Advanced Real-Time Situational Awareness Sourced from Synchrophasor Data

"Faster than the Eye, not faster than PI"

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BPA Business Challenge

Leverage new Phasor Measurement Units (PMUs) deployment to provide wide-area situational awareness for grid stability.

Harden and build out the PI Data Historian beyond SCADA

Create a reusable infrastructure for analysis and alarming

Technical Challenges

PMUs are new devices

- newer interface protocol
- Expect 1.0 behavior

Fast data means:

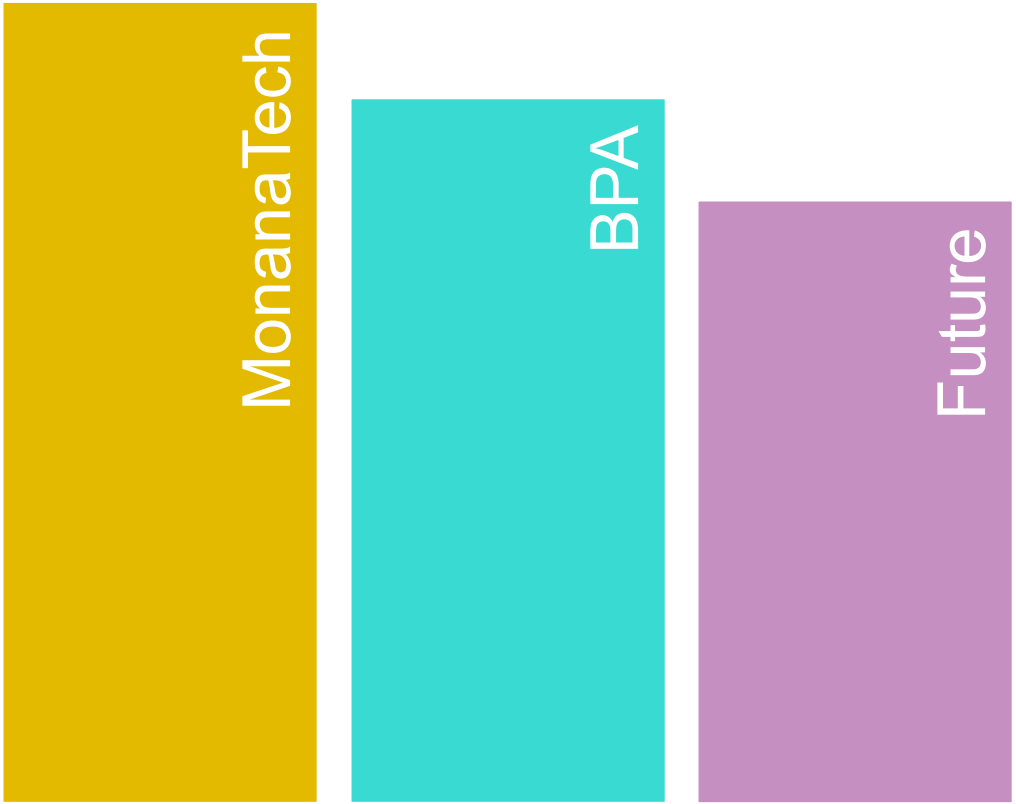
- Network constraints
- Computer processing and storage constraints

Emerging science on new data set

- Calculations will change/evolve

BPA Goals for Situational Awareness (SA) Applications

- Create a reusable architecture, that allow new SA applications (calculations) to be easily implemented



SA Applications Developed

ODM
- Low Frequency (e.g. 0.25 Hz) Oscillation Detection of devices on Power Grid*

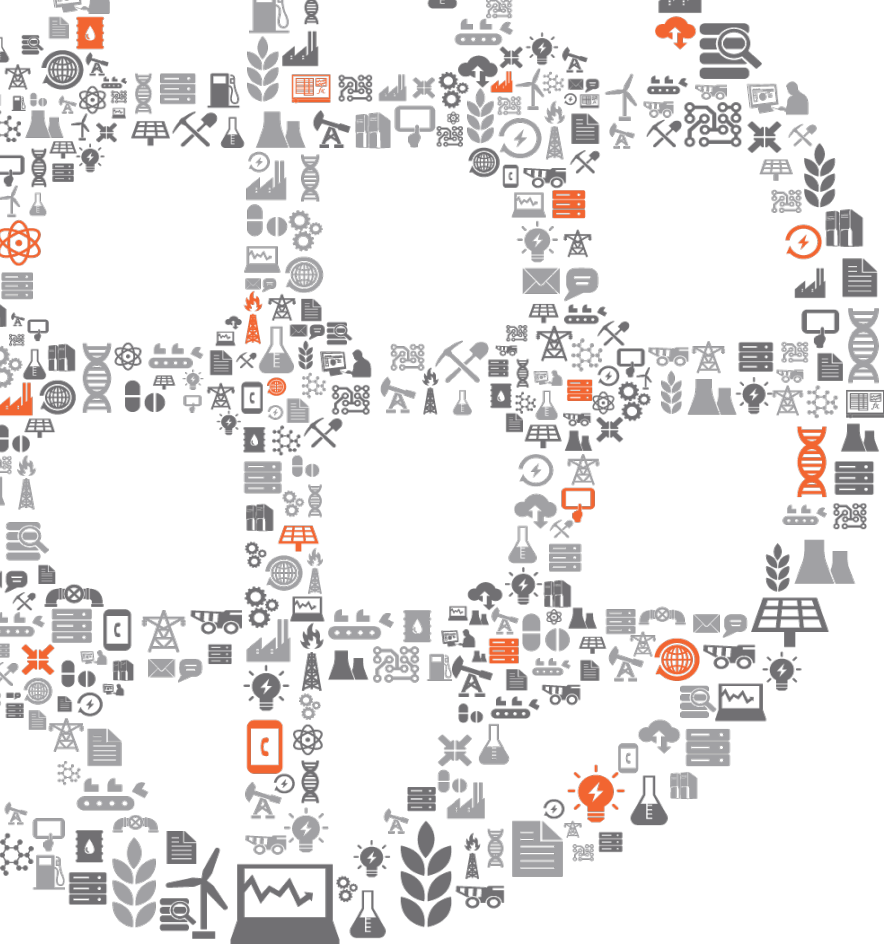
MMM
- Detection of Poor Inner Area Oscillation Dampening (Mode Meter)*

