

Building a Large Scale AF Model Enabling Operational Intelligence

Presented by Jeff Parker – Senior Operations Engineer
Cody Parker – Supervisor Operations Support



SPP at a Glance

- Located in Little Rock
- About 600 employees
- Primary jobs —
electrical engineering,
operations,
settlements, and IT
- 24 x 7 operation
- Full redundancy and
backup site



Our Major Services

- Facilitation
- Reliability Coordination
- Transmission Service/
Tariff Administration
- Market Operation
- Standards Setting
- Compliance Enforcement
- Transmission Planning
- Training
- Balancing Authority

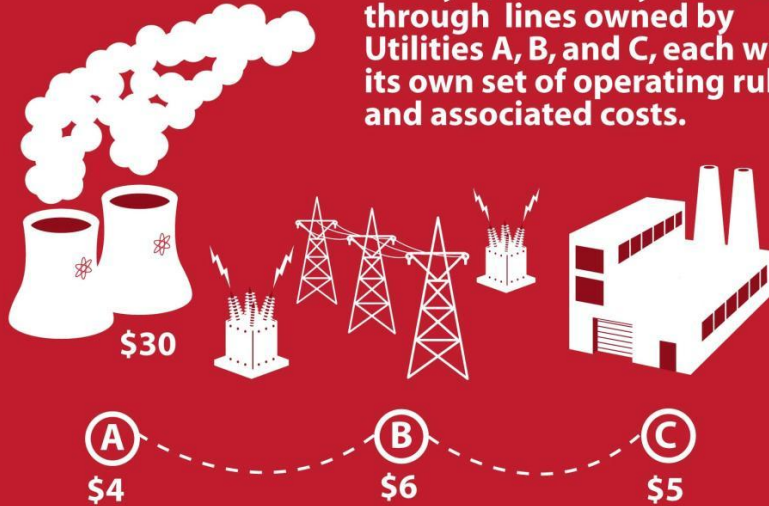
Our Approach

- Regional
- Independent
- Cost-effective
- Focus on reliability

Transmission Service

Without SPP

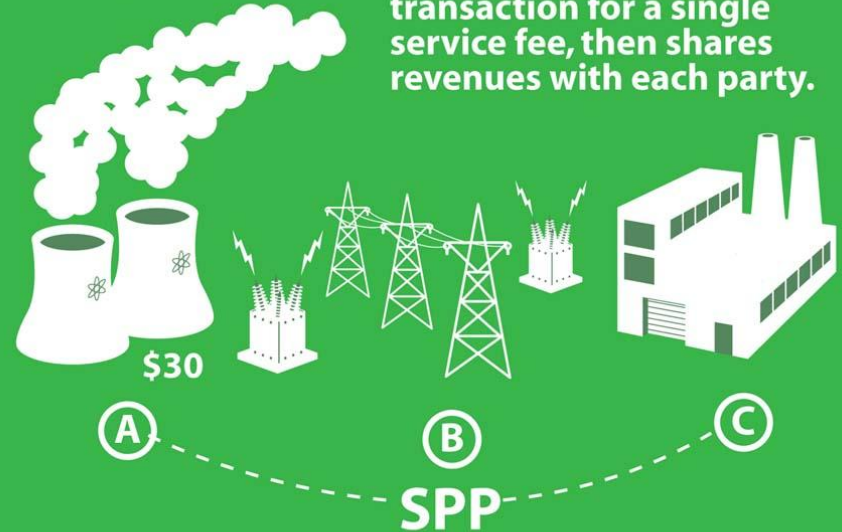
To get from a generator in Utility A to a customer in Utility C, electricity must flow through lines owned by Utilities A, B, and C, each with its own set of operating rules and associated costs.



