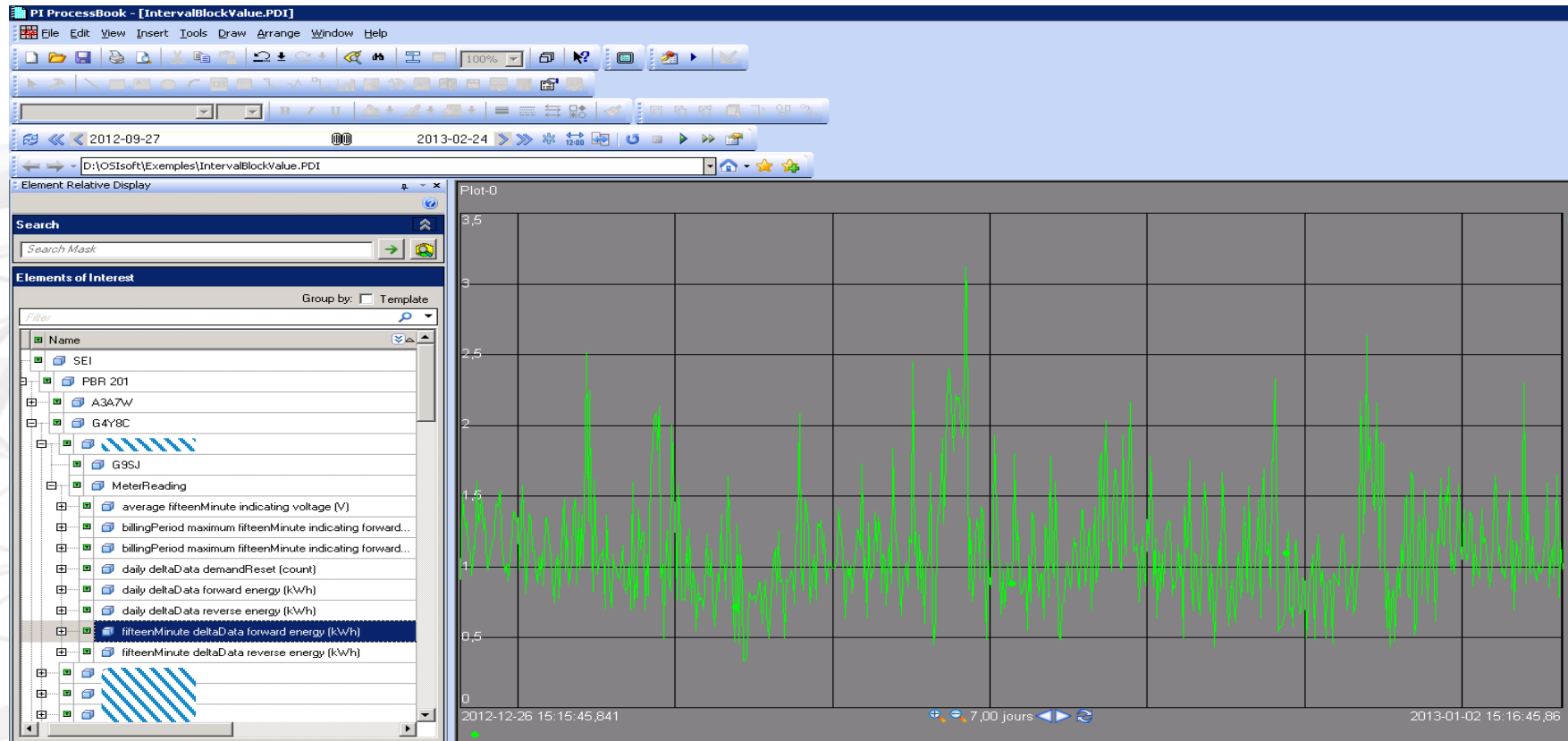


TRANSFORMER
ANALYSIS



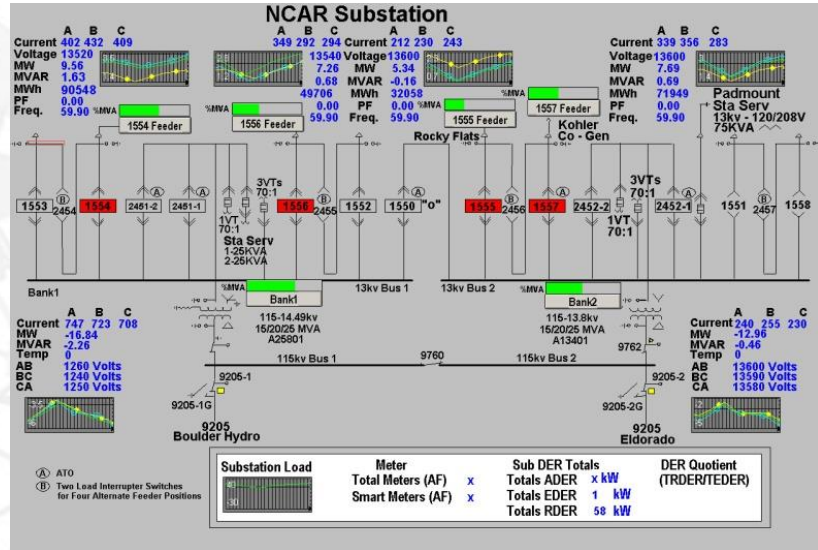
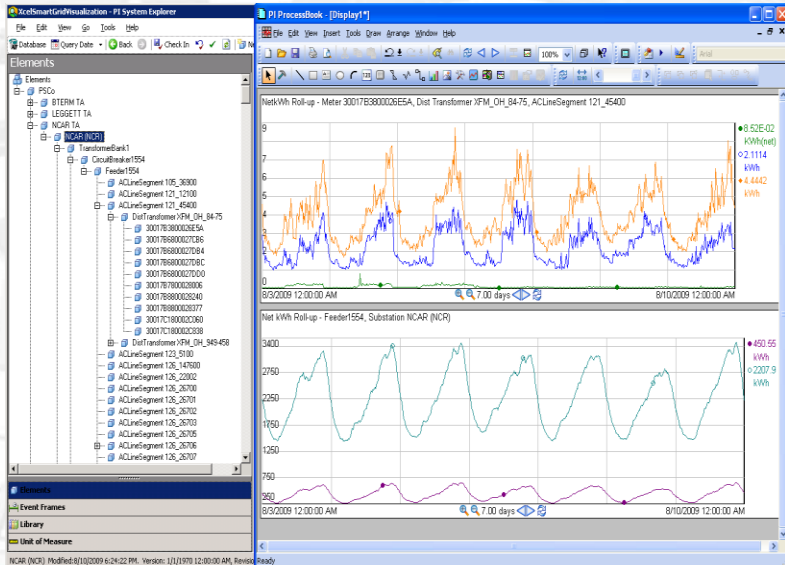
DISSOLVED
GAS
ANALYSIS