AAM
- Excessive Phase Angle Alarm +

IDM
- Power System Island Detection+

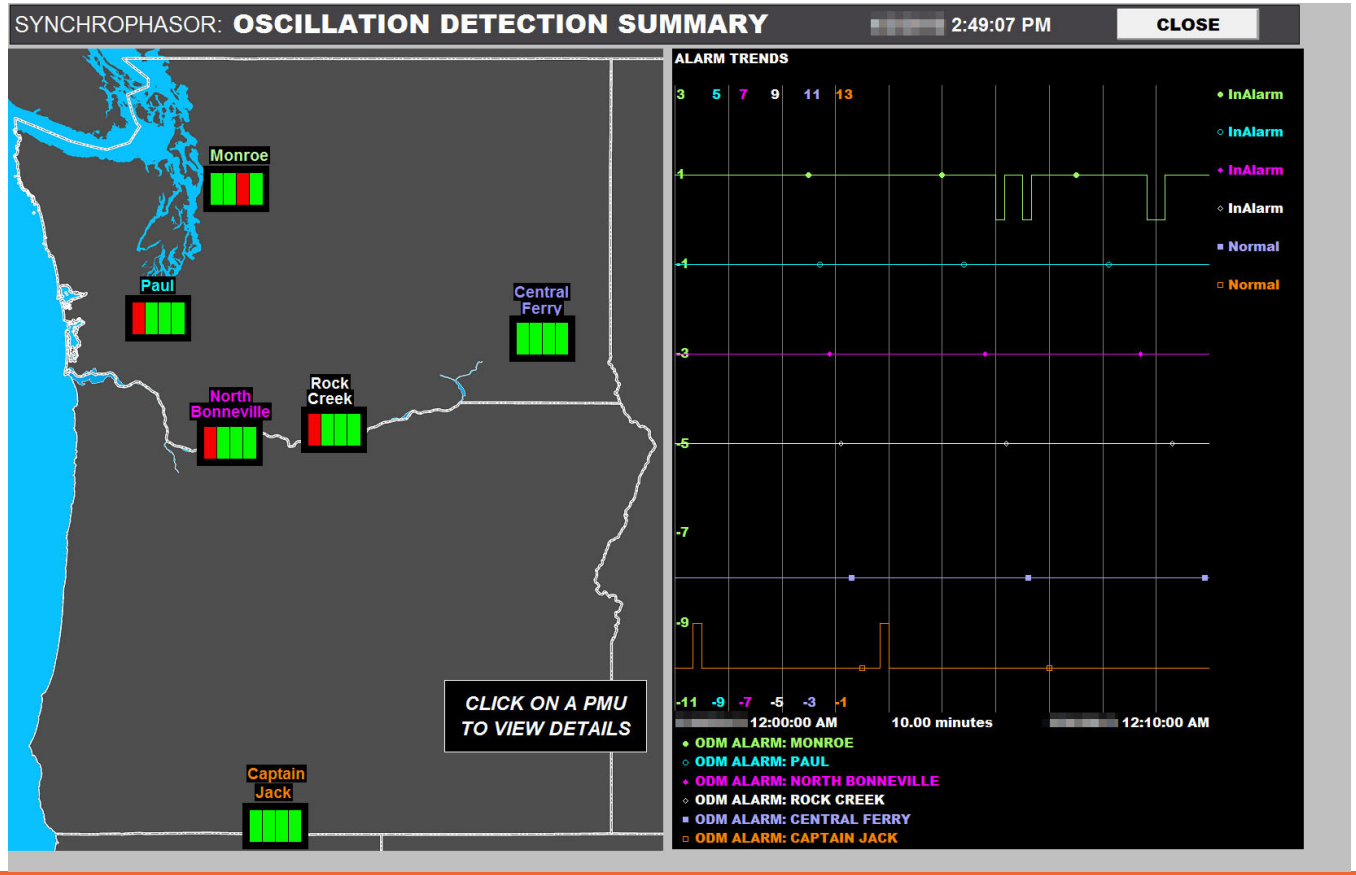
* WECC/MontanaTech

\+ BPA Developed

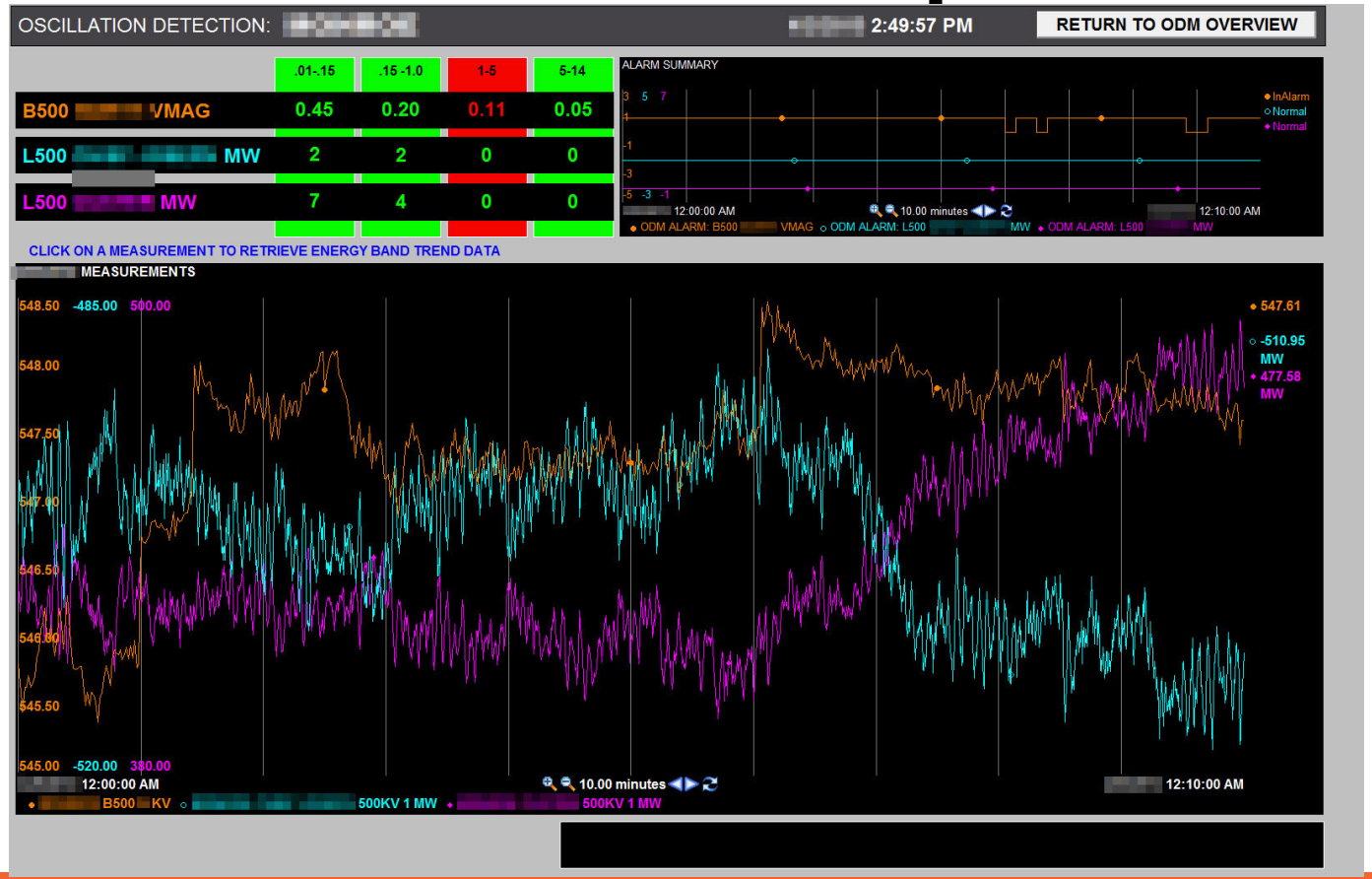


Sample Displays

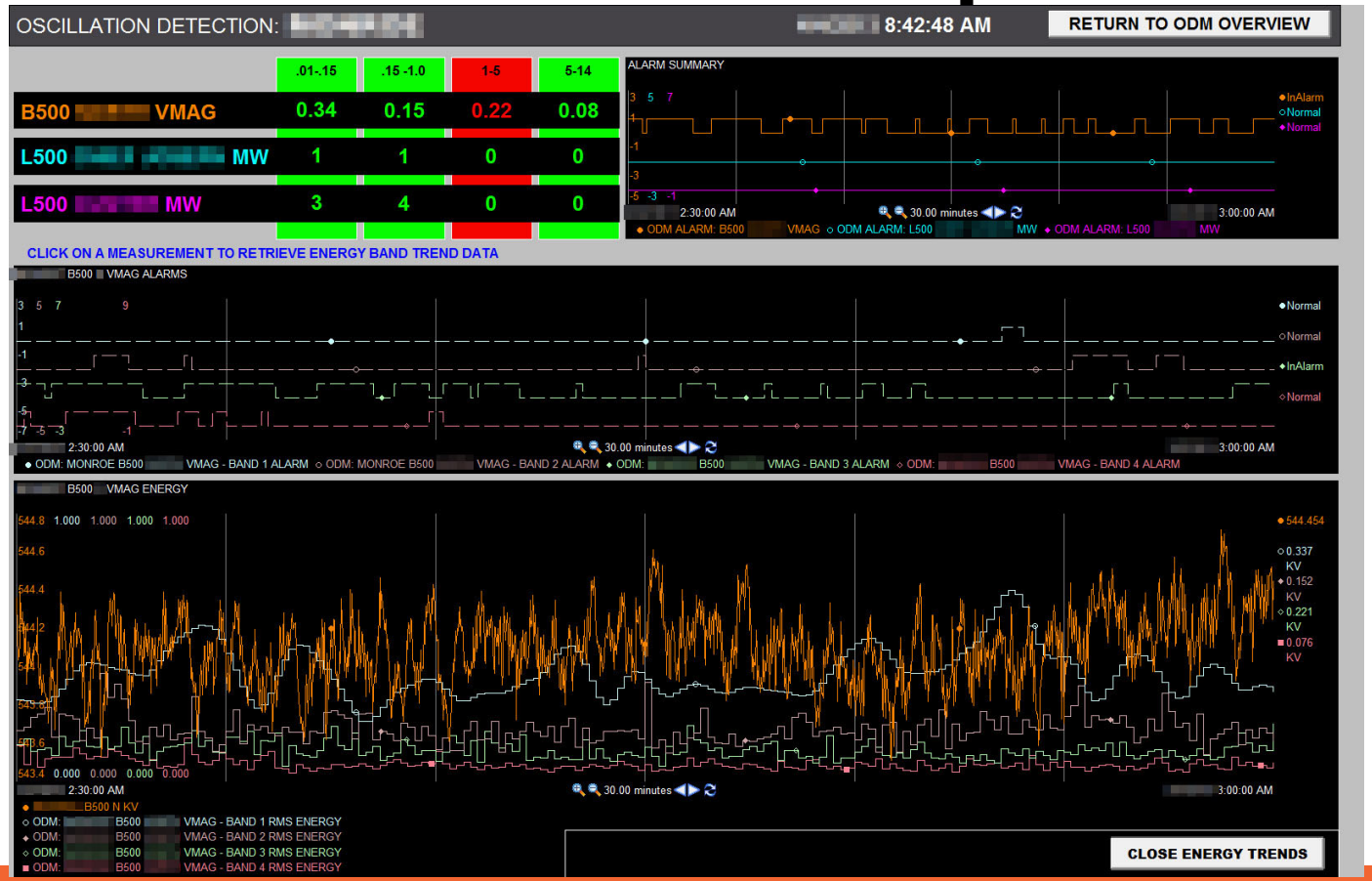
Oscillation Detection (ODM)



