
Lessons Learned in Phasor Measurement Unit (Synchrophasor) Management at AEP

Carey Schneider

Manager, Transmission System and Asset Monitoring

What is a Phasor Measurement Unit?

Function of a relay that reports the magnitude and phase angle of an analog and/or derived phasor with respect to the global time reference, as per the SynchroPhasor standards (IEEE 1344, IEEE C37.118). The current standard is IEEE C37.118-200.



IEEE C37.118-200

- ✓ “Description: Synchronized phasor (SynchroPhasor) measurements for power systems are presented. This standard defines SynchroPhasor, frequency, and rate of change of frequency (ROCOF) measurement under all operating conditions. It specifies methods for evaluating these measurements and requirements for compliance with the standard under both steady-state and dynamic conditions. Time tag and synchronization requirements are included. Performance requirements are confirmed with a reference model, provided in detail. This document defines a phasor measurement unit (PMU), which can be a stand-alone physical unit or a functional unit within another physical unit. This standard does not specify hardware, software, or a method for computing phasors, frequency, or ROCOF.”

SYNCHROPHASOR

- ✓ A Synchrophasor is a phasor that is time stamped to an extremely precise and accurate time reference
- ✓ Basically a solid-state relay in conjunction with a GPS clock
- ✓ Synchronized phasors (synchrophasor) provide a real-time measurement of electrical quantities across the power grid
- ✓ Continuously measures voltages and current phasors and other key parameters and transmits time stamped messages
- ✓ The time stamped phasors can be transmitted to a local or remote receiver at rates up to 90 samples per second

PMU WHAT DOES IT DO?

PMUs measure (synchronously):

- ✓ Positive sequence voltages and currents
- ✓ Phase voltages and currents
- ✓ Local frequency
- ✓ Local rate of change of frequency
- ✓ Circuit breaker and switch status

PMU APPLICATION EXAMPLES

- ✓ Regional behavior may be understood from local measurements
- ✓ Phasor measurement data can be used to supplement or enhance existing control center functions and provide new functionalities
- ✓ Phasor measurement data associated with a GPS time stamp can deliver a synchronized voltage and current phasor measurements across a wide region
- ✓ By measuring the phase directly, the power transfer between buses can be computed directly
- ✓ Disturbance monitoring –Transient and Dynamic responses

WHO IS USES THE PMU DATA?

PMU DATA IS MONITORED BY:

AEP ATST PMU Synchrophasor team

Stakeholders PJM, ERCOT, and SPP

AEP Operations/Grid Development

Relays used by AEP for PMU

AEP utilizes two specific relay brands the GE L90/D60/N60 and SEL4xx relays for SynchroPhasor applications.



AEP chose these relays to future proof the anticipated PMU needs

Enabling PMU functionality at AEP

(230 PMUs enabled as of 10/2018)

Non-project method (typical)

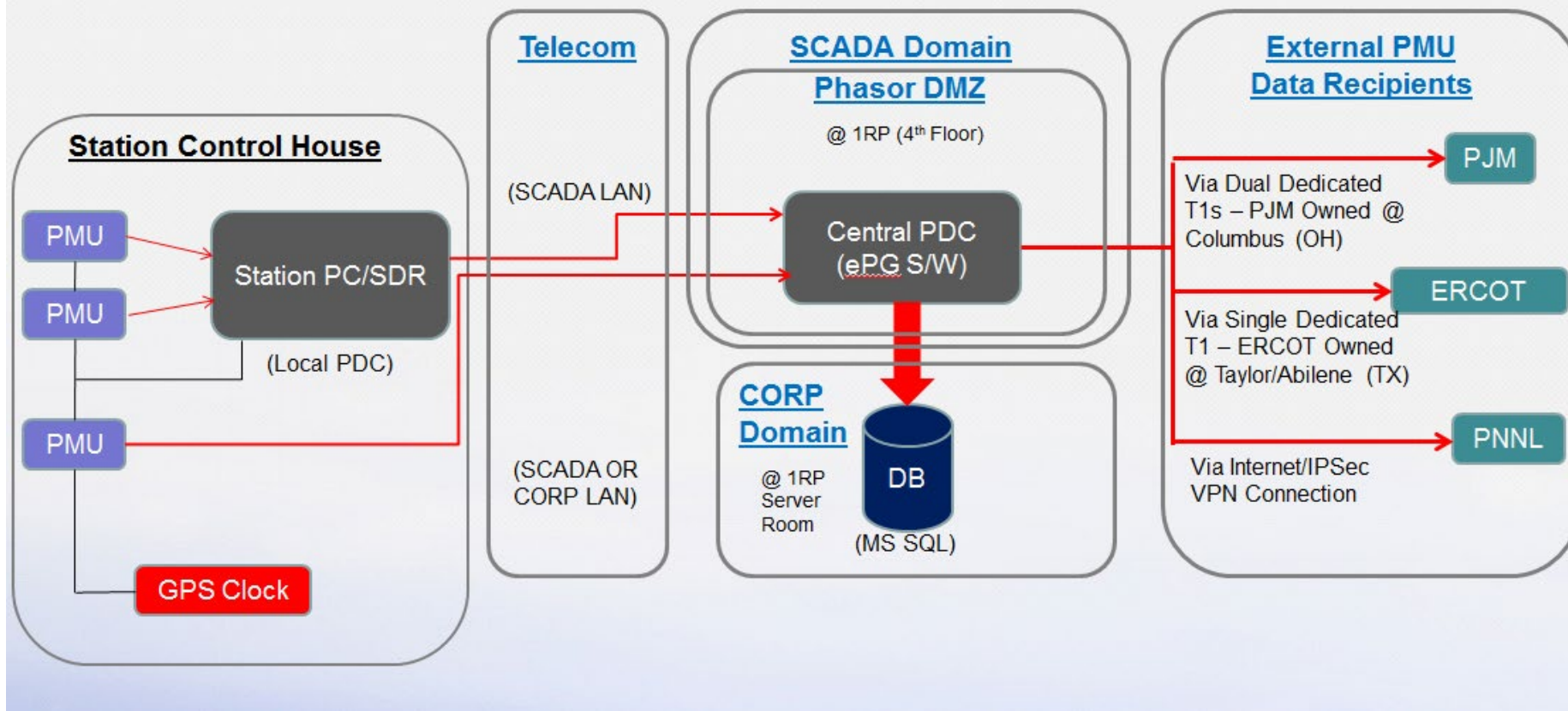
1. Have installed a PMU capable relay device
2. Install proper communications
3. Check for station PMU bandwidth requirements
4. If bandwidth and relay are capable, then enable PMU settings remotely

Project method

1. Install PMU capable relay device
2. Install telecom infrastructure for bandwidth needs
3. Enable PMU settings