$\$15 \text{ transmission service} + \$30 \text{ energy} = \$45$

With SPP

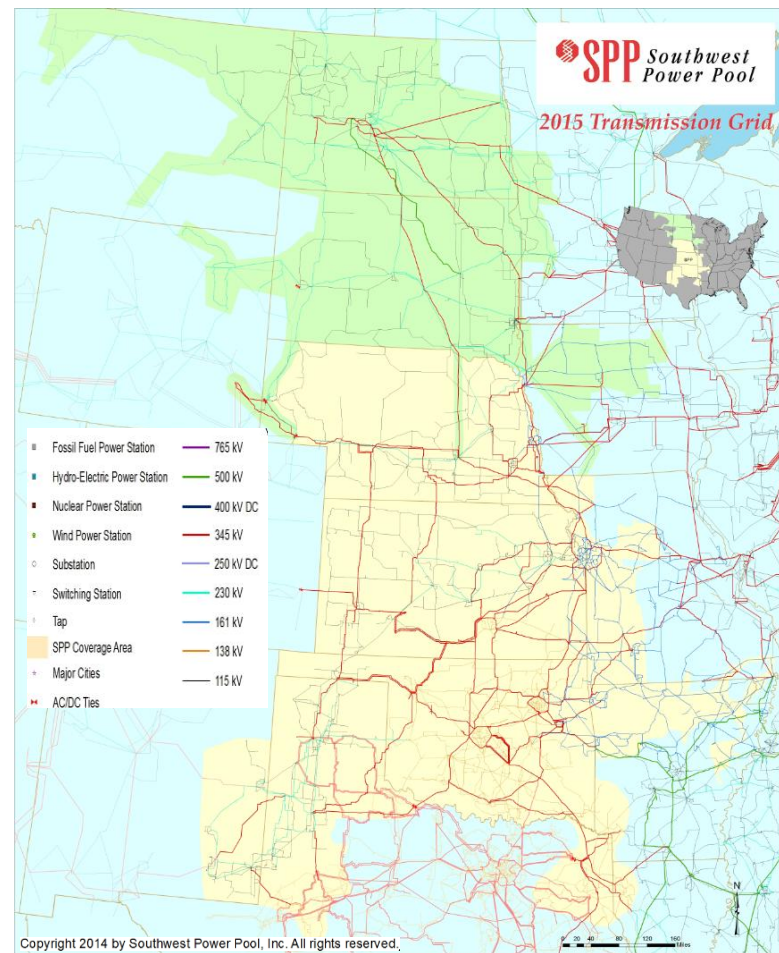
SPP moves electricity across Utilities A, B, and C in one transaction for a single service fee, then shares revenues with each party.



$\$5 \text{ transmission service} + \$30 \text{ energy} = \$35$

Operating Region

- 370,000 miles of service territory
- More than 15 million people
- 627 generating plants
- 4,103 substations
- 48,930 miles transmission:
 - 69 kV – 12,569 miles
 - 115 kV – 10,239 miles
 - 138 kV – 9,691 miles
 - 161 kV – 5,049 miles
 - 230 kV – 3,889 miles
 - 345 kV – 7,401 miles
 - 500 kV – 93 miles



PI System Implementation Timeline

- 02/01/12
 - Signed EA
- 5/13/13
 - PI System deployed in five environments across multiple domains and two data centers
- 3/1/14
 - PI System used in production
- 6/24/14
 - Upgraded to PI Server 2014
- 9/1/14
 - One millionth PI Tags created





Building an Asset Framework Model

Building a AF Model

SPP has the need to record over a million streaming points with reasonably fast update times, perform calculations and have users be able to locate the data they need.

AF is able to provide the structure needed to group and locate data. However, with such a large model, over 150,000 AF Elements, the challenge was in creating robust templates, hierarchy and automated processes to generate the model.

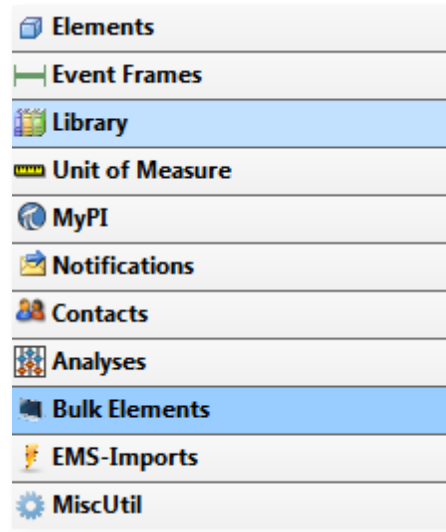


Business Challenge

- Recorded over 1 million data points with 4 second updates
- Real time calculations

