Synchrophasor Projects and Data Challenges at BPA

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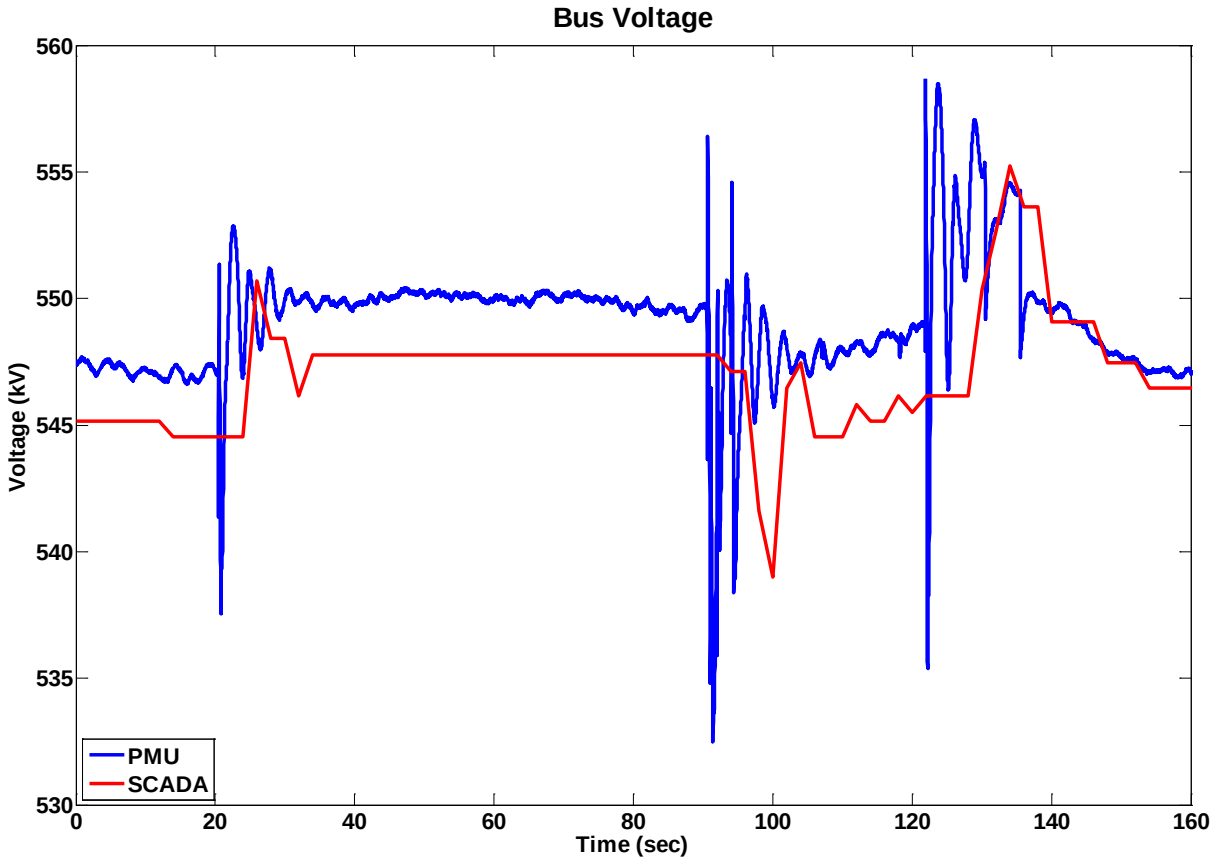
Outline

- Motivation for Synchrophasors
- BPA Projects
- Applications
- Synchrophasor Data/Challenges