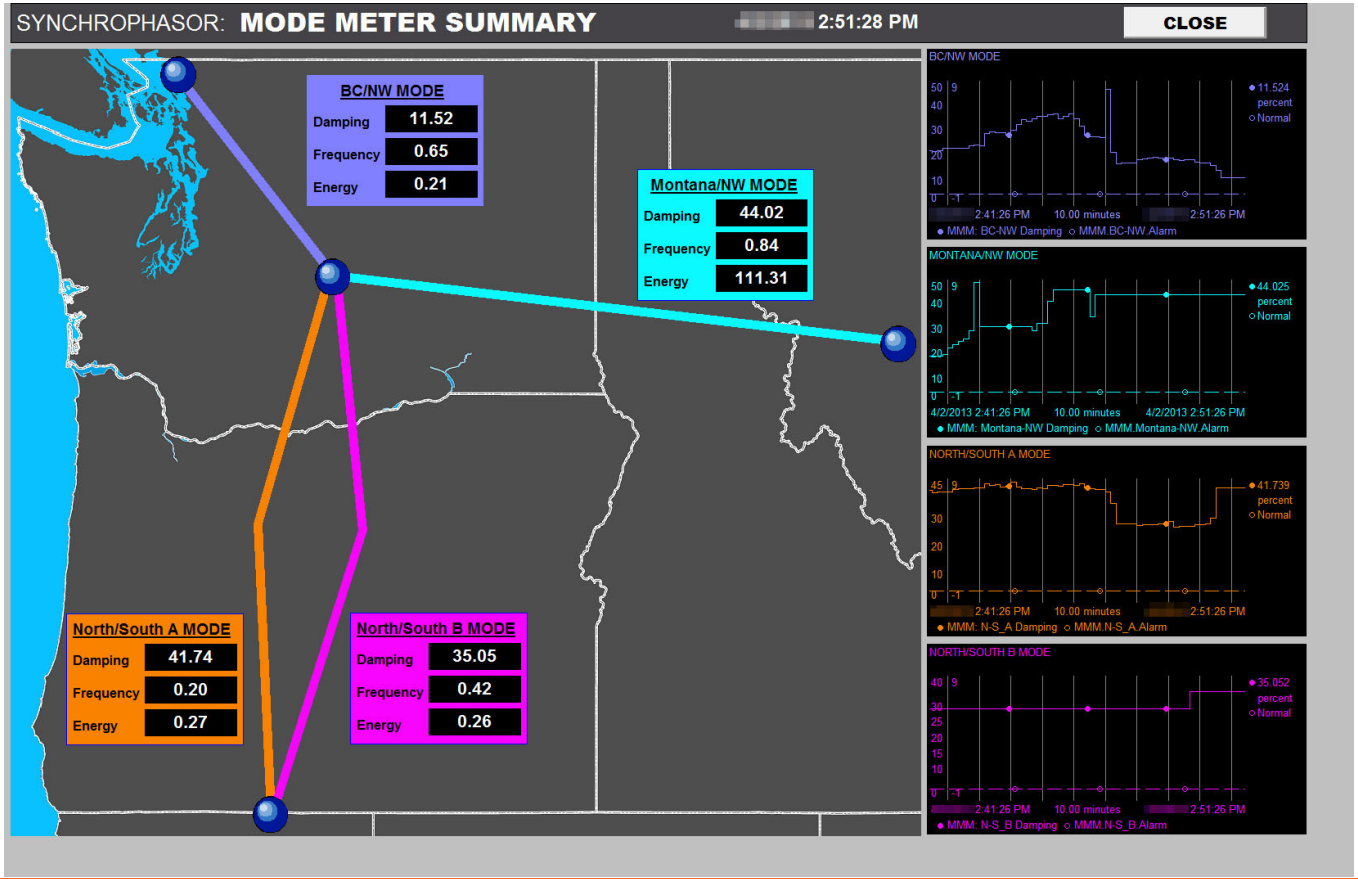
ODM Detail-Inputs



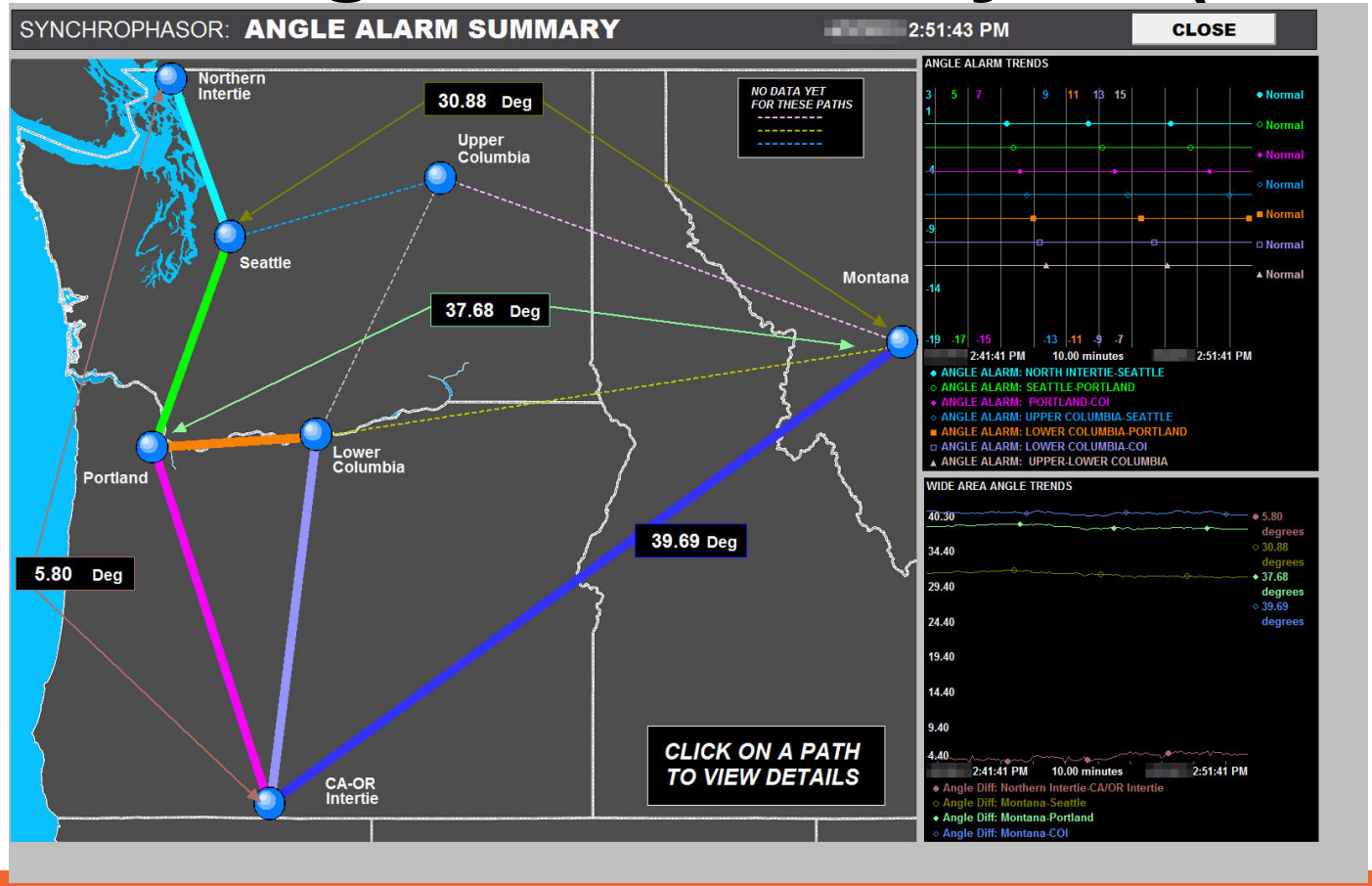
ODM Detail-Outputs



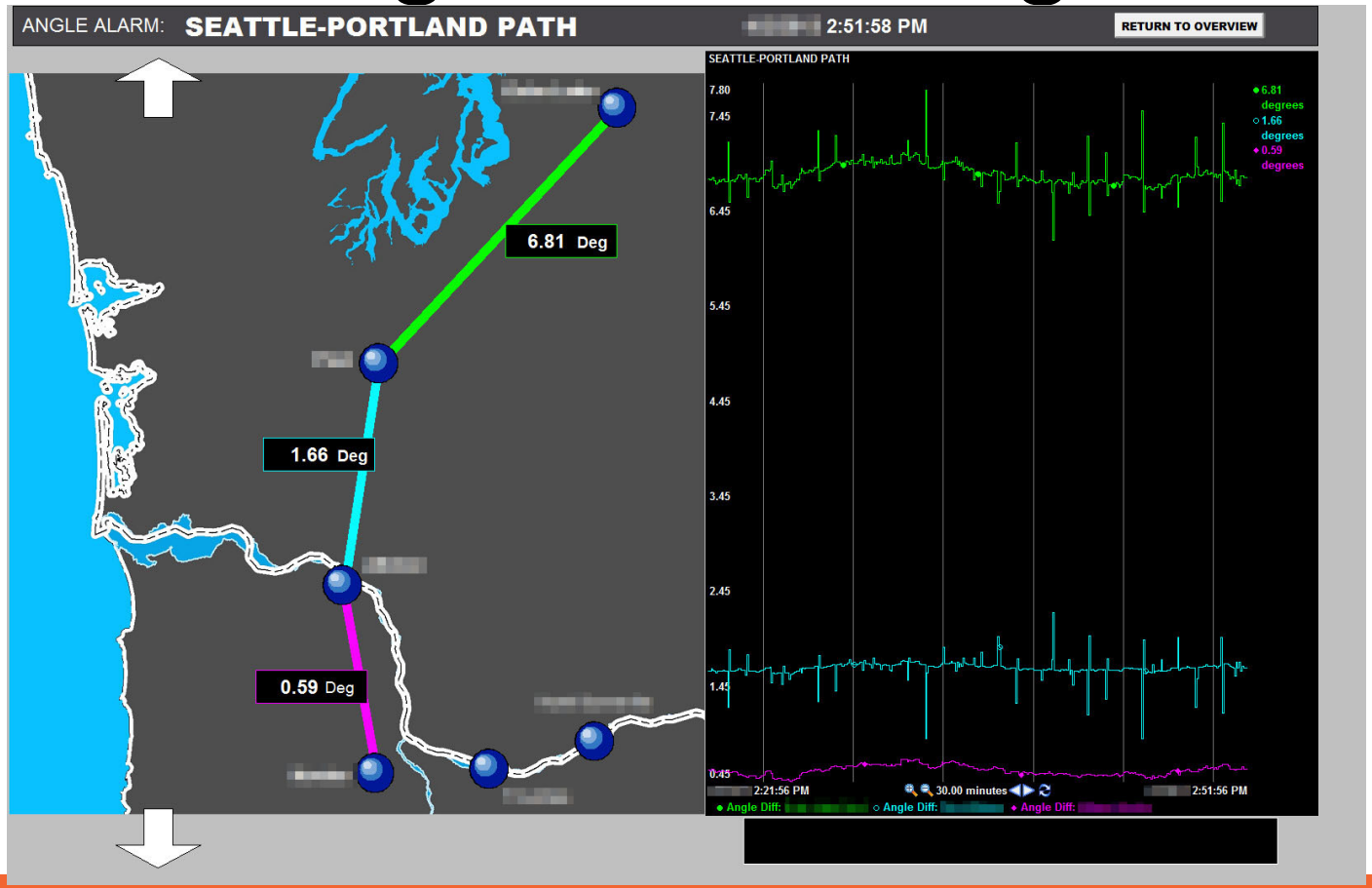
Mode Meter (MMM)



