

# Building a Large Scale AF Model **Enabling Operational** Intelligence

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





© Copyright 2015 OSIsoft, LLC

## 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

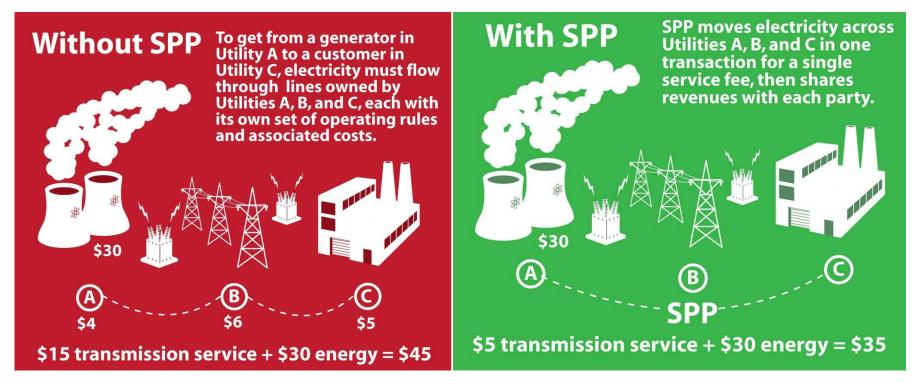
- Standards Setting
- Compliance Enforcement
- Transmission Planning
- Training
- Balancing Authority



Independent • Focus on reliability

3

# **Transmission Service**



### **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
  - <sup>-</sup> 115 kV 10,239 miles
  - <sup>-</sup> 138 kV 9,691 miles
  - <sup>-</sup> 161 kV 5,049 miles
  - <sup>-</sup> 230 kV 3,889 miles
  - <sup>-</sup> 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.

**USERS CONFERENCE 2015** 

#### 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

Elements	
- Event Frames	
🎬 Library	
🚥 Unit of Measure	
🔞 MyPI	
Notifications	
A Contacts	
🗱 Analyses	
Bulk Elements	
🛃 EMS-Imports	
🔅 MiscUtil	

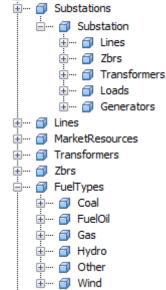
#### **Results and Benefits**

- 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 reference
  - 15k Loads
  - 70k Circuit Breakers
  - 130k SCADA **Measurements**

- Based on EMS hierarchy
- Keep nodes small as possible



AREA

#### 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

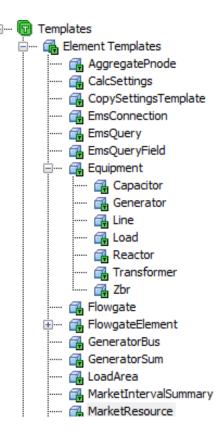
- Import EMS and Market Models into Staging Database
- Create SQL Views for each AFElementTemplate

#### **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



		÷	<u> (</u>	MVar							
	Ð		<u>ريم</u>	ê MW							
			K MWh								
N	<u>l</u> ame	:		MW							
Description:			SCADA DIS_ANALOG: MW Scac								
Configuration <u>I</u> tem:		Item:	: Indexed:								
Categories:			Generation								
0	Defau	lt <u>U</u> OM:		megawatt 👻							
Value Type:			Single 🔻								
Default Va <u>l</u> ue:			0 MW								
0	Data <u>R</u> eference:			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;ptdassname=dassic;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