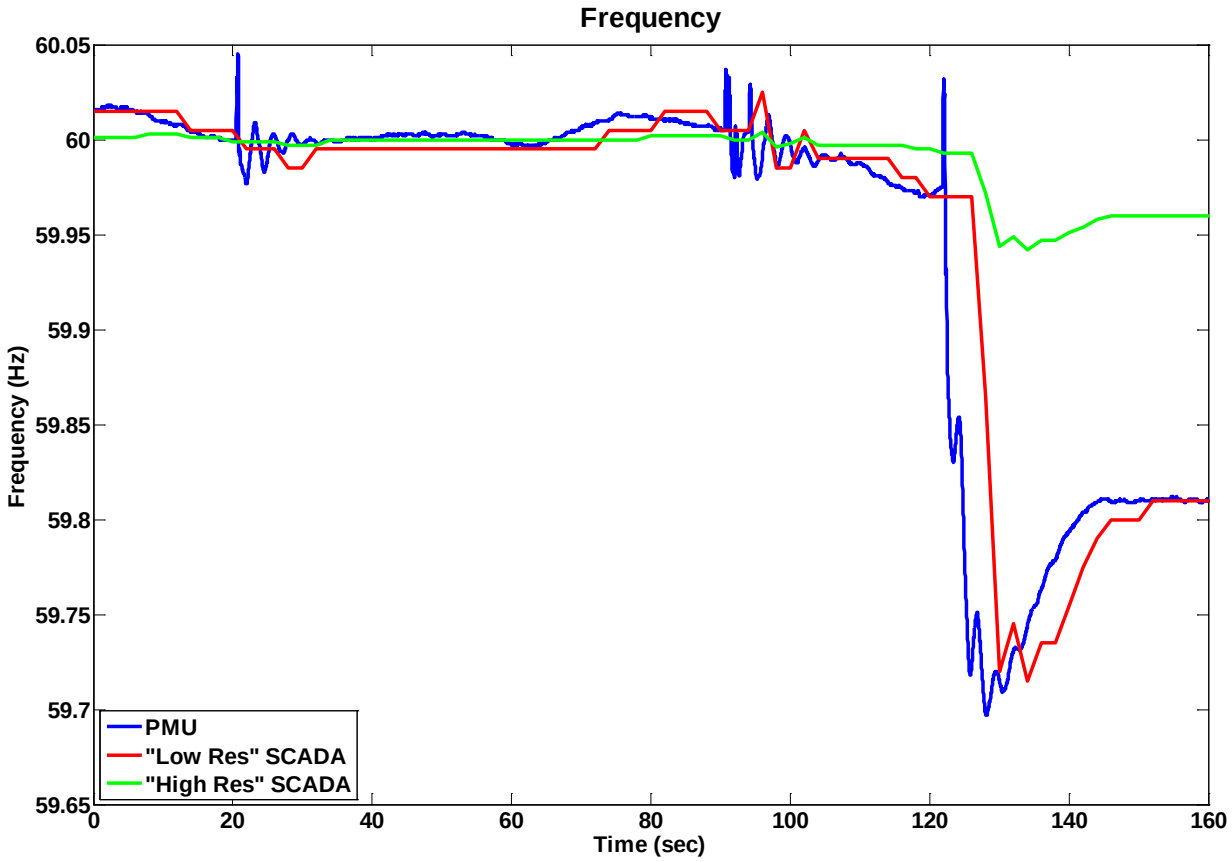
Why Synchrophasors?

- High speed, real time data stream
  - 30, 60 or 120 samples per second
  - Fills gap between SCADA and DFR data rates
- Time synchronized measurements
  - Wide area phase angle differences
- Flexibility in data stream
  - Analog and digital values are included
- High resolution, high visibility