Solution

- Asset Framework (AF)
- Custom PI System Explorer Plugins
- AF SDK
- Asset Analytics

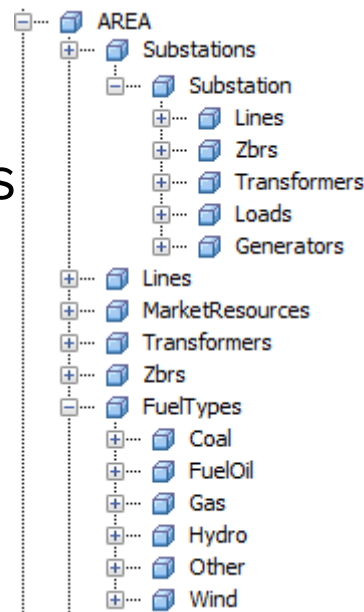


Results and Benefits

- Automated AF Elements and PI Tag creation
- Complex AF calculations recorded as PI Tags

Designing and Maintaining AF Model

- Large Network Model
 - 12k Substations
 - 16k Lines
 - 3.5k Transformers
 - 2.7k Generators
 - 3k Capacitors and Reactors
 - 15k Loads
 - 70k Circuit Breakers
 - 130k SCADA Measurements
- Based on EMS hierarchy
- Keep nodes small as possible
- Make use of references (links) whenever possible



AF Modeling Process

Asset Framework is used to consolidate information from multiple systems: Energy Management System (EMS), Markets, Outage Data, Forecast Data. The models are combined in SQL Views and AF Elements are built using the AF SDK.

PI AF Templates

- Create AFELEMENTTemplates for Equipment Types
- Create AFAttributeTemplates to build PI Tags

Import Other System Models

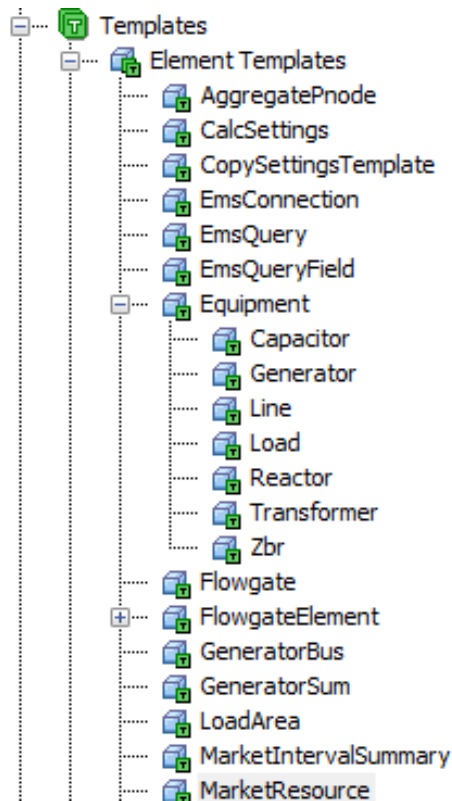
- Import EMS and Market Models into Staging Database
- Create SQL Views for each AFELEMENTTemplate

Build PI AF Elements

- Build AFELEMENTs from AFELEMENTTemplates and SQL Views
- Build PI Tags for each AFELEMENT

AF Templates

- Build Templates for each equipment type
- Use PI Tag Creation feature to automatically generate PI Tags