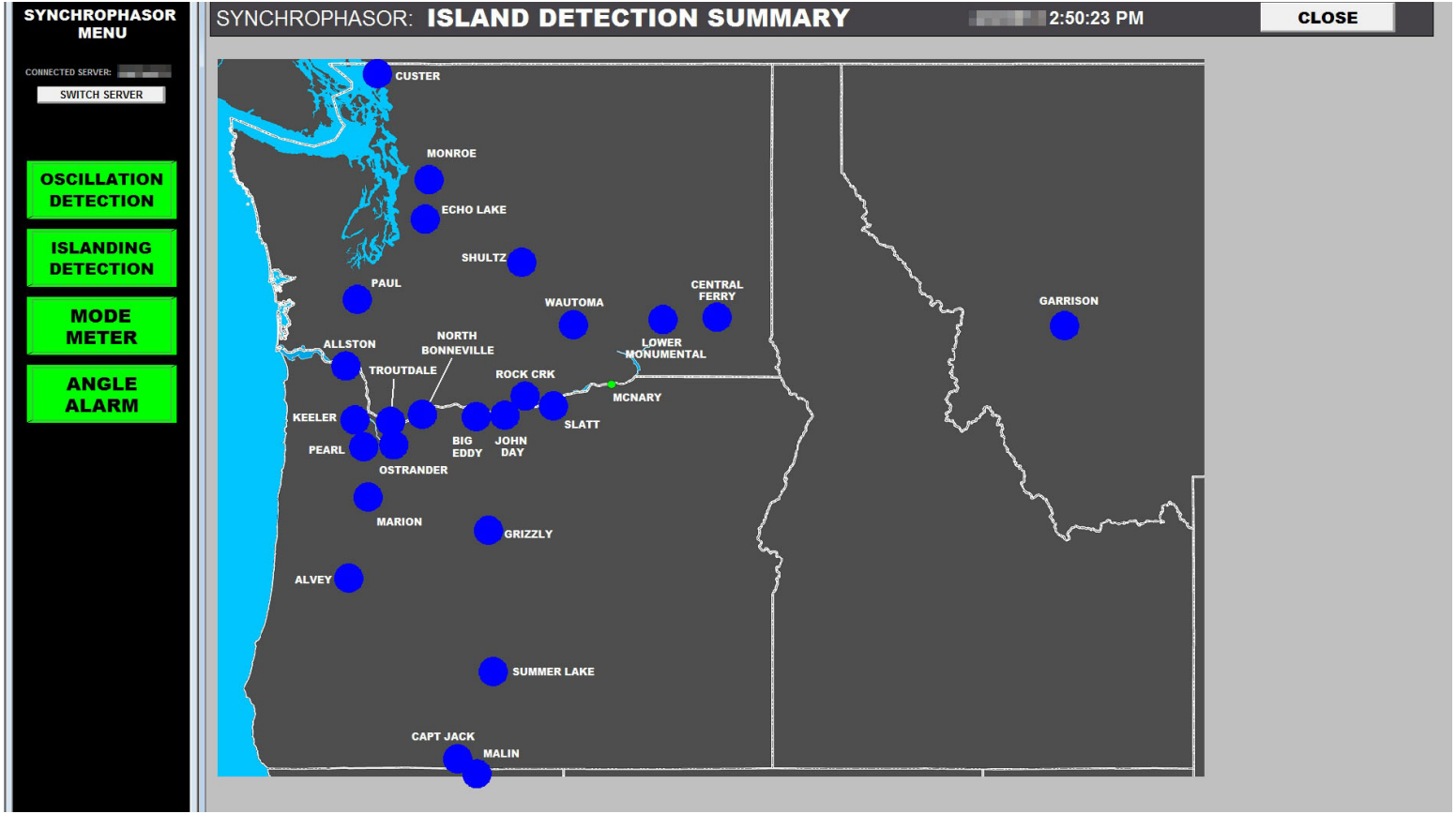
Angle Alarm Analysis (AAM)



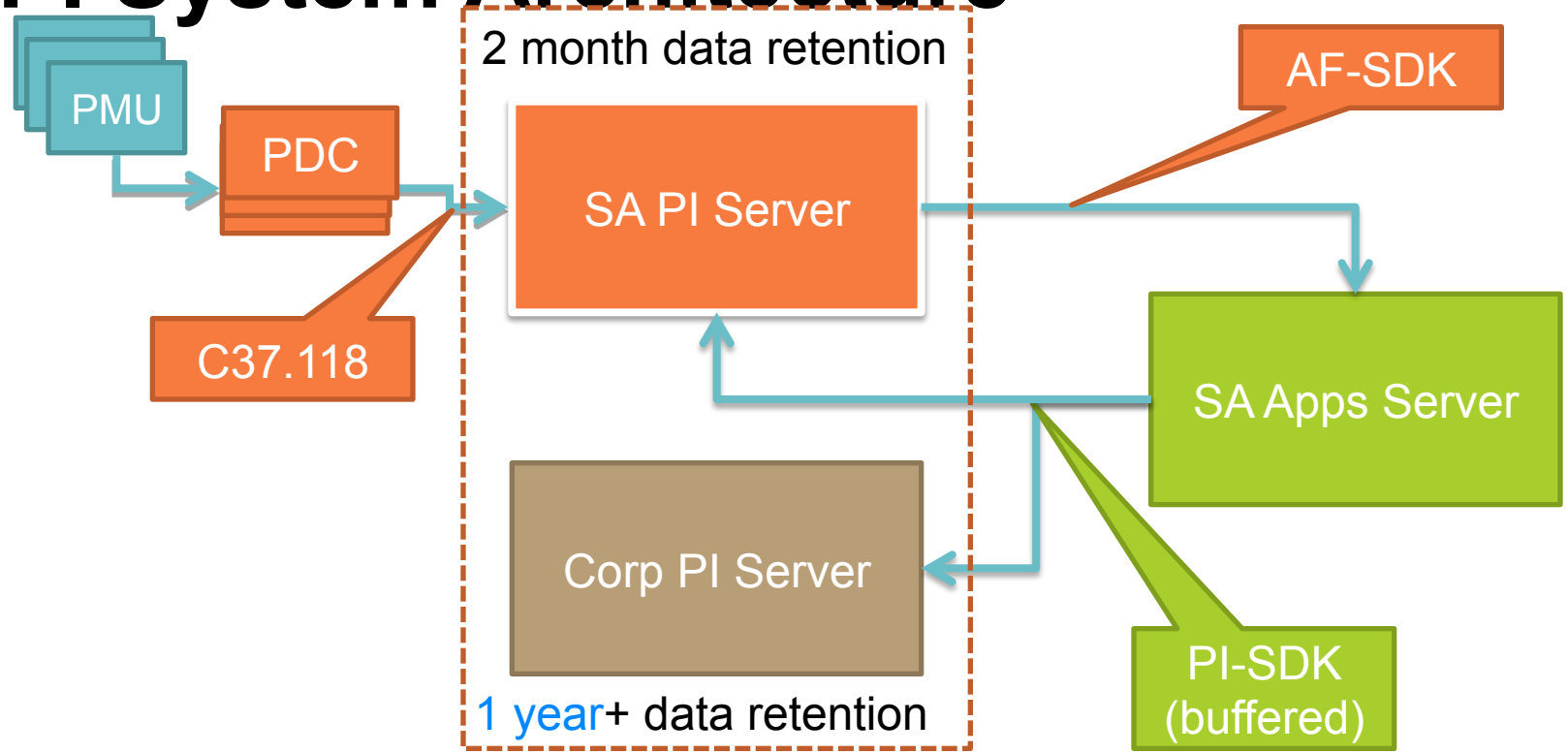
Angle Alarm - Region



Power Islanding Detection (IDM)