PMU vs. SCADA Example



PMU vs. SCADA Example



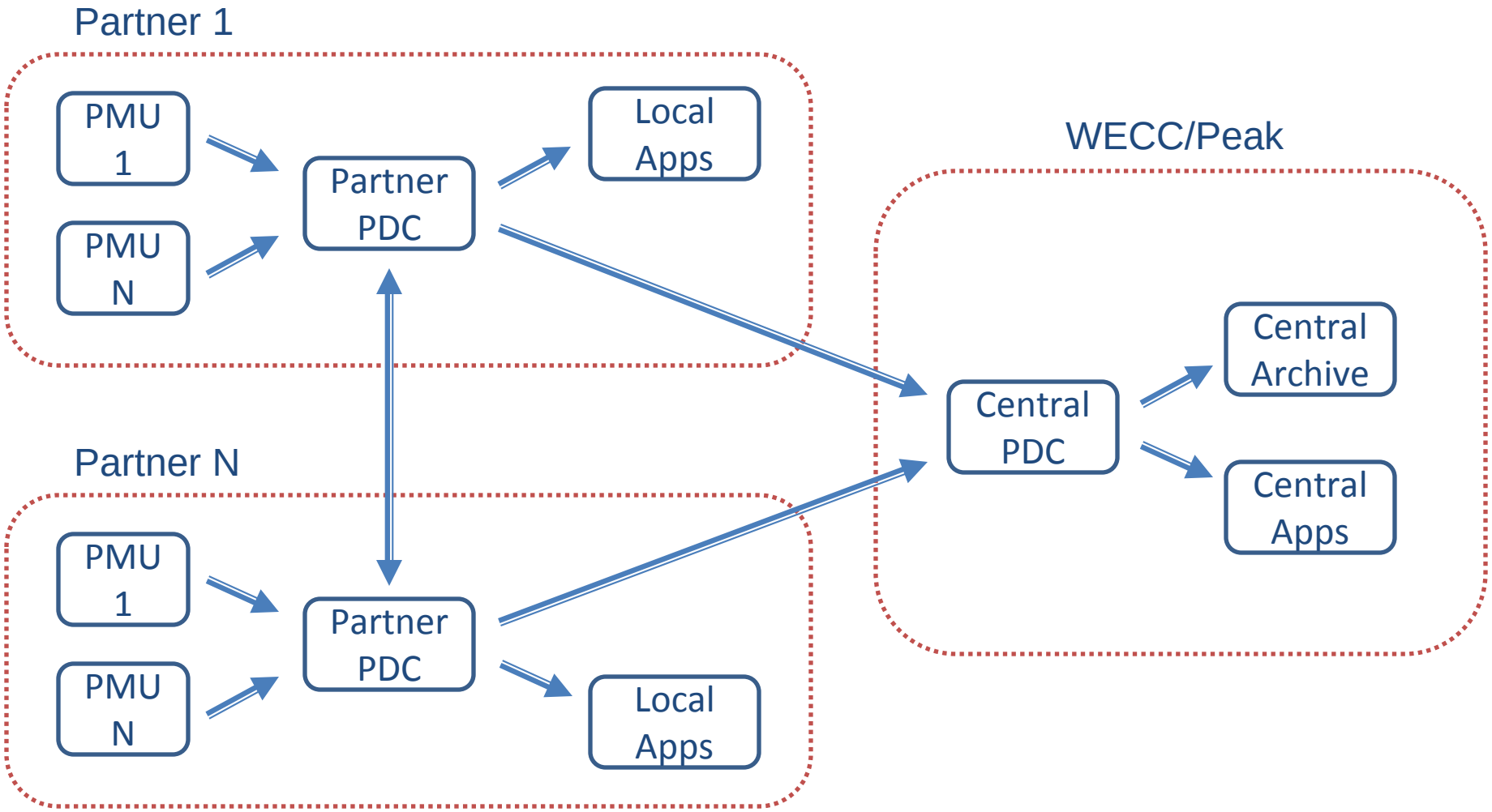
BPA Synchrophasor History

- First PMUs installed at BPA in response to August, 1996 blackout
- First PDC developed and installed at BPA, with system running in May, 1997
- BPA R&D system had 25 PMUs, with additional links to neighboring systems
- Demand for synchrophasor data has caused transition from R&D to operational system