ProcessBook – AMI Data (CIM)



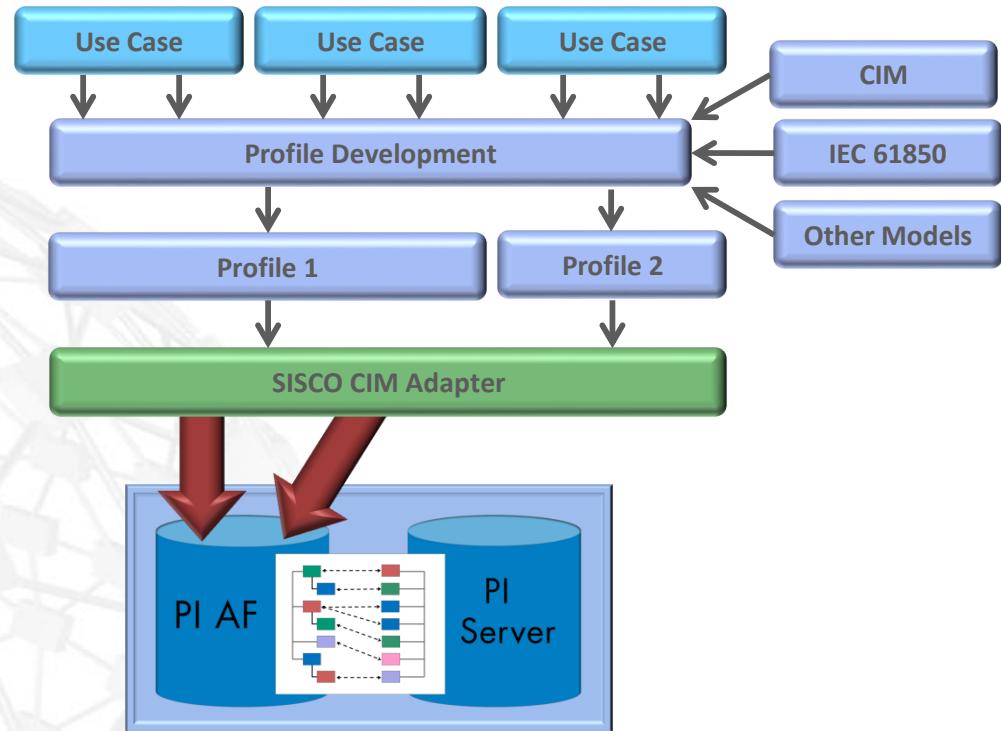
“Roll-up” Mechanism: Net KWh Roll-Up

- Each trend shown is aggregated load (kWh) up to the next higher trend from an individual meter, transformer, line segment, breaker, and substation
- If you overlay the Distribution SCADA load (from PI), the difference would be losses or leakage
- The physical model is in PI AF (CIM) allowing the aggregation and roll-up of individual loads
- End to End visibility – Basic PI integrating meter and distribution system(s) operational data



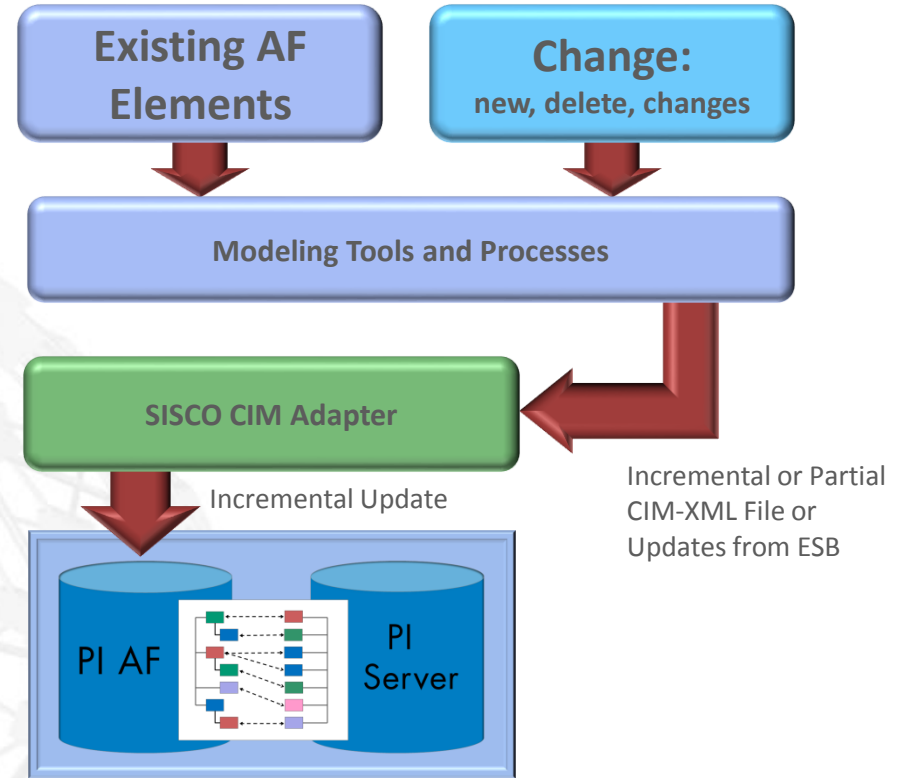
CIM Adapter and PI AF Deliver Flexibility

- Multiple use cases can be addressed with one profile.
- Multiple profiles can be supported for use cases that can't share a profile
- PI AF is flexible to support many models
- A disciplined modeling process with SISCO CIM Adapter brings it all into the PI System



CIM Adapter Helps You Embrace Change

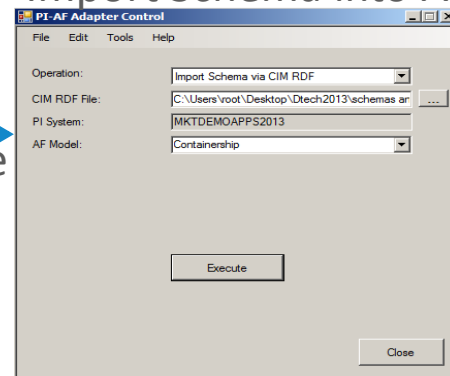
- The model driven process captures change and creates incremental updates
- SISCO CIM Adapter incrementally updates PI AF models.
- The individual hierarchies can be updated and kept synchronized with each other.