💫 \\PIAF\Assets - PI System Explore	r (Administra	itor)		-					- • ×			
<u>F</u> ile <u>V</u> iew <u>G</u> o <u>T</u> ools <u>H</u> elp	р											
쭮 Database 🔑 Credentials 🛗 Que	ery Date 👻 🤇	🕥 🛃 🔇 Back 🌘	🕽 🗟 Check	In 🧐 🖌 🛃 Refresh								
EMS-Imports	Import mod	lel data from EMS										
⊞ 🗇 FGT 🔷	Info											
⊕	Edit Exe	ecution										
🗊 GENMOM_PLANT	Edit Query											
⊕····	Name:	LN2										
🗊 GENMOM_UNIT	Description	h: Line measurem	ents									
⊕····												
🕀 🗊 LD												
i∃ 🗇 LN ⊟√── LN2 =												
🗇 \$KEY												
🗇 \$SUB 🎯 AREA	Attributes											
🕤 CO							(	Group by: 🔲 <u>C</u> atego	ory 🔲 Template			
🗇 DV 🎯 ID	Filter	Filter P 🗸										
🗇 KV	∕:∎♦	Name	۵	Value				Time Stamp	<u></u>			
MEAS_RECID     MEASKV_RECID	/ 🗉	Application		RTNET				1/1/1970 12:00:00 AM				
····· 🗇 NODE	/ =	💷 Database		NETMOM				1/1/1970 12:00:00 AM				
🗇 ST 🗇 VOLTAGE	🖉 🖿 🔳 Family			EMS					0 AM			
		🗉 Key		•				1/1/1970 12:00:00 AM				
	•								4			
Elements	Edit Fields											
- Event Frames	Elem	ents \$KEY	Edit Field			Select Serve	r IM_DEV	<ul> <li>Load Field</li> </ul>	s			
🎒 Library		\$SUB	Name	MEASKV_RECID		<= Ad	d Selected Fields	Validate Que	ery			
m Unit of Measure		AREA	Value	P\$ND_LN2>I\$BS_N	D>I\$MEAS_BS	Name	DataType	Field	<u>^</u>			
🔞 MyPI			DataType	Int32	\$KEY	String	\$KEY_LN2					
A Notifications			Description			\$SUB		\$SUB_LN2				
A Contacts				the line.		AMP	-	AMP_LN2				
Bulk Elements		MEASKV_RECID				AMPAVAIL		AMPAVAIL_LN2				
🗱 Analyses		NODE ST			-	AMPMEAS	-	AMPMEAS_LN2				
🛃 EMS-Imports		VOLTAGE		Save	AMPMEASD Boolean AMPMEASD_LN2 AMPS Single AMPS_LN2			-				
🔅 MiscUtil			L			Lenna	oingic	Anit 0_LIN2				
Import model data from EMS									.::			

# Customized Tools

 SQL Views showing all equipment attributes for an AF Element Template

😓 SQLQuery1.sql - Microso	ft SQL S	erver Managen	ent Studio (Administrator)				
<u>File Edit View Project Debug Tools Window H</u> elp							
: 🛅 🕶 📨 😂 🛃 🥥 🔔 New Query 📑 📸 📸 👗 🖦 🙈	·) - (*	- E - E		- 🏄 'SQL			-
i 盟 권ː master - ? Execute ▶ Debug ■ ✓							
Object Explorer 🔹 무 🗙	SQLQ	)uery1.sql - cd	er (pimapping (69))* 🛛 🗙				
Connect 🕶 🛃 💷 🍸 😰 🍒			* Script for SelectTopNRows comma	nd from SSMS ******/			
🕀 🔯 dbo.vw_aggrPnodes			TOP 1000				
		3	[EquipmentType] ,[Name]				
dbo.vw_capacitors		5	,[Nume] ,[Substation]				
dbo.vw_ChildPnodes		6	,[Node]				
😠 📰 dbo.vw_EmsTagCheck		7	,[Voltage]				
🕀 🔝 dbo.vw_equipment		8	,[NormalLimit]				
		9	,[EmerLimit]				
		10 11	,[LoadshedLimit] ,[isTie]				
dbo.vw_FuelTypeResources		12	,[ISTE] ,[EmsNetmomKey]				
dbo.vw_genbus		13	,[EmsNetmomKey]Division]				
		14	,[EmsNetmomKey EmsId]				
🖶 🔝 dbo.vw_generators		15	,[EmsNetmomKey Node]				
		16	,[EmsNetmomKey Owner]				
		17 18	,[EmsNetmomKey Substation] ,[EmsNetmomKey Voltage]				
		10	,[segment]				
		20	,[oldID]				
		21	[KEY_TO_MATCH_CMT]				
	100 %	6 - 4					
		Results By Me	ssages				
		····		0.1		14.10	AL
		EquipmentTyp		Substation	Node	Voltage	NormalLimit
Bolovw_scada_ungital     Bolovw_scada_uncompressed	1	Line	5059	NICKTAP	1	69	28
dbo.vw_scada_uncompressed	2	Line	ELKS1NICKT69_1	NICKTAP	1	69	28
do.vw_spp_ictures     do.vw_spp_unit_links	3	Line	5112	SPARK	2	69	60
	4	Line	5115	SPARK	2	69	60
doorw_spp_ands     doorw_substations	5	Line	ACADIA_RORK	ACADIA	B27	138	765
dbo.vw_TieCorridors	6	Line	RAMOS-BUVSTA99	BERKWKTP	1237	138	270
	7	Line	5089	CENTENL	3	138	252
	8	Line	5089B	CENTENL	4	138	203
dbo.vw_tyInZin     E	9	Line	5049	BRAPID	4	138	310
dbo.vw_units	10	Line	5121B	JULTAP4	4	138	270
dbo.vw_XFMRParents	11	Line	5121	JULTAP4	4	138	270
	12	Line	5048	BRAPID	4	138	286
	13	Line	BSALETECHE13_1	BSALES	3	138	270
dbo.vw_ZBRs	14	Line	NORBND4_G1COLU	N_BEND1	1	138	50
🗉 🧰 Synonyms	•						
🕀 🧰 Programmability	Q	uery executed :	uccessfully.				pimappin
🖙 🚔 Capileo Brakar							
Ready							