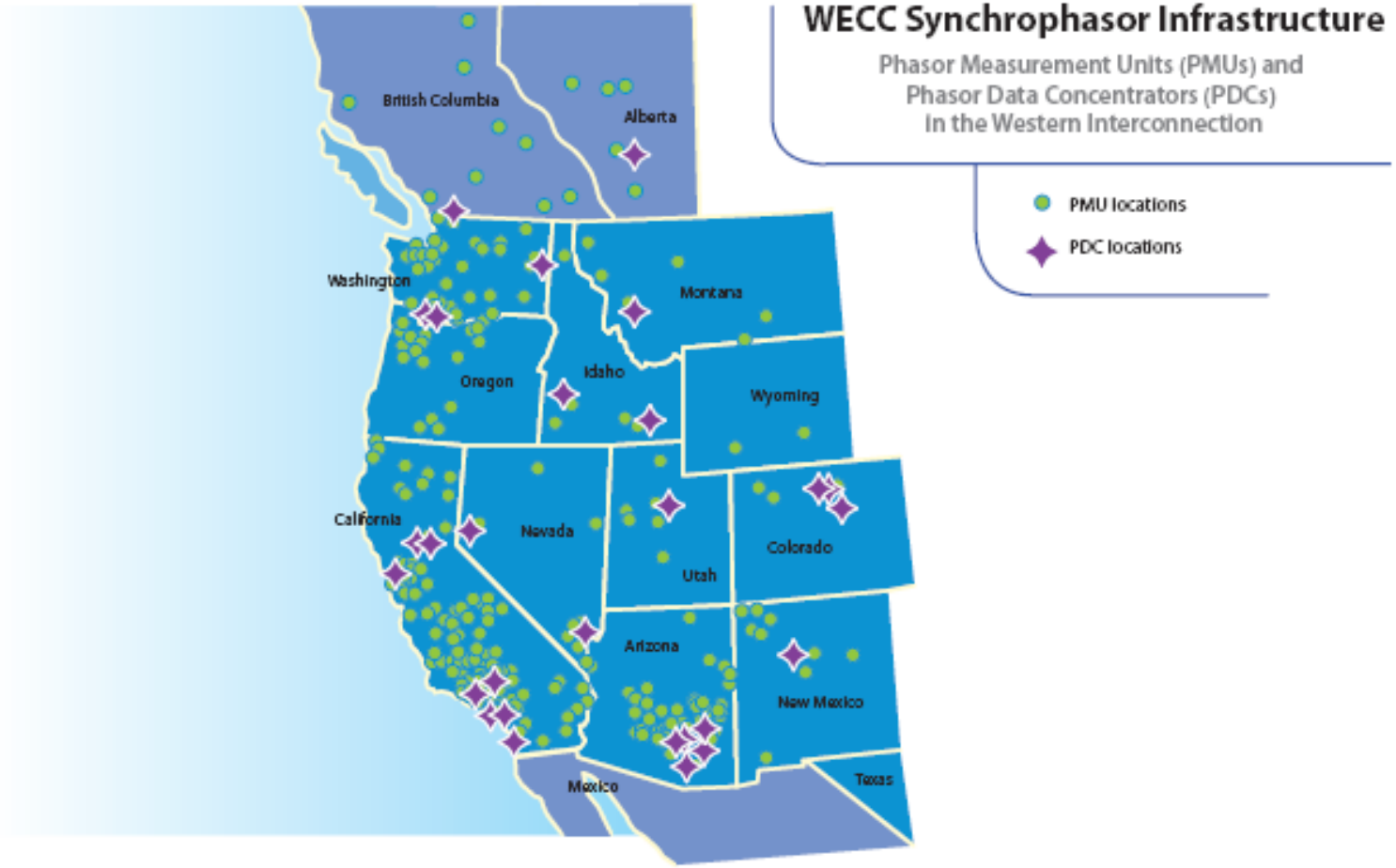
Project Background

- SGIG grant through WECC
- WISP project - BPA partner utility
- Stream data to WECC and to/from 11 other partners
- Transition from R&D to operational system
- C37.118-2005 at 60 frames per second
- Currently ~160,000 measurements/second
- 112 PMUs at 40 sites
- More installations planned in next five years