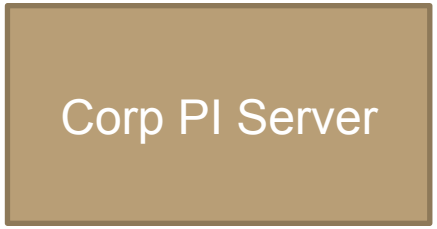
PI System Architecture



SA PI Server Details

- 24 Core Windows server, 32G physical memory
- 1 GB Archive fills every hour
- 2 months of online data for Situational Awareness (SA) PI (2TB Storage)

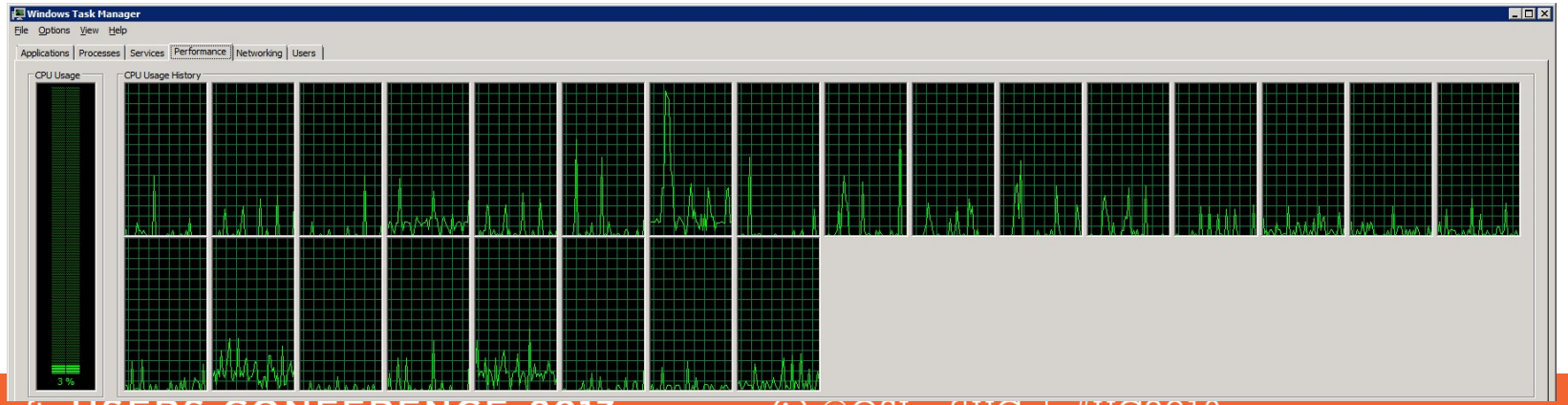
Historian PI Details



- 24 Core Windows server, 32G physical memory
- 1 year of high resolution (60 sps) data online
- All event data online
- All low-speed data (outputs from calculations every 5 to 10 seconds) online

SA Application servers

- 2 servers
  - 24 Core Server
  - 64 GB Physical Memory
  - Windows 2008 R2

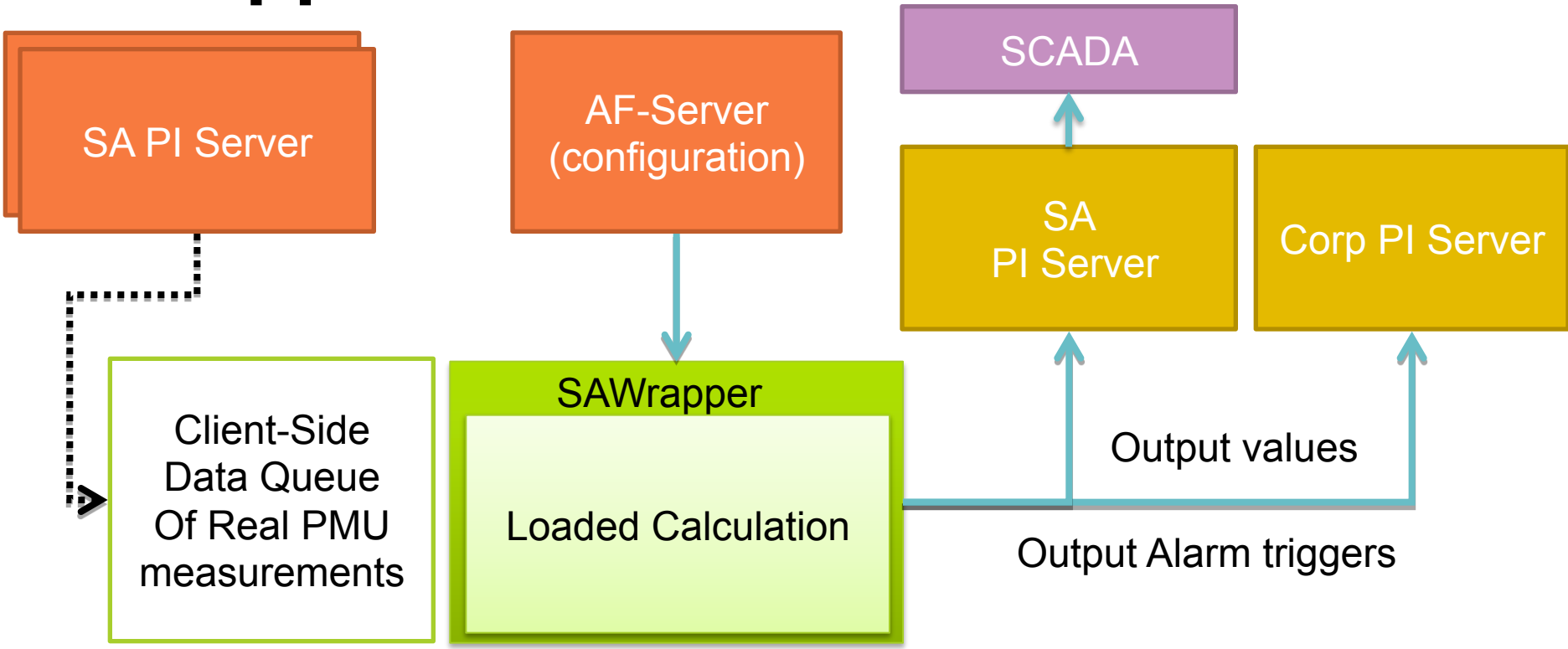


Current Event Rates

C37118 Interface	Events/Min
From WISP PMUs stream 1	2,336,544
From WISP PMUs stream 2	2,590,145
From WISP PMUs stream 3	1,071,036
From WISP PMUs stream 4	809,655
From WISP Partner PMU steams	32,357