	MVar
+	MW
	MWh

Name: MW

Description: SCADA\DIS_ANALOG: MW Scada

Configuration Item: ☐ Indexed: ☐

Categories: Generation

Default UOM: megawatt

Value Type: Single

Default Value: 0 MW

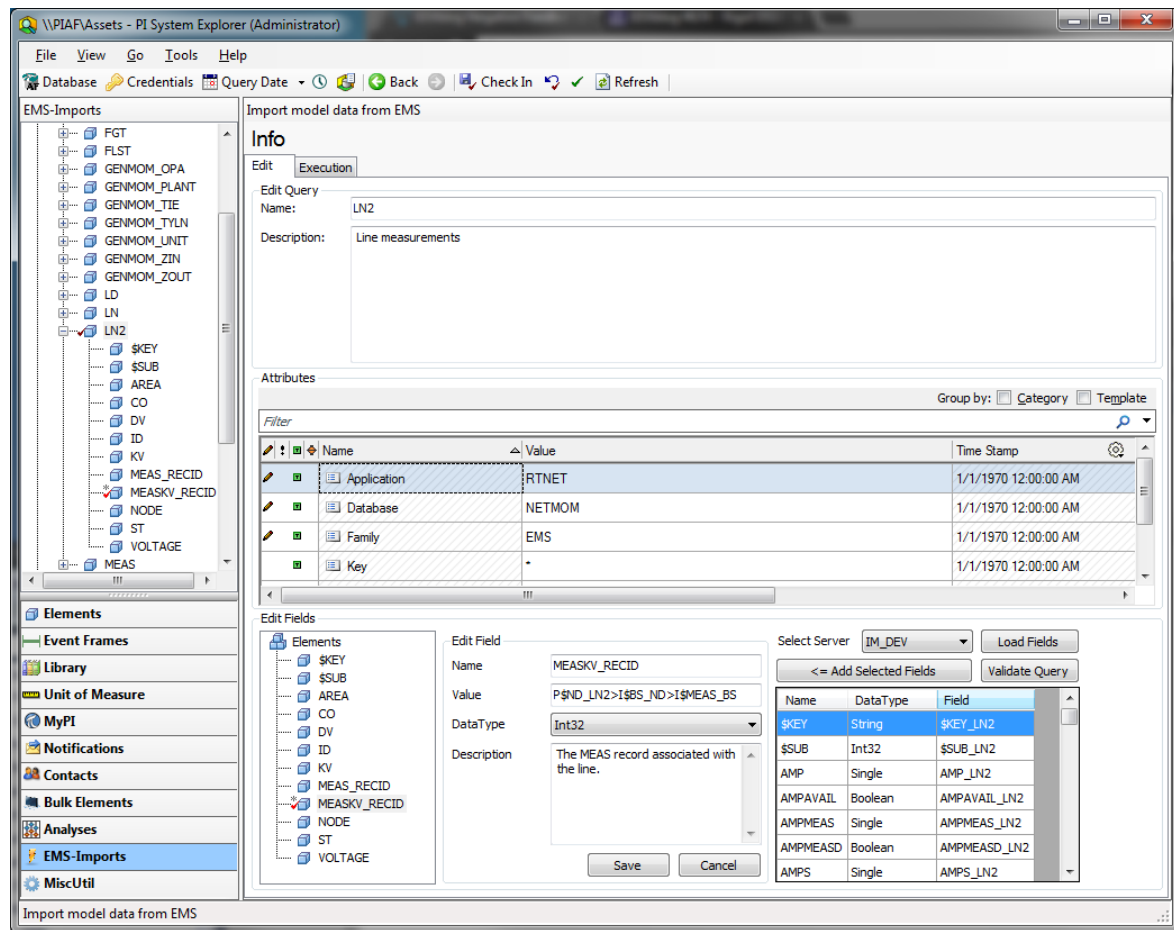
Data Reference: PI Point

Settings...

\\%Server%\%@\.[ScadaKey
%;compressing=0;descriptor="%Description
%";excdev=0;excdevpercent=0;excmax=0;exde
sc=%@\.[ScadaKey
%;instrumenttag=DIS_ANALOG;location1=1;locat
ion4=1;pointsource=HABC_SCADA;pointtype=Flo
at32;ptclassname=classic;step=1;scan=1

Customized Tools

- Import EMS and Market Models into Staging Database
- Develop PI System Explorer plugins to import data
- Store all plugin configuration as AF Elements