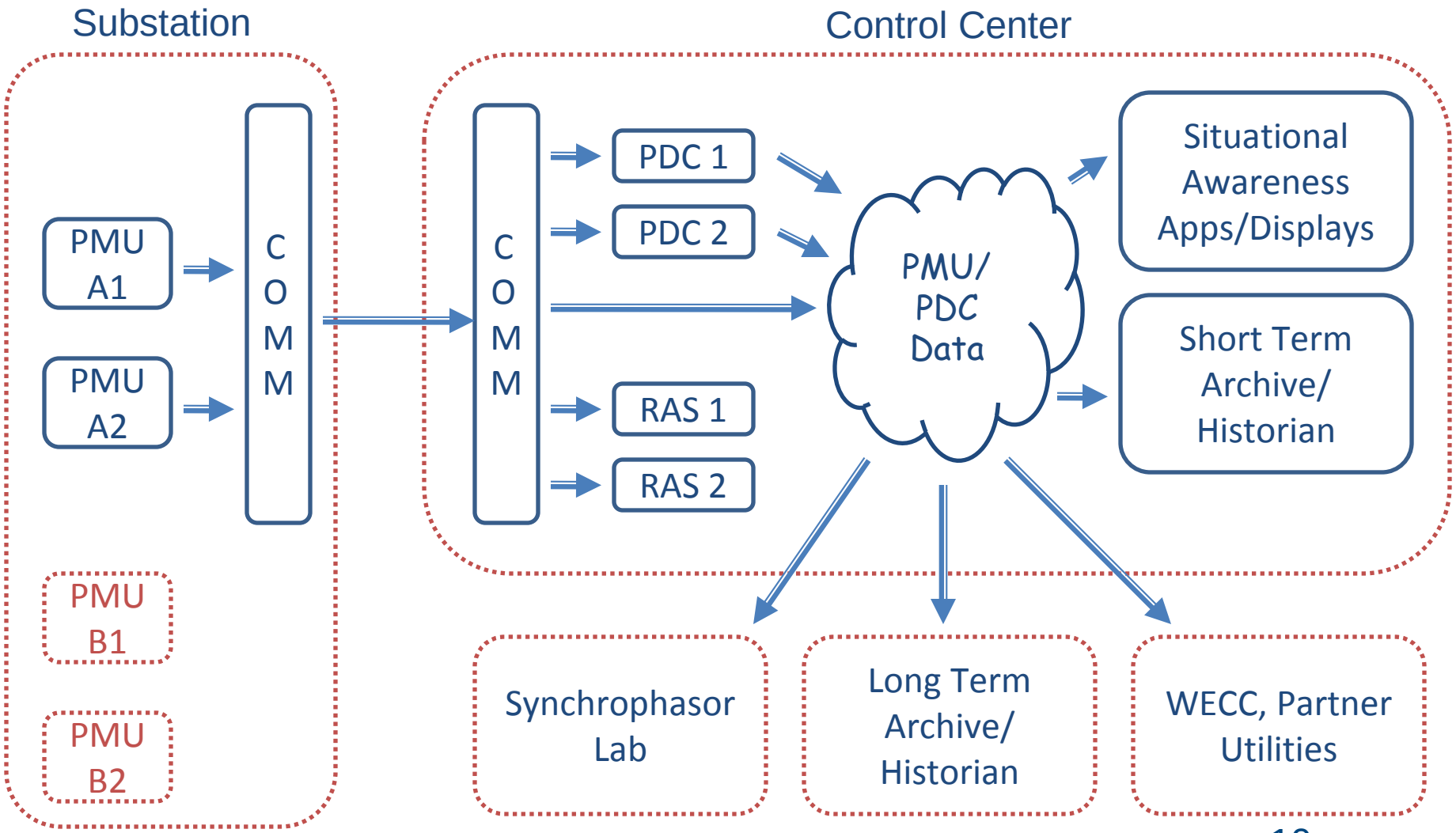
WISP Architecture



WISP Installations



BPA Synchrophasor System



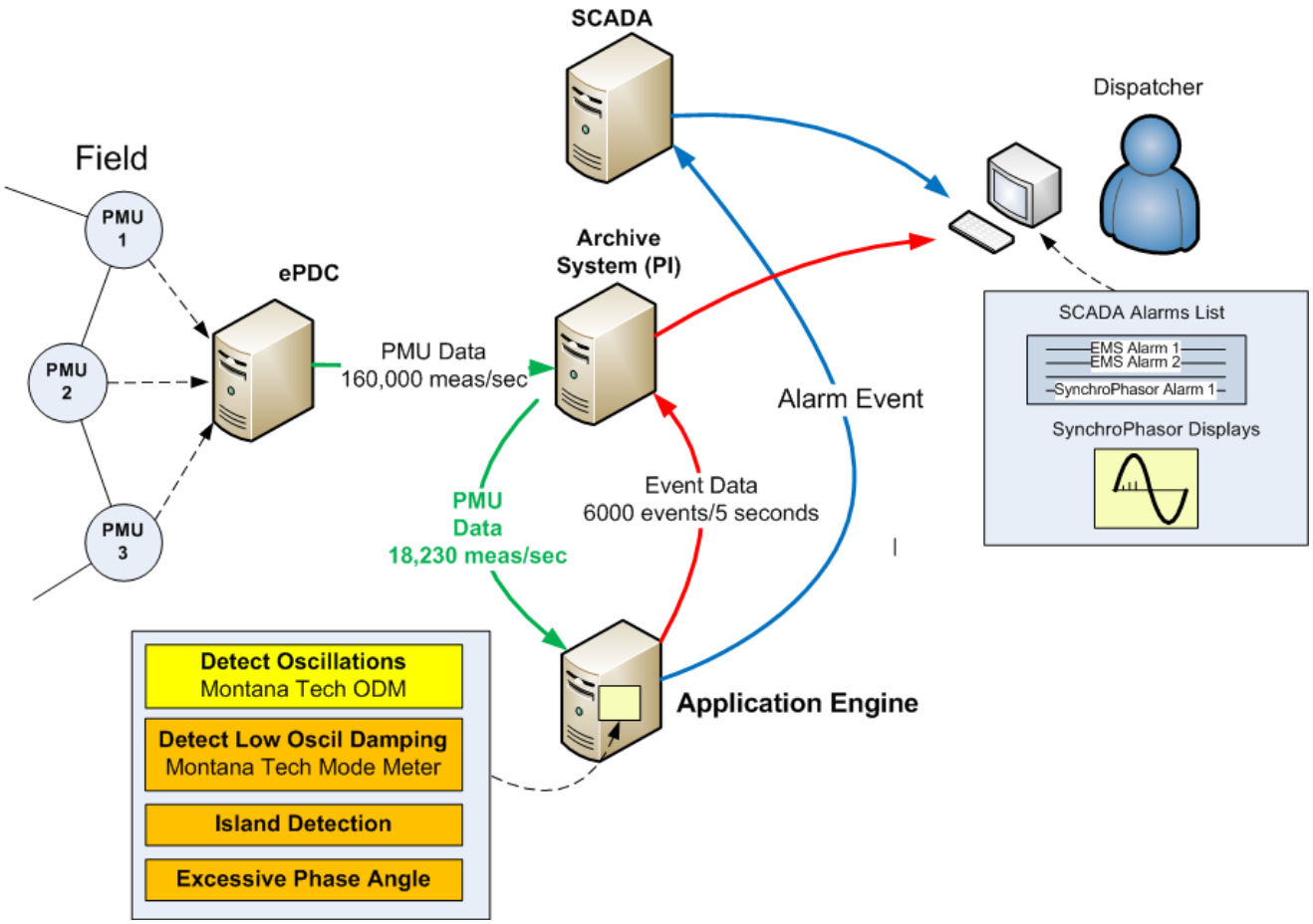
System Design

- Redundant field and control center installations
- Primary/backup data streams
- PDCs select “best data” from each redundant pair of PMUs
- Dedicated SONET channels
- Encrypted UDP multicast streams
- Inter-control-center link

BPA PMU Installations

- Fully redundant, including GPS antenna, GPS receiver, PMU, data stream, network equipment
- C37.118 “Data Validity” bit programmed
- Test mode switch
- SER/SCADA alarms
- Low voltage detection
- Dual, independently configured data streams

Control Center Design



Synchrophasor Applications

- Online Visualization and Alarming - currently running in control centers
  - Oscillation Detection
  - Mode Meter
  - Island Detection
  - Phase Angle Alarming

Synchrophasor Applications

- Offline Tools
  - Post-event Analysis
  - Model Validation
- Wide-Area Control, Remedial Action Schemes
- R&D Applications
  - Voltage Stability
  - Linear State Estimation
  - Event Location

Synchrophasor Lab

- For researchers, vendors, BPA staff to try out tools and applications
- Access to real-time data streams from all BPA PMUs and partner streams
- Access to long term PMU archive
- Isolated from control centers, protected by firewall

Synchrophasor Archive

- Control Center – OSIsoft PI historian
  - 3+ months
  - Interface to real-time applications
  - Fully redundant and maintained