Current Event Rate: 113,966 Events/second

SA Apps Architecture

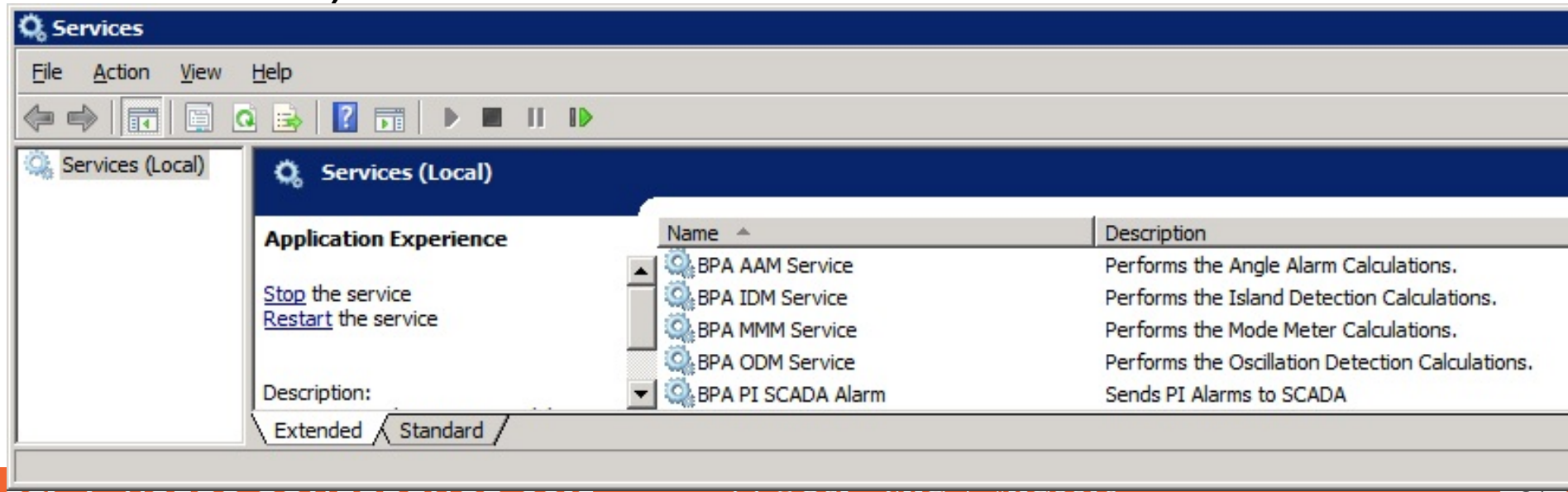


Re-Assembling IEEE C37.118 (PMU Communications Protocol)

- Analyses require time aligned data

Windows Services

- Each calculation runs as its own service (similar to ACE)