Customized Tools

- SQL Views showing all equipment attributes for an AF Element Template

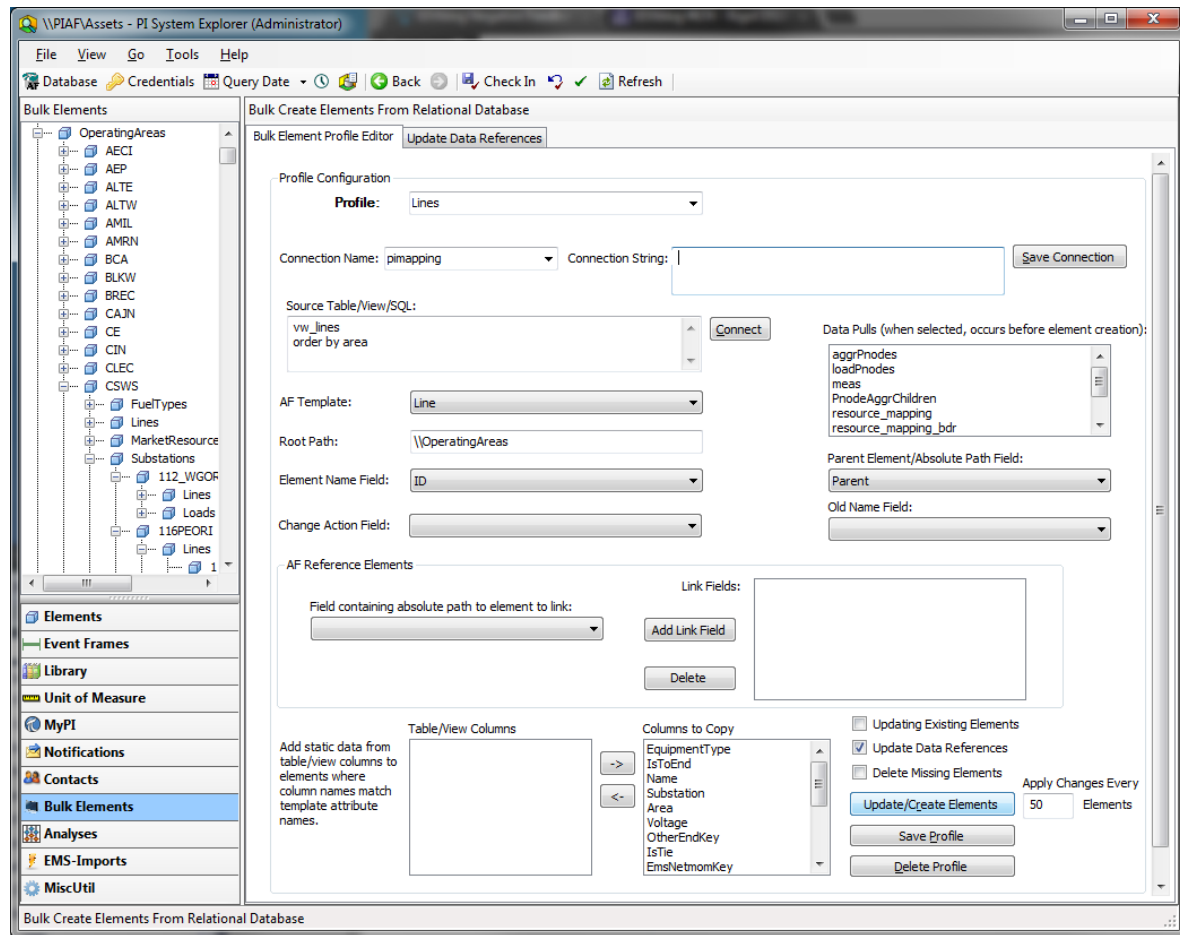
The screenshot displays the Microsoft SQL Server Management Studio (Administrator) interface. The 'Object Explorer' on the left shows a tree view of the database structure, with 'dbo.vw_Lines' selected. The main query window shows a SQL script for selecting the top 1000 rows from the 'vw_Lines' view. The 'Results' pane at the bottom displays the output of the query as a table with columns: EquipmentType, Name, Substation, Node, Voltage, and NormalLimit. The status bar at the bottom indicates 'Query executed successfully.' and 'pimapping'.

```
1 /***** Script for SelectTopNRows command from SSMS *****/
2 SELECT TOP 1000
3     [EquipmentType]
4     , [Name]
5     , [Substation]
6     , [Node]
7     , [Voltage]
8     , [NormalLimit]
9     , [EmerLimit]
10    , [LoadshedLimit]
11    , [isTie]
12    , [EmsNetomKey]
13    , [EmsNetomKey|Division]
14    , [EmsNetomKey|EmsId]
15    , [EmsNetomKey|Node]
16    , [EmsNetomKey|Owner]
17    , [EmsNetomKey|Substation]
18    , [EmsNetomKey|Voltage]
19    , [segment]
20    , [oldID]
21    , [KEY_TO_MATCH_CMT]
```