# 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

💫 \\PIAF\Assets - PI System Explore	er (Administrator)
<u>File V</u> iew <u>G</u> o <u>T</u> ools <u>H</u> el	lp l
😭 Database 🤌 Credentials 🛅 Qu	iery Date 👻 🕼 🚱 Back 💿 🖳 Check In 🧐 🖌 👔 Refresh
Bulk Elements	Bulk Create Elements From Relational Database
OperatingAreas	Bulk Element Profile Editor Update Data References
	Profile Configuration
Imm Imm ALTW Imm Imm Imm AMIL	Profile: Lines -
	Connection Name: pimapping   Connection String:
iter for the section of the section	Source Table/View/SQL;
⊕	vw_ines order by area
Given Given Constraints	AF Template: Line   PnodeAggrChildren resource_mapping resource_mapping.bdr
Substations	Root Path: \\OperatingAreas Parent Element/Absolute Path Field:
	Element Name Field:
	Change Action Field:
⊡ ⊡ <u>Lines</u>	AF Reference Elements
	Field containing absolute path to element to link:
Elements	Add Link Field
Event Frames	
unit of Measure	Delete
🔞 MyPI	Table/View Columns Columns to Copy Updating Existing Elements
Notifications	Add static data from EquipmentType
8 Contacts	elements where Delete Missing Elements Apply Changes Every
Bulk Elements	Countin Traines Macun template attribute 4. Substation Area Update/Create Elements 50 Elements
🗱 Analyses	OtherEndKey Save Profile
🝷 EMS-Imports	IsTie EmsNetmomKey T
🐡 MiscUtil	
Bulk Create Elements From Relationa	al Database



# Results and Benefits



### **Asset Analytics**

 Use existing Hierarchy for calculations

 Image: Second system
 FuelTypes

 Image: Second system
 Image: Second system

 Image: Second system
 Image: Second

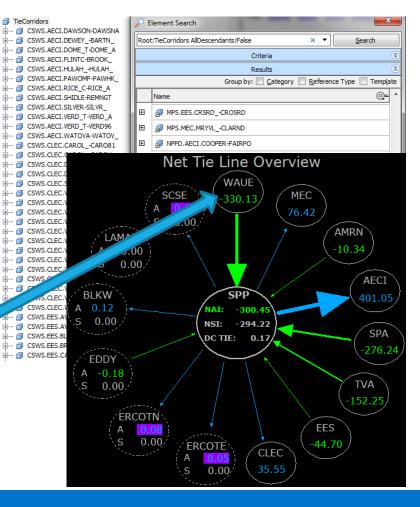
 Analysis Templates for easy replication of calculations

General	Attribute Tem	plates	Ports	Analysis Templates		
				Name:	TotalGeneratio	on
0	Name			Description:		
Ø	DispatchMW			Categories:		
¢	NetGeneration	n				
đ	Setpoint			Analysis Type:	Expression	Rollu
đ	SetpointRamp	bed				
Ø	TotalGenerati	on				
Rollup a	ttributes from d elements of (	ı Coal	ngAreas\	LES\FuelTypes\Coal		A
Rollup a Chile This	ttributes from	n Coal al				A
Rollup a Chile This To selec	attributes from d elements of ( element - Coa	n Coal al	ia below			_
Rollup a Chile This Fo selec Attribu	attributes from d elements of ( element - Coa t attributes se te Name:	n Coal al t criteri	ia below			A
Rollup a Chile This To selec Attribu Attribu	ttributes from d elements of 0 element - Coa t attributes se ite Name: ite Category:	n Coal al t criteri	ia below			_
Rollup a Chile This To selec Attribu Attribu	attributes from d elements of ( element - Coa t attributes se te Name:	n Coal al t criteri	ia below			_
Rollup a Chile This To selec Attribu Attribu Elemer	ttributes from d elements of 0 element - Coa t attributes se ite Name: ite Category:	n Coal al t criteri	ia below			_
Rollup a Chile This To selec Attribu Attribu Elemer Elemer	ttributes from d elements of ( element - Coa t attributes se te Name: te Category: nt Category:	n Coal al t criteri MWO	ia below ut	,	Eval	_