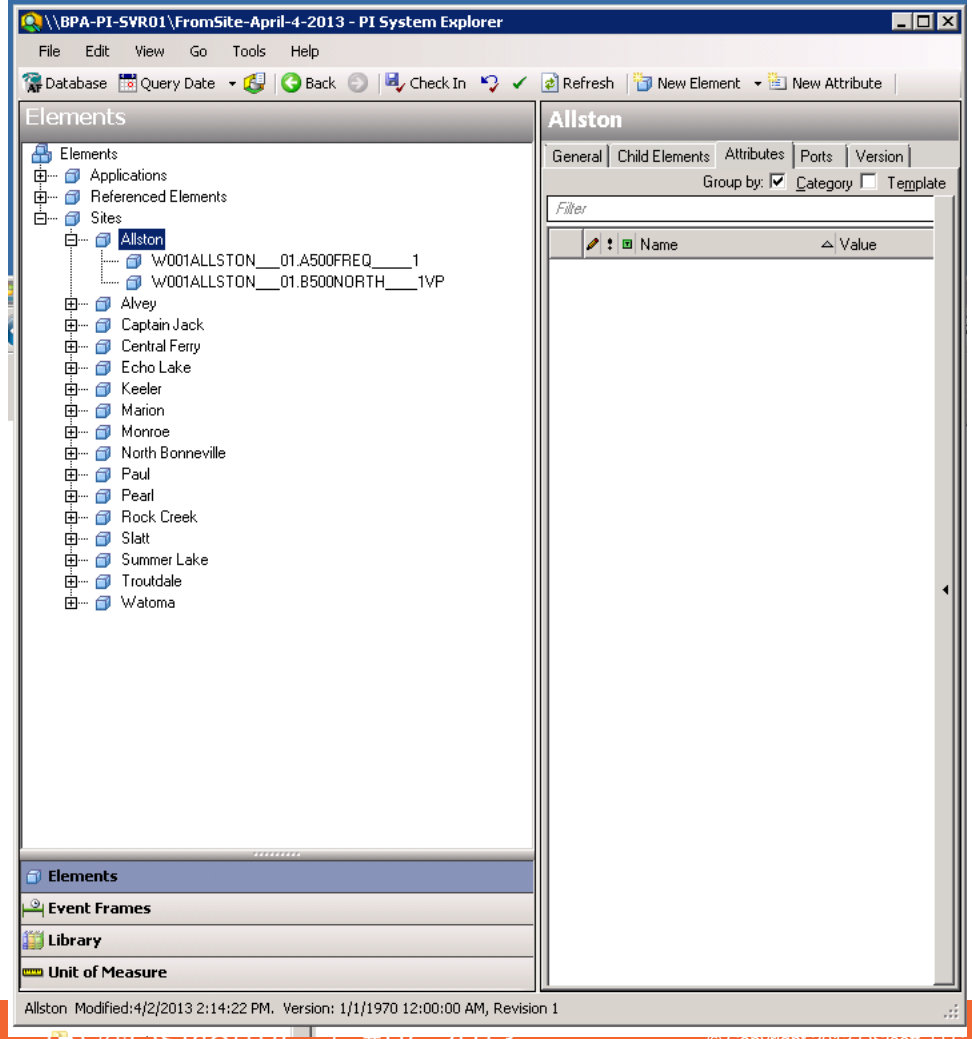


AF Database

PI Data References

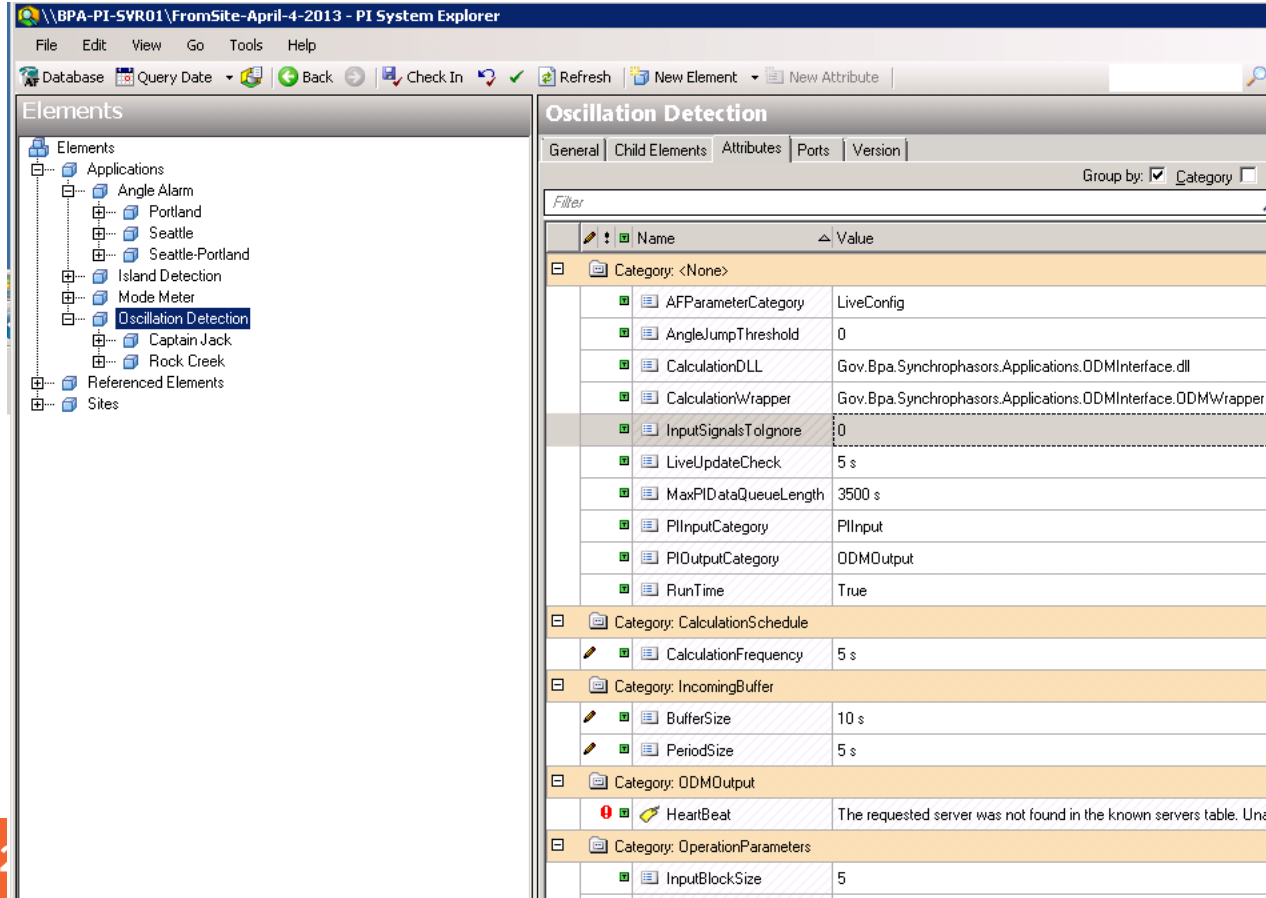
Meta Data for PMUs.

Calculation Definition



AF Database – Calculation Definition

- Extensible Calculations
- Configurable Tuning and monitoring



Re-Assembly Rules

- Per block time: count of events must match rule

Data Rate * Block Time

60 events * 5 seconds

- Any block not matching the rule is counted as bad.

BPA Synchrophasor SA Deployment

Kudos and Cautions!

PI Server 2012 is rock solid!

Fast Interface patch turnaround

PI-SDK… Watch threading!

AF-SDK 2012 – looking good!

SA Wrapper Requirements

- IData – sends and retrieves data from the calculation
- ILog – enables logging out of the calculation

Looking Ahead: PMU Deployment Goals

Currently deployed PMUs -- 82 (42 stations)

Target deployment 2014 – 104

Partner data integration – 41

Looking Ahead: Analysis