	EquipmentType	Name	Substation	Node	Voltage	NormalLimit
1	Line	5059	NICKTAP	1	69	28
2	Line	ELKS1NICKT69_1	NICKTAP	1	69	28
3	Line	5112	SPARK	2	69	60
4	Line	5115	SPARK	2	69	60
5	Line	ACADIA_RORK	ACADIA	B27	138	765
6	Line	RAMOS-BUVSTA99	BERKWKTP	1237	138	270
7	Line	5089	CENTENL	3	138	252
8	Line	5089B	CENTENL	4	138	203
9	Line	5049	BRAPID	4	138	310
10	Line	5121B	JULTAP4	4	138	270
11	Line	5121	JULTAP4	4	138	270
12	Line	5048	BRAPID	4	138	286
13	Line	BSALETECH13_1	BSALES	3	138	270
14	Line	NORBND4_G1COLU	N_BEND1	1	138	50

Customized Tools

- Plugin to build AF Elements from SQL Views
- Processes Adds, Deletes and Renames
- Command line version for running as a scheduled task or batch script

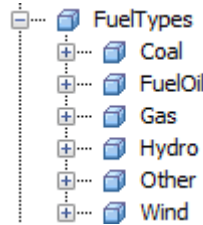




Results and Benefits

Asset Analytics

- Use existing Hierarchy for calculations
- Analysis Templates for easy replication of calculations



MarketResourceSum

General | Attribute Templates | Ports | Analysis Templates

Name: TotalGeneration

Description:

Categories:

Analysis Type: ☐ Expression ☒ Rollup

Example Element: [OperatingAreas\LES\FuelTypes\Coal](#)

Rollup attributes from

☒ Child elements of Coal

☐ This element - Coal

To select attributes set criteria below

Attribute Name: MWOut

Attribute Category:

Element Category:

Element Template:

Select the function(s) to write to an attribute

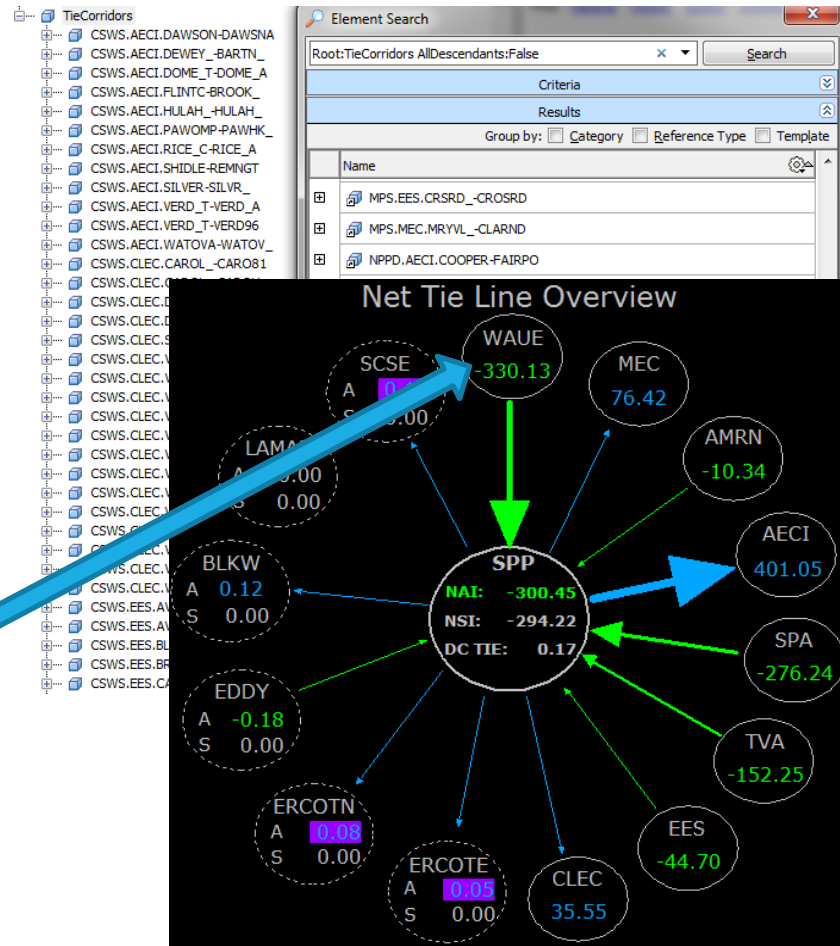
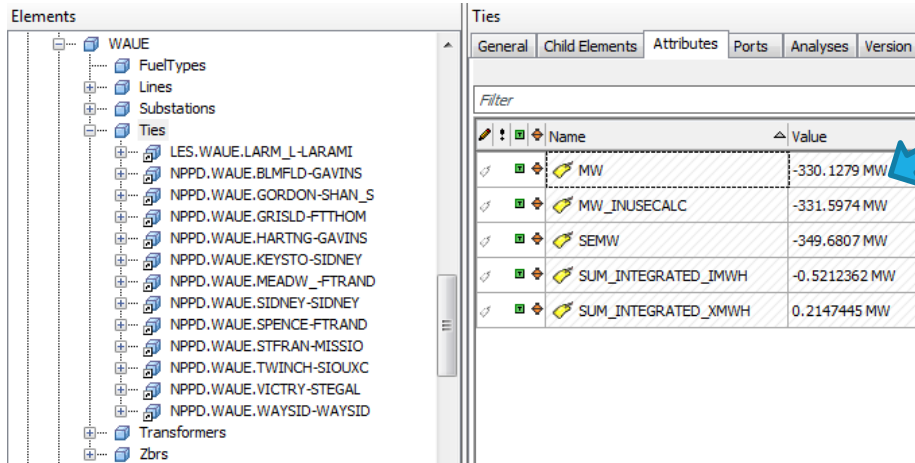
Function Output(s) Value

