Synchrophasor Network and Archiving at BPA

Tony Faris

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BPA's Synchrophasor System

- Majority of PMUs installed as part of WISP/SGIG grants in 2010's
- Applications include oscillation detection, frequency event detection, model validation, phase angle monitoring, and SP-based control (RAS)
- Synchrophasor lab for application development and testing, "sandbox" environment for research-grade tools
- **Network and archiving infrastructure decisions driven by application requirements**

BPA's Synchrophasor System

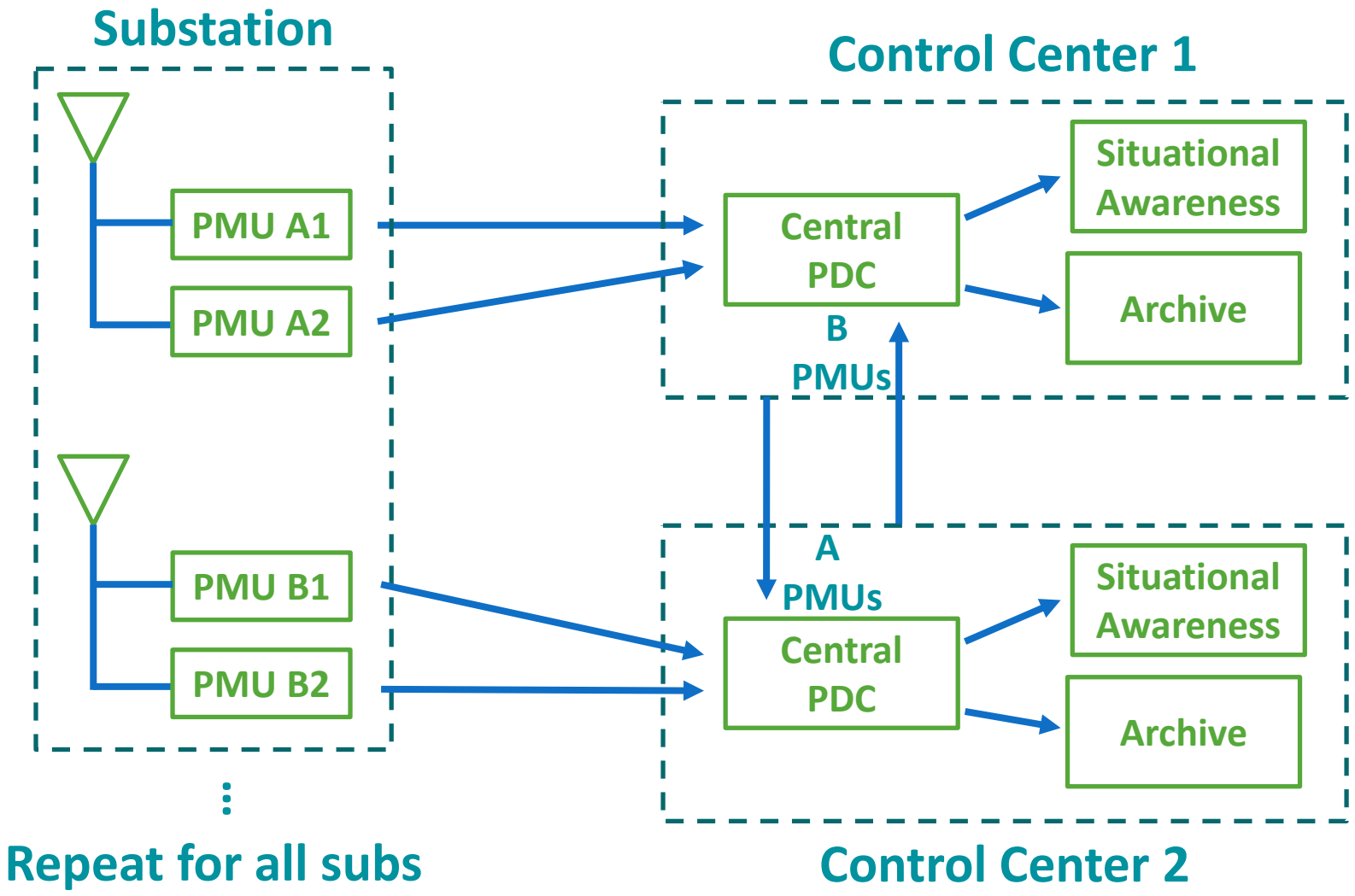
- ***Challenge:*** *Real-time control applications require "no single point of failure"*
  - Redundancy in hardware and dataflow
  - Fully redundant implementations are costly for design, install, commissioning, and maintenance
  - Not all installations used for control
  - Some installations at non-BPA stations (e.g., wind collector sites)
- ***BPA Solution:*** *Classify PMU installations by their use*
  - "Control" for real-time operational decision making
  - "Data" for information-only, post-event analysis
- ***Lesson:*** *Identify end users, plan for future expansion and application development*