## **Asset Analytics**

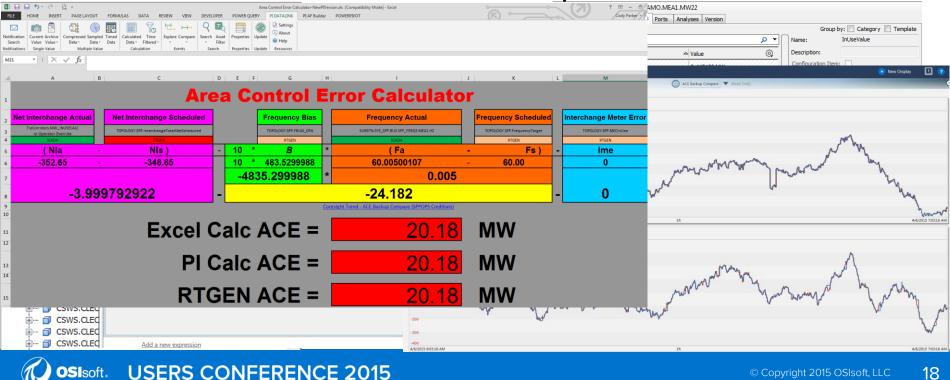
 Quickly create new hierarchy for new calculations

lements	Ties	
Image: Construct of the second state of the second stat	General       Child Elements       Attributes       Ports         Filter <ul> <li>I</li> <li< td=""><td>Analyses Vers Value -330.1279 MW -349.6807 MW -0.5212362 MW 0.2147445 MW</td></li<></ul>	Analyses Vers Value -330.1279 MW -349.6807 MW -0.5212362 MW 0.2147445 MW



### Asset Analytics

#### PI Server can serve as backup to EMS RTGEN



© Copyright 2015 OSIsoft, LLC

18

### **Event Frames**

14 1 10

#### Used to alert operators of real-time issues

warket	Resource	_								
Genera	Attribute Te	emplates Ports	Analysis Templates							
						Name:	ResourceTripEver	nt		I
୍ଷ ଟ୍ରୀ ମୁ:ର୍ଚ୍ଚ H	ResourceTri	ise and Reg Perf pEvent	Configuration SetpointCRPrev := if Not Template: MarketResourc	Schedule Natural Frequency=4 Natural	Output(s) MVar SetpointCR; EffectiveEner Event frame	Description: Categories: Analysis Type:			may be about to trip of	1
		MarketResources	\ <u>CSWS.AECC_ELKINS2</u> urceUnitTrip							luate
Nam	ne Ex	pression							Value	e
Ramp	т) с	FagVal('MW')	- TagVal('MW', '*-60s	'))						8
Limi	it Ab	os(Max('EffMa	xLimit' * 0.1, 'EcoMax	<' * 0.1, 'DnR	ampRate' * 2, 100))					×
ACEO	ineck If (Ramp < 0 and ('\\OperatingAreas\SPP\MarketResources ACEChange') < (.8*Ramp)) Then True Else False									×
Star		If (ACECheck = True and Ramp < -Limit and 'PlanCommitted' = True) Then True Else False								
EndT	Trigger Tj	ype an expression	(optional)							
Add a new expression										





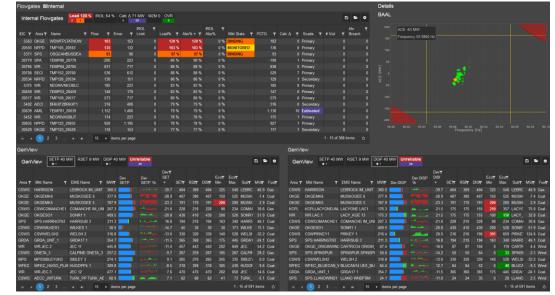
#### **Building a AF Model**

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





2





© Copyright 2015 OSIsoft, LLC