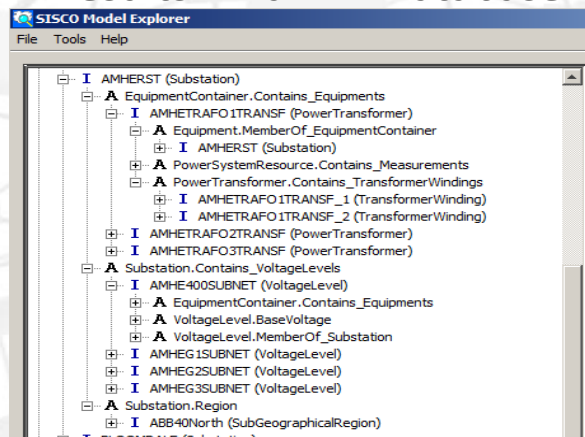
General CIM Adapter Process



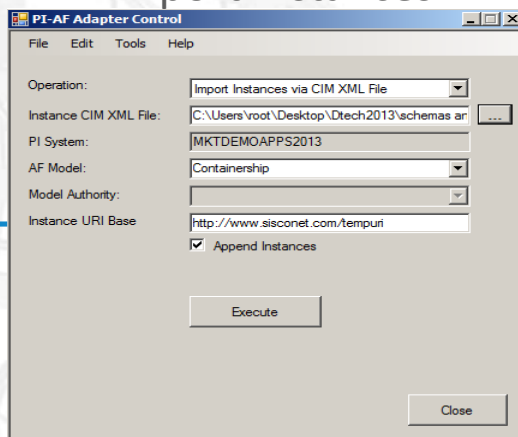
Import Schema into AF



Results in full AF Database



Import Instances



Local
Information

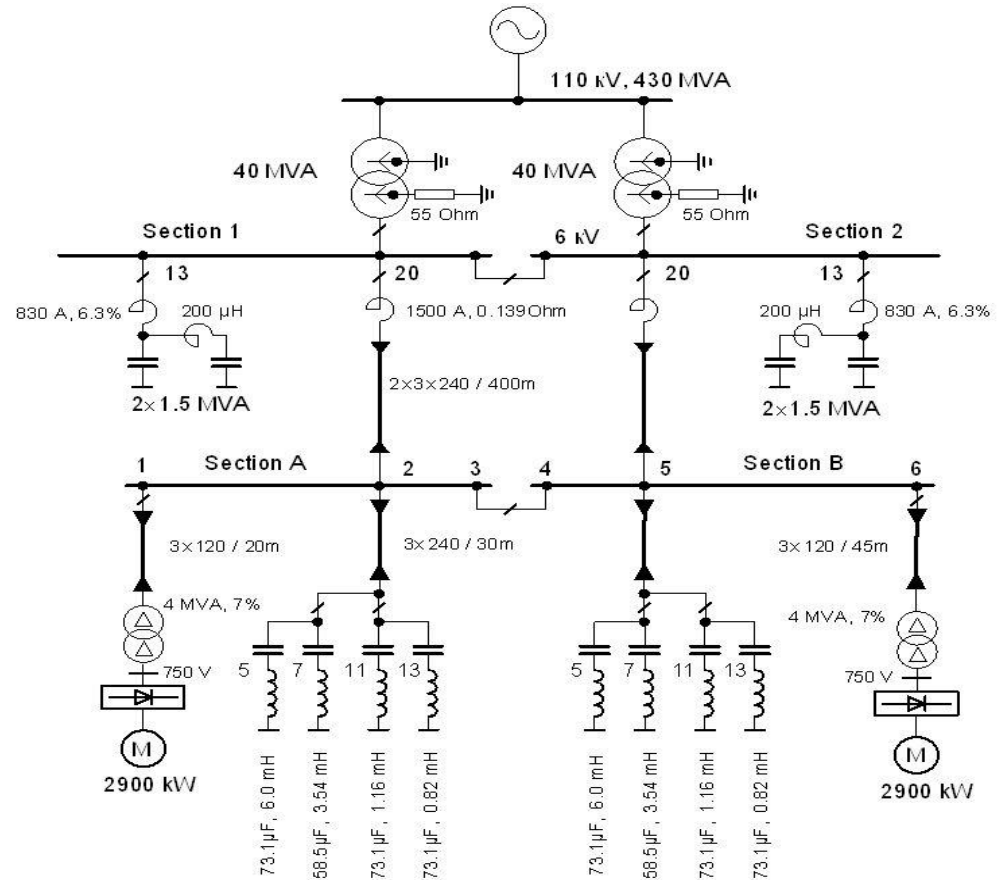


Some facts about AF hierarchies

- The use of multiple hierarchies really creates the equivalent to a “mesh” model.
- Most hierarchies are created using parent-child references which can create maintenance issues.
- Name uniqueness is easier to manage with a mesh model.
- Real world constraints can cause interesting issues.

In the real world....

There is no hierarchy in
terms of electrical
conductance!



Mesh looks like a hierarchy, but allows multiple “views” of information

The image displays two side-by-side screenshots of the SISCO Model Explorer application, illustrating how a hierarchical mesh structure can be viewed from different perspectives.