BPA's Synchrophasor System

- Control PMU Installations
  - May be used to make operational decisions
  - Fully Redundant (PMU, GPS, Network, etc.)
  - Encrypted stream, access control
  - 77 pairs at 54 sites (1-2 pairs per site)
- Data PMU Installations
  - Only used for post-event analysis
  - No redundancy, encryption
  - May be installed at non-BPA sites
  - Limited security and access control
  - 32 PMUs at 23 sites (1-3 per site)

This presentation will focus on control PMU infrastructure

System Architecture



Network Architecture Challenges

- ***Challenge:*** *A single PMU streams to multiple destinations on the network*
  - Two control centers, development and production PDCs
  - Synchrophasor RAS
  - Synchrophasor Lab
  - Network monitoring center
  - Central maintenance office
- ***BPA Solution:*** *Multicasting is a requirement for PMU and supporting network*
  - Required coordination with multiple vendors
- ***Lesson:*** *Have clear requirements defined before selecting hardware. Coordinate with vendors as needed.*

Network Architecture Challenges

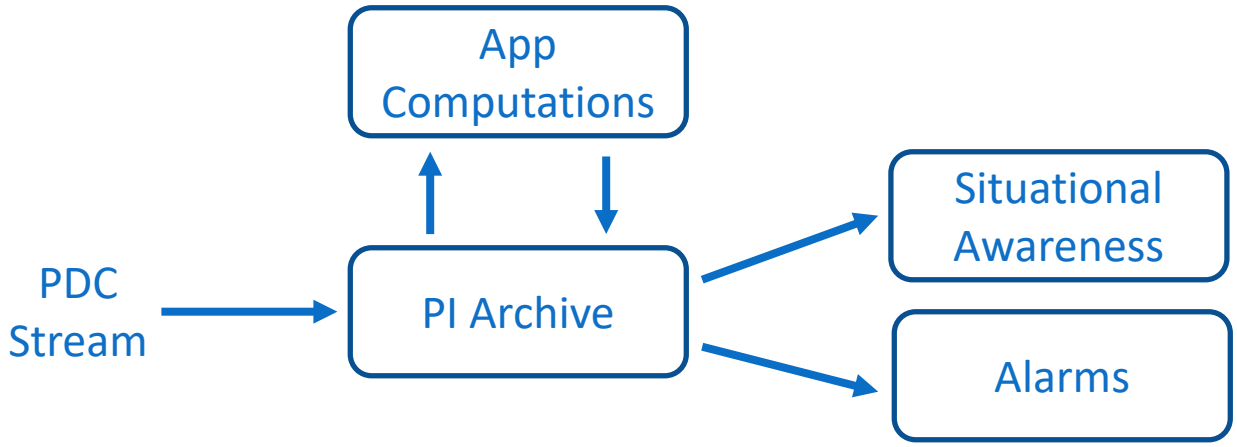
Challenge	BPA Solution	Lesson
Not ANOTHER network!	Yes, another network. Use existing infrastructure (fiber), but dedicated network for PMU data.	Synchrophasors require high bandwidth channels. Network must be sized and managed accordingly.
Increased criticality of data due to real-time applications	Full-scale cyber security plan, including encryption, physical and electronic access restrictions, etc.	Define cyber security requirements, clearly outline implications to daily operations
Expectation of higher data availability and accuracy (quality)	Continuous monitoring of network traffic, status flag statistics, etc.	Use freeware, site-licensed apps, etc. and **prioritize quality checks and maintenance**
Neighboring regions have PMU data that is potentially useful	Establish two-way real-time streams with partners	Despite technical challenges, wide area sharing is very possible and increasingly valuable