☒ Sum [TotalGeneration](#)

Evaluate

Asset Analytics

- Quickly create new hierarchy for new calculations



- PI Server can serve as backup to EMS RTGEN



Event Frames

- Used to alert operators of real-time issues

MarketResource

General | Attribute Templates | Ports | Analysis Templates

Name	Configuration	Schedule	Output(s)
MVarRollup		Natural	MVar
Reg Response and Reg Perf...	SetpointCRPrev := if Not...	Frequency=4	SetpointCR; EffectiveEner...
ResourceTripEvent	Template: MarketResourc...	Natural	Event frame

Example Element: [MarketResources\CSWS.AECC_ELKINS2](#)

Event Frame Template: [MarketResourceUnitTrip](#)

Name	Expression	Value
Ramp	<code>(TagVal('MW') - TagVal('MW', '*-60s'))</code>	⊗
Limit	<code>Abs(Max('EffMaxLimit' * 0.1, 'EcoMax' * 0.1, 'DnRampRate' * 2, 100))</code>	⊗
ACECheck	<code>If (Ramp < 0 and ('...\OperatingAreas\SPP\MarketResources\ACEChange') < (.8*Ramp)) Then True Else False</code>	⊗
StartTrigger	<code>If (ACECheck = True and Ramp < -Limit and 'PlanCommitted' = True) Then True Else False</code>	
EndTrigger	Type an expression (optional)	

[Add a new expression](#)

Hide CASE INT MKT RC CDAT

ACE
AGC
BAAL
CRD
Floor Room
Frequency
Gen Loss
Head Room
Island
Time
TLR

14:05 04/06/2015

MPS.DOGWOOD:-
78.82098MW Age:00h
04m

Building a AF Model

SPP has the need to record over a million streaming points with reasonably fast update times, perform calculations and have users be able to locate the data they need.

AF is able to provide the structure needed to group and locate data. However, with such a large model, over 150,000 AF Elements, the challenge was in creating robust templates, hierarchy and automated processes to generate the model.