Left Screenshot: The tree view shows a hierarchy starting with **SubGeographicalRegion.Substations**. Under this, **AMHERST (Substation)** is highlighted with a red box. Below it, the tree expands to show various equipment and measurements, including **AMHETRAFO1TRANSF (PowerTransformer)**, **PowerSystemResource.Contains_Measurements** (with sub-items like **AMHERSG1BUSGEN_APPOWER (Analog)**), **AMHETRAFO1TRANSF_1 (TransformerWinding)**, and **AMHE400SUBNET (VoltageLevel)**.

Right Screenshot: The tree view shows a different perspective, starting with **Disconnecter(I:283)**. Under this, **AMHE400BAY1SW_A (Disconnecter)** is expanded, showing **ConductingEquipment.BaseVoltage** and **Equipment.MemberOf_EquipmentContainer**. The **Equipment.MemberOf_EquipmentContainer** node is expanded to show **AMHE400SUBNET (VoltageLevel)**, which is further expanded to show **VoltageLevel.BaseVoltage** and **VoltageLevel.MemberOf_Substation**. The **VoltageLevel.MemberOf_Substation** node is highlighted with a red box, and a red line connects it to the **AMHERST (Substation)** node in the left screenshot.

Result of Integration with PI AF

Classes per
CIM with
Extensions

Substation with calculated
differential frequency
measurement from
synchronizing relay

IEC 61850 Object Name:
AMHERST9_RSYN1\$MX\$DifHzClc\$f

The screenshot displays the PI System Explorer interface. On the left, the 'Elements' tree shows a hierarchy of classes, with a red box highlighting a list of classes including PMU, PowerTransformer, RegularTimePoint, RegulatingControl, RegulationSchedule, Season, Server, ShuntCompensator, SiscoUnresolvedInstance, StaticVarCompensator, SubGeographicalRegion, SubLoadArea, and Substation. Below this, a specific object is selected, and its details are shown in the right pane. The object's name is 'AMHERST9_RSYN1\$MX\$DifHzClc\$f', and its value is '0.000423431396484375'. The right pane also shows the object's configuration, including its categories, default UOM, value type, and data reference.

Name	Value
AnalogValue.value	0.000423431396484375
IdentifiedObject.aliasName	AMHERST9_RSYN1\$MX\$DifHzClc\$f
IdentifiedObject.localName	
IdentifiedObject.mRID	
IdentifiedObject.name	AMHERST9/RSYN1\$MX\$DifHzClc\$f
IdentifiedObject.pathName	
SISCO	

AMHERST9/RSYN1\$MX\$DifHzClc\$f Modified: 9/12/2013 5:14:50 PM. Version: 1/1/1970 12:00:00 AM, Revision 2

Result of Integration with PI AF

\\MKTDEMOAPP52013\demo - PI System Explorer (Administrator)

File Edit View Go Tools Help

Database Query Date Back Check In Refresh New Element New Attribute

Elements

- IEC61970CIMVersion
- IED
- ISOUpperLayer
- Line
 - Utility40busAMHE400GRAN
 - Utility40busAMHE400MARC
 - Utility40busAPCBLOO220MONR
 - Utility40busAPCCROS400BLOO
 - Utility40busBOW1400TRO1
 - Utility40busBOW2400TRO2
 - Utility40busBOWM400MARC
 - Utility40busCentrMARC400CLAR
 - Utility40busCentrTROY400MARC
 - Utility40busCentrWU1220CLA1
 - Utility40busCentrWU2220CLA2
 - Utility40busCentrWINL400CLAR
 - Utility40busCentrWINL400TROY
 - Utility40busCROS400GRAN
 - Utility40busJUNE220BLOO
 - Utility40busMAP1220CLA1
 - Utility40busMAP2220CLA2
 - Utility40busMARC400LAN
 - Utility40busNorthAMHE400BOWM
 - AMHE400MARLINE
 - dAng 511d440b-8b65-4afa-8a05-b9d54de29f10
 - DifAngClc f8a050a4-c15b-4fef-9759-97cf7df3bb60
 - NorthAMHE400BOWM8/RSYN1\$MX\$DifAngClc\$f
 - Utility40busNorthAMHE400BOWM
 - Utility40North
 - Utility40busSouthMAP1220JUNE
- Utility40busTROY400BLOO
- Utility40busTROY400BLOO
- Utility40busUECGRAN400LAN
- Utility40busWU1220MAP1
- Utility40busWU2220MAP2
- Utility40busWU2220TROY

- LNInet
- LoadArea
- POOL1_(INTERNAL)
- POOL2_(EXTERNAL)

NorthAMHE400BOWM8/RSYN1\$MX\$DifAngClc\$f

General Child Elements Attributes Ports Model View Version

Filter

Name	Value
AnalogValue.value	8.4995193481445312
IdentifiedObject.aliasName	NorthAMHE400BOWM8_RSYN1\$MX\$DifAngClc\$f
IdentifiedObject.localName	
IdentifiedObject.mRID	
IdentifiedObject.name	NorthAMHE400BOWM8/RSYN1\$MX\$DifAngClc\$f
IdentifiedObject.pathName	
SISCO	

Group by: Category

Name: IdentifiedObject.aliasName

Description: The aliasName is f

Configuration Item: ☐

Categories: demo.IdentifiedOb

Default UOM: <None>

Value Type: String

Value: /M8_RSYN1\$MX\$

Data Reference: <None>

Settings...

Angle separation across the
Amherst Bowman line is ~8.5°

NorthAMHE400BBOWM8/RSN1\$MX\$DifAngClc\$f

NorthAMHE400BOWM8/RSYN1\$MX\$DifAngClc\$f Modified:9/12/2013 5:14:52 PM. Version: 1/1/1970 12:00:00 AM, Revision 2

Adding COMTRADE Information

Use of AF References Enables Synergy

- What if you want to know if a transient disturbance occurred that affected a transformer?