  - Retrieval/conversion using OSIsoft tools
- Synchrophasor Lab – Flat binary archive
  - 3 years, 200 TB
  - R&D grade, not redundant
  - For long-term analysis, baselining, application development, sharing with researchers, etc.
  - Retrieval/conversion using BPA developed tools

Data Quality/Validation

- Sources of quality issues
  - Bad timing, GPS issues, spoofing/jamming?
  - PT/CT inaccuracies
  - PMU failures
  - Field maintenance
  - Communications issues, dropouts
- Bad data detection and reporting
- Data cleansing and correction

Data Challenges

- Big data – spatial and temporal
- Data extraction/conversion
  - Efficient sharing with vendors, universities, etc.
- Real time vs. non-real time vs. pseudo-real time requirements
- Data silos – SCADA, PMU data, GIS, weather, etc.
- Constantly changing system conditions, baselining

Data Challenges

- How do we find “bad” data disguised as “good” data?
- How much “bad” or missing data is acceptable?
- How do we store and retrieve large quantities of PMU data efficiently? Securely? Reliably?

Potential Solutions

- Compression
  - Many applications don't require highest precision
  - Loss of data fidelity, information hidden in "noise"
- Mapping/Indexing
  - Potential for fast accessing, long term analysis
  - Large overhead, difficulty with complex events
- Historians/Databases
  - Simple data storing and retrieval
  - Limited by vendor development, software releases

Contact

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