Archiving

- ***Challenge:*** *Incorporate a new data set and suite of applications into a control room environment*
  - Minimize learning curve for operators and data users
  - Build upon existing infrastructure, if possible
- ***BPA Solution:*** *PI-based implementation, with displays/alarms developed in-house*
- ***Lesson:*** *Applications and archive should work seamlessly together. Include operators in development decisions*

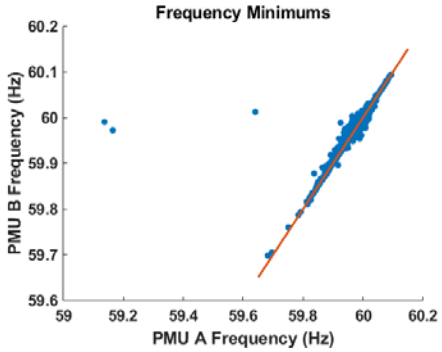
Archiving - Operational

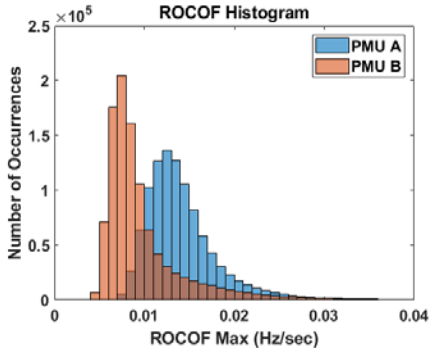
- Control Center archive: OSI-soft PI
  - Raw SP data stored in PI
  - Applications extract data from PI, perform operations (oscillation energy, frequency events, etc.), and write results (including alarm status) back into PI
  - Archived data available for extraction with PI-based tools



Archiving - Laboratory

- ***Challenge**: Operational archive is limited in length.*
  - Interested in data mining, machine learning, long-term analysis





- ***BPA Solution**: An R&D-grade archive designed for long-term storage*
- ***Lesson:** Archives are not one-size-fits-all. As with networks, plan for future development and expansion.*

Archiving - Laboratory

- Long term (4+ years) of full-fidelity data stored in 200 TB archive in BPA .pdat format
  - Includes all BPA PMUs and WECC partner data
  - Flat binary files, with C37.118 config frame followed by one minute of data frames
  - Goals: minimize computational effort on archiving process, store all available information from PMU/PDC

Archive Challenges

Challenge	BPA Solution	Lesson
This is A LOT of data. How much should I archive?	6 months for operations, multiple years for R&D	There is valuable information in long-term storage. Keep as much as possible.
Many users need access to the archive	PI allows access for multiple users on corporate network. Lab archive allows access to anyone on lab network.	Archive architecture must align with network architecture for users to effectively access data
Event data is more valuable than ambient data	Keep event data permanently, in multiple locations	Storage is inexpensive. Set thresholds liberally, store events permanently.

General Lessons Learned

- Significant value comes from significant investment
  - Executive-level commitment is necessary
- Applications drive requirements, end users drive industry development
- Plan for the future
  - New SP applications are always under development
  - Today's research projects will be on control room floor in the future

Contact

Tony Faris
Bonneville Power Administration
Electrical Engineer
ajfaris@bpa.gov