Protection and disturbances add another dimension

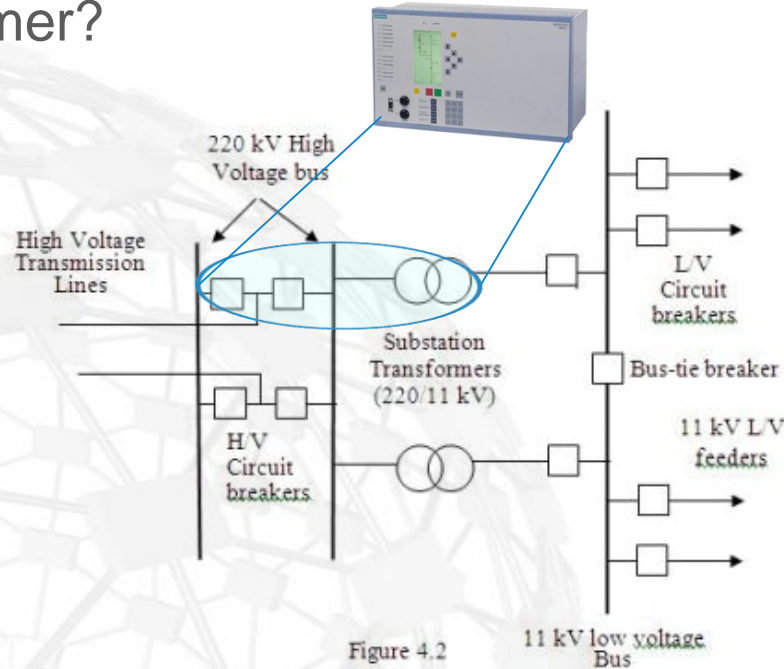
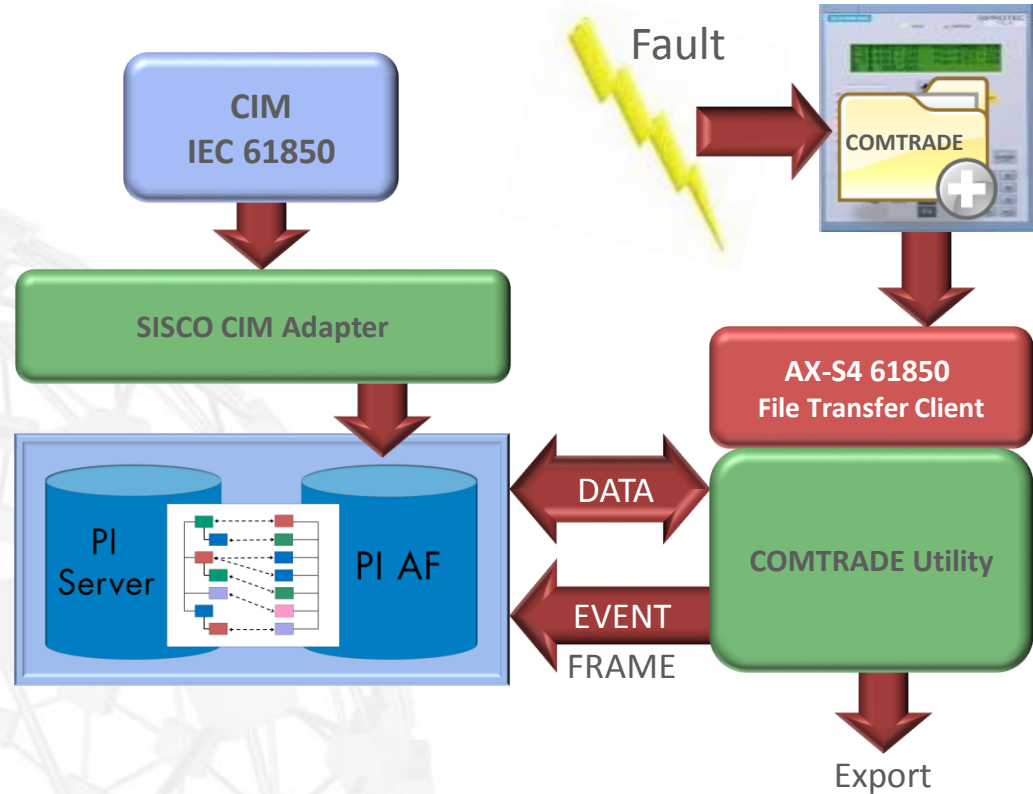