Increase geographic data models

- + CA
  + Montana
  + Alberta
  + Nevada

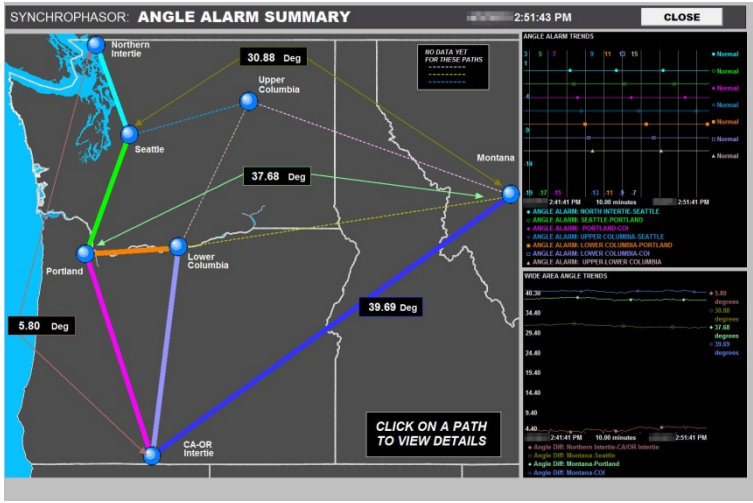
Add Analyses

- Geospatial Frequency Analysis
- Generation Insertion Efficiency

BPA Situational Awareness

Advanced Real-Time Situational Awareness using Synchrophasor data.

BONNEVILLE POWER ADMINISTRATION



Business Challenge

- Turn Real-Time PMU data into Operator Awareness
- Leverage latest in high speed Phasor Measurement Analysis
- Prepare for future calculations

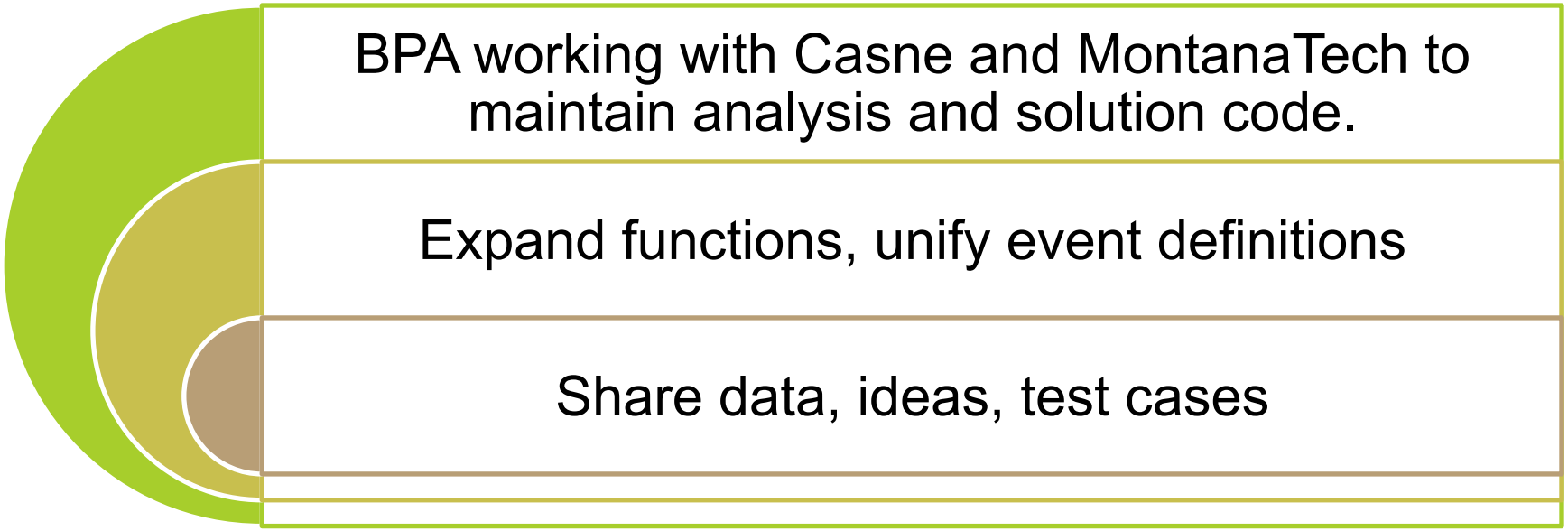
Solution

- PI AF based analysis plugin architecture
- PI Server 2012 using PI-AF 2012 data access

Results and Benefits

- Online displays show abnormal system behavior.
- Replay of real event data shows event identification, ready and waiting!
- Potential of early warning for system instability

Forum Developing!



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