Solution

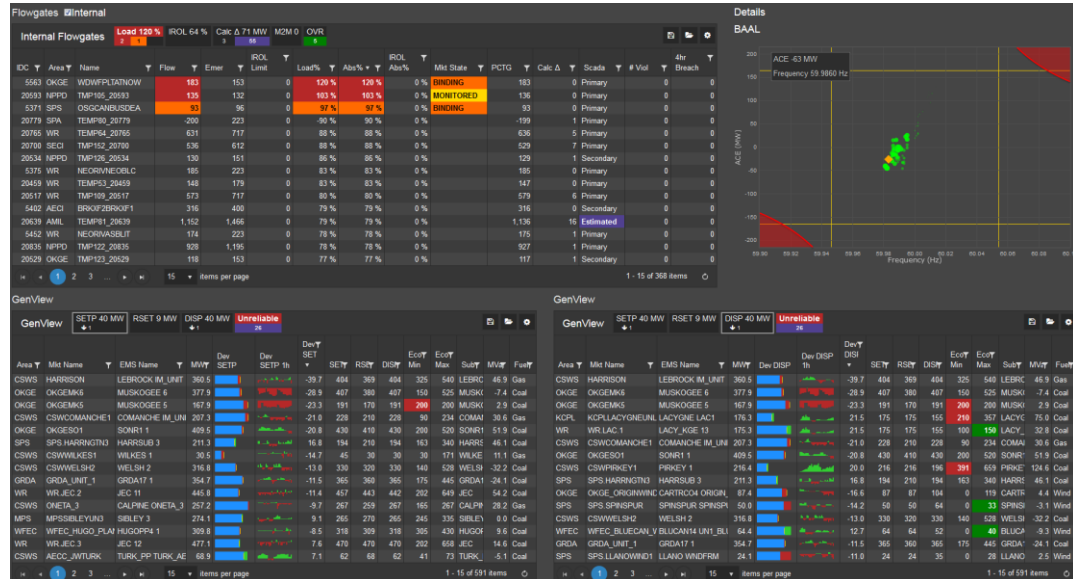
- PI System Explorer Plugins
- AF SDK
- Asset Analytics

Results and Benefits

- Automated AF Elements and PI Tag creation
- Complex AF calculations recorded as PI Tags
- Customized user displays using AF Data

Next Steps

- Event Frames
- Notifications
- More Calculations
- All based on existing AF Model



Presenters

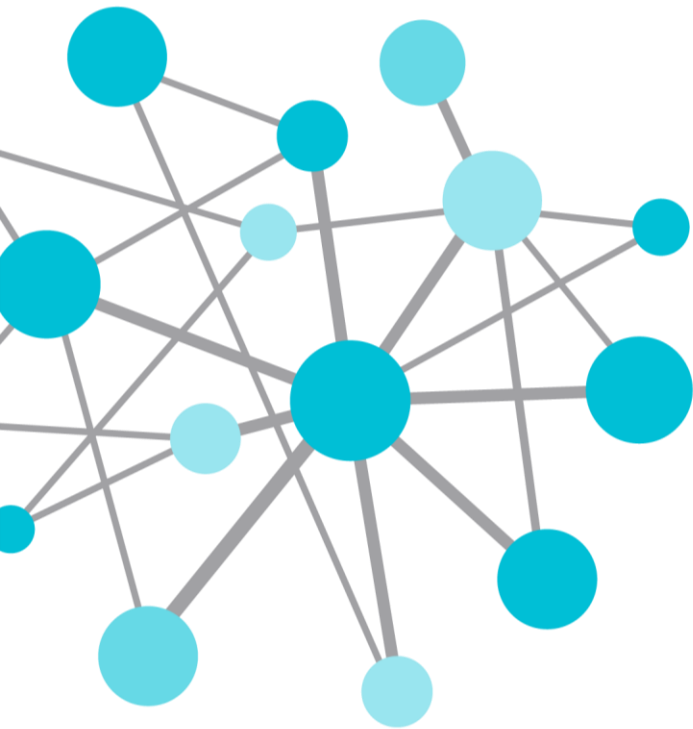
- Jeff Parker
 - jparker@spp.org
 - Senior Operations Engineer
 - Southwest Power Pool
- Cody Parker
 - cparker@spp.org
 - Supervisor Operations Support
 - Southwest Power Pool

Questions

Please wait for the **microphone**
before asking your questions

State your
name & company





THANK
YOU

Brought to you by  **OSI**soft.