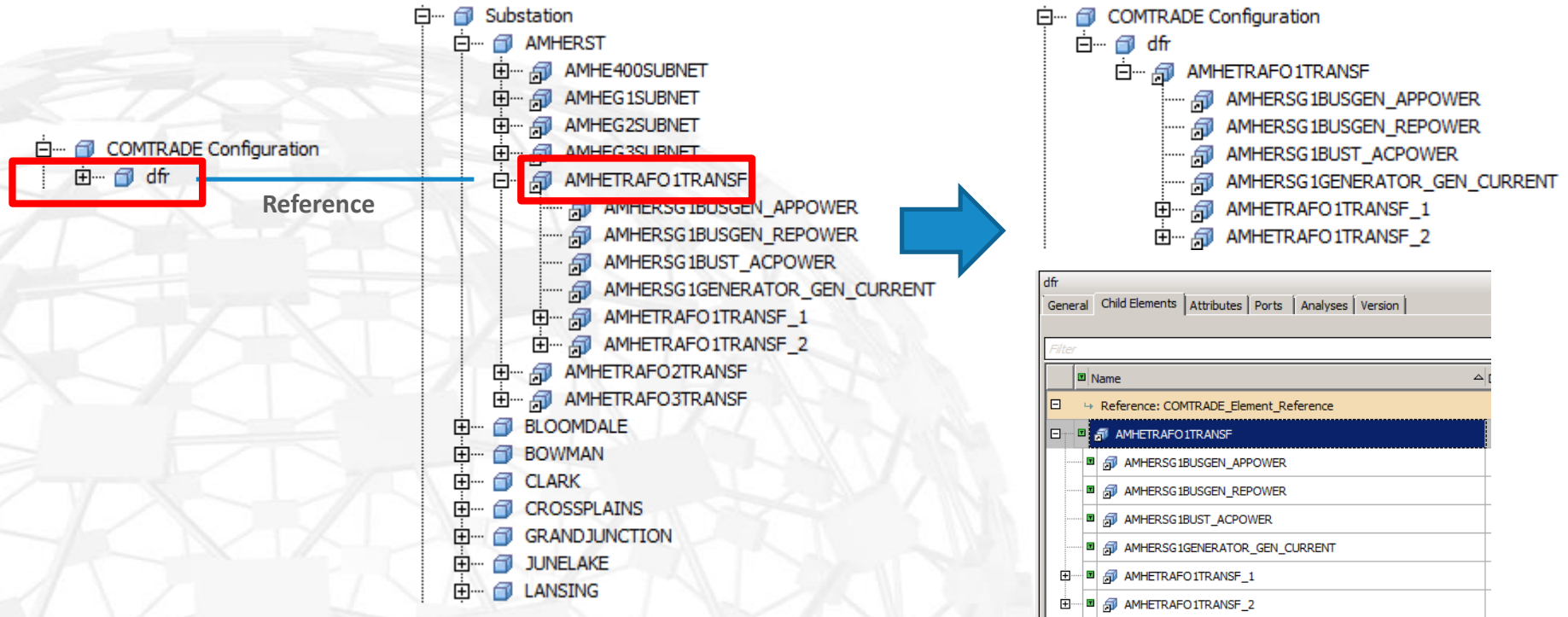
Figure 4.2
Distribution substation

PI AF with CIM Works Across Applications

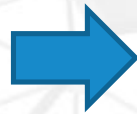
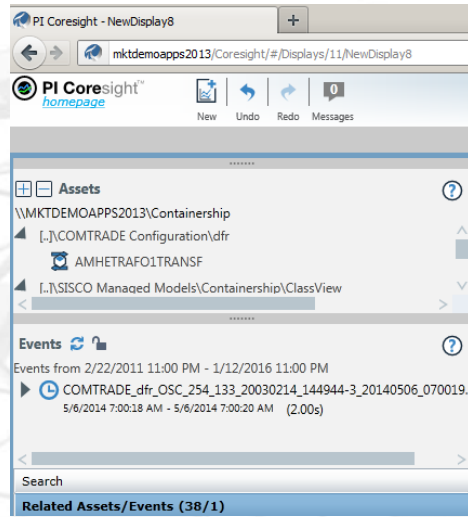
- SISCO COMTRADE Utility brings disturbance data into the PI System using PI Event Frames
- CIM and PI AF models help correlate all the data in the context needed by the individual application needs.



Use of References Allow Model/Application Expansion



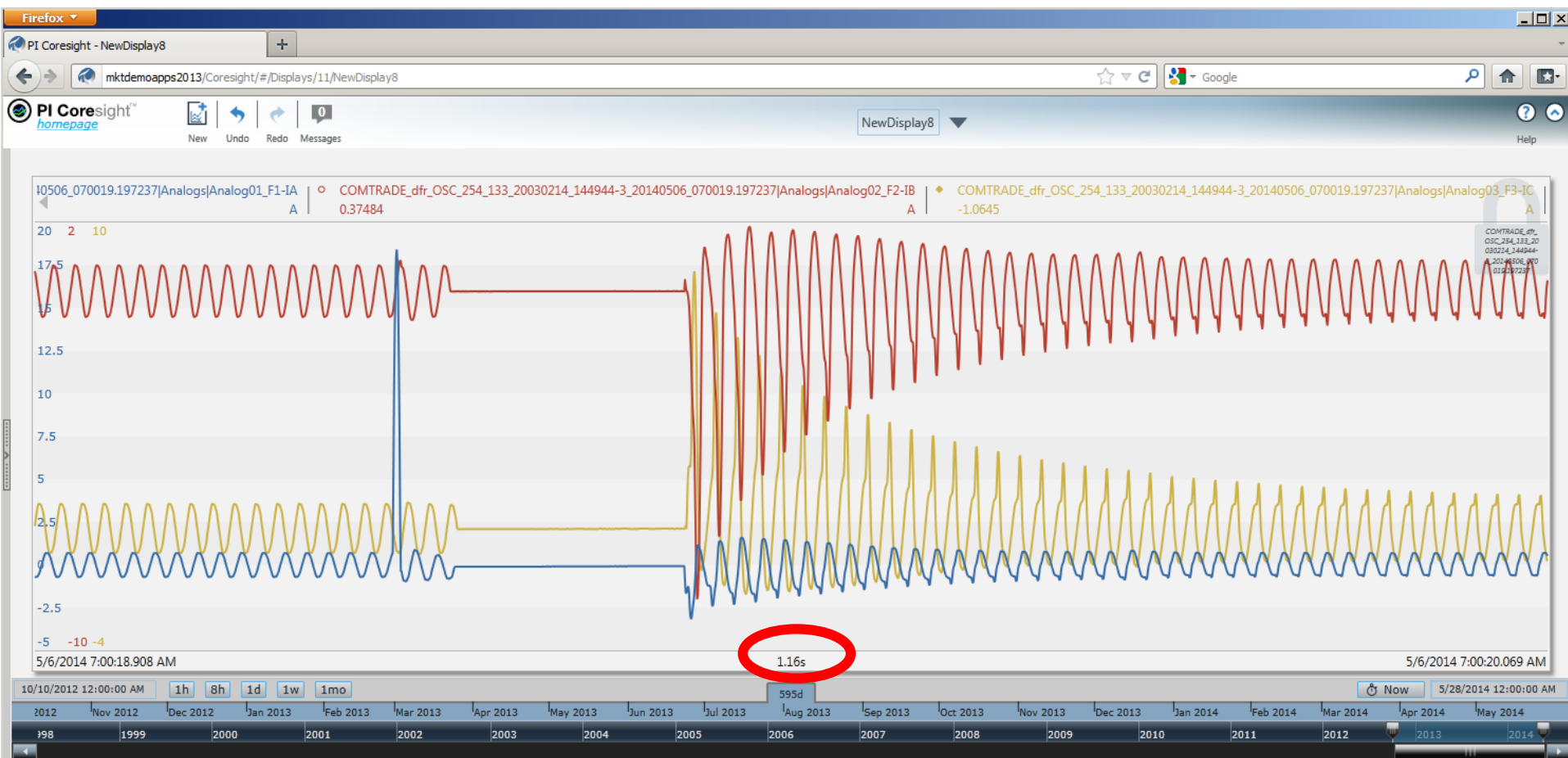
Referenced PI Event Frames + Coresight = Visualization



Drag



A closer look...



Who Needs to be Notified of Event?

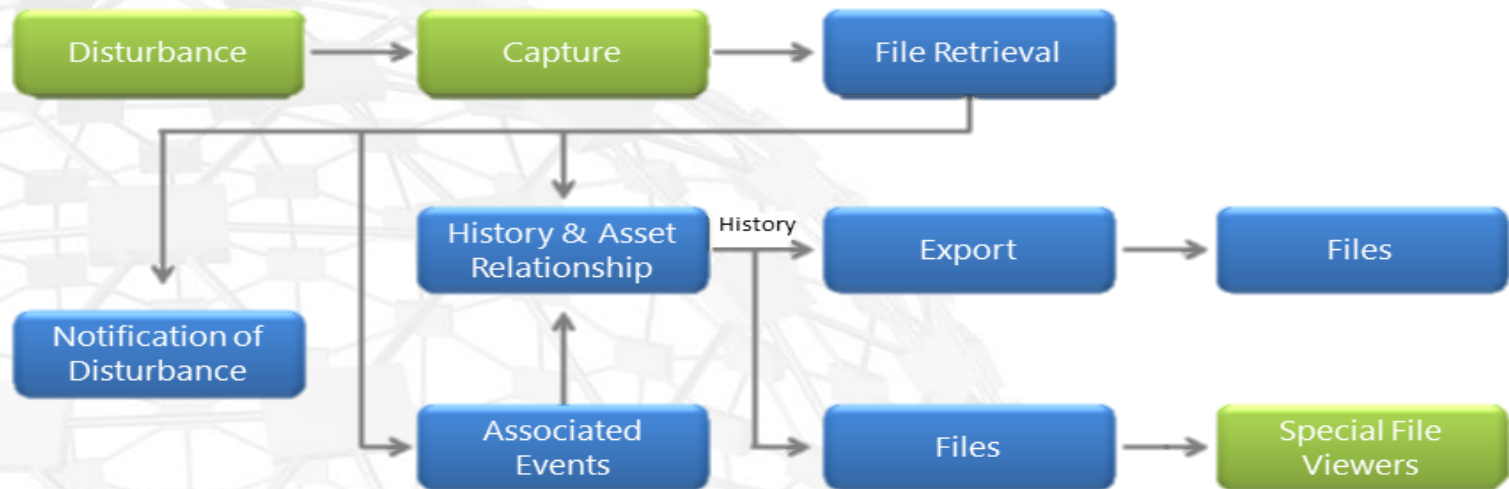
- Protection engineers that a new COMTRADE file has been obtained.
- Asset managers in regards that key assets could have been impacted.
- Others
 - “Easy “ to deliver notification through email. Other notification channels are possible and programmable.

PI Notifications Tricks of the Trade:

- In order to cause a trigger, the PI Tag change must go through the snapshot (current).
- Currently, PI Tag changes can trigger a notification (even if done through the lens of PI AF).
- PI Event creation and PI AF attribute value (non-PI Tag) change have both been requested to be added as a trigger.

How it Works?

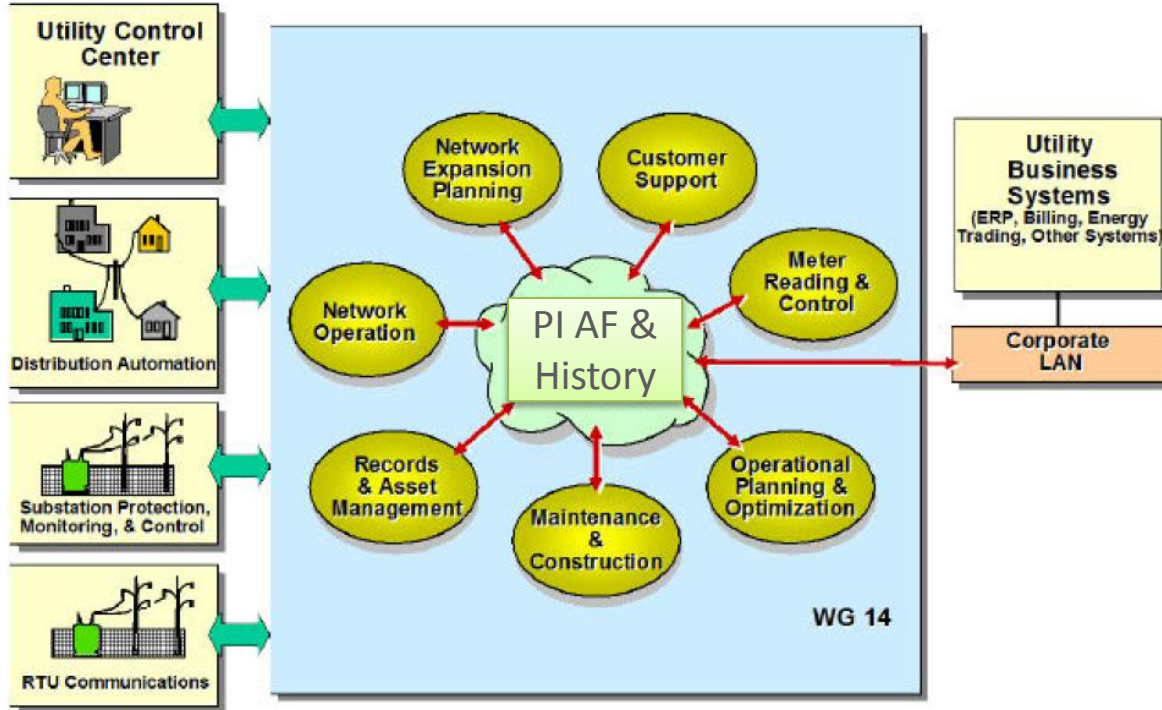
COMTRADE UTILITY



Metering and Messaging

Using Models for Integration With Other Systems

Models and AF can be central to messaging

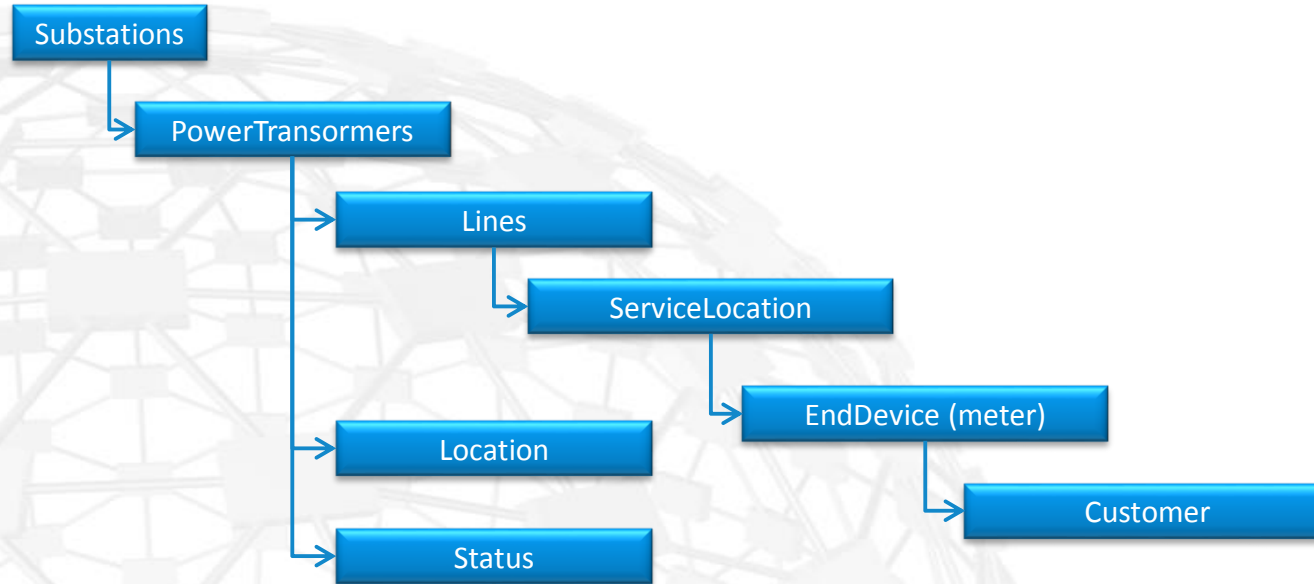


From IEC 61968-1

Messaging is Centric

- Messaging that comes from other systems can be handled via various OSIssoft interfaces (e.g. Meter HeadEnds/MDMs) or custom code.
- What about using PI/PI AF to generate messages?
 - » Use case: SCADA monitored Feeder Transformer is down due to protection event. How/what should notify the outage or customer support systems?

Relationships Needed For The Use Case (simplified)



Now possible to define a XML message that:

- Conveys the location of the outage (needed for dispatch)
- Customers impacted
- More modeling can allow more information.

PI AF as a trigger for a message

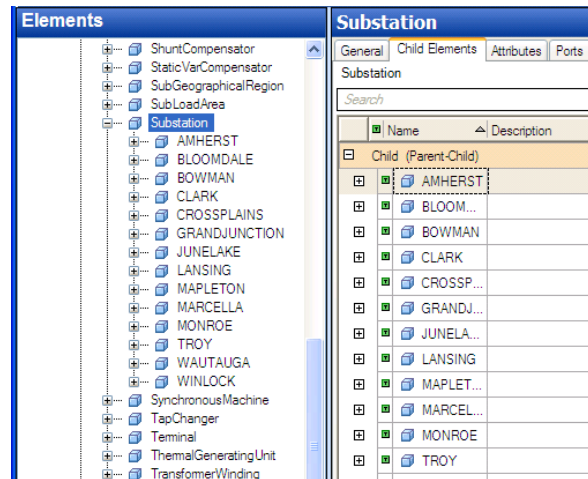
- PI AF can create events that can be subscribed to (e.g. PI Analytics)
 - » Current scalability is being improved
- Give a trigger, an application can generate a XML message defined by a XSD created via profiling or standard.
- Future versions of PI Analytics should be capable of using .NET assemblies and PI AF triggers to perform this function.

Summary

CIM is a pre-existing standardized utility oriented data model that provides a platform to build an application data model that addresses enterprise level needs.

IEC 61850 provides a data model that provides context and meaning to telemetry data that can be associated to CIM

PI AF and SISCO CIM Adapter provide an excellent foundation to support effective application of application data models for utilities.



Business Challenge

- Taking advantage of application data models that meets individual group needs while supporting enterprise wide integration and data sharing that can be adapted to changes.

Solution

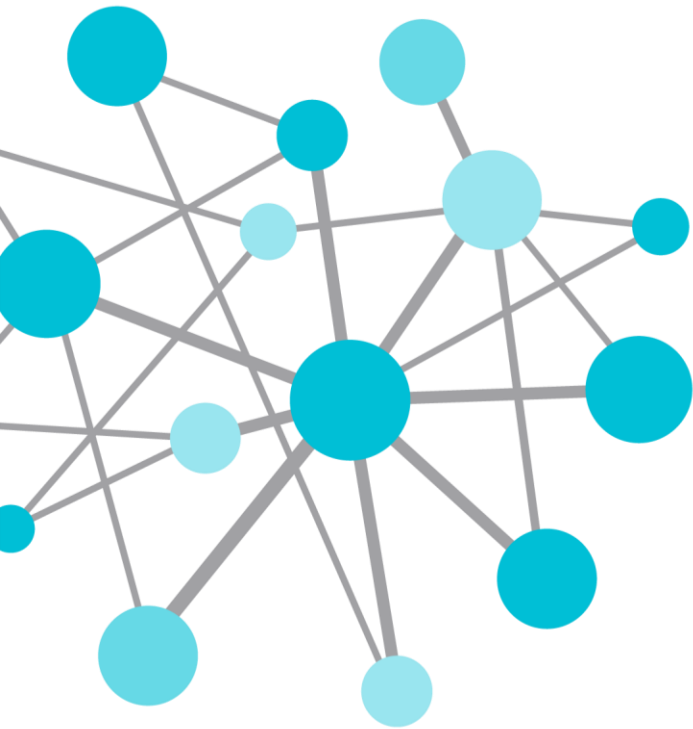
- PI AF to organize all PI System data
- SISCO CIM Adapter to automate PI AF modeling
- CIM based model driven process to manage change

Results and Benefits

- A single enterprise level based for PI AF that can be optimized for individual application needs
- Flexibility to minimize effort adapting to change

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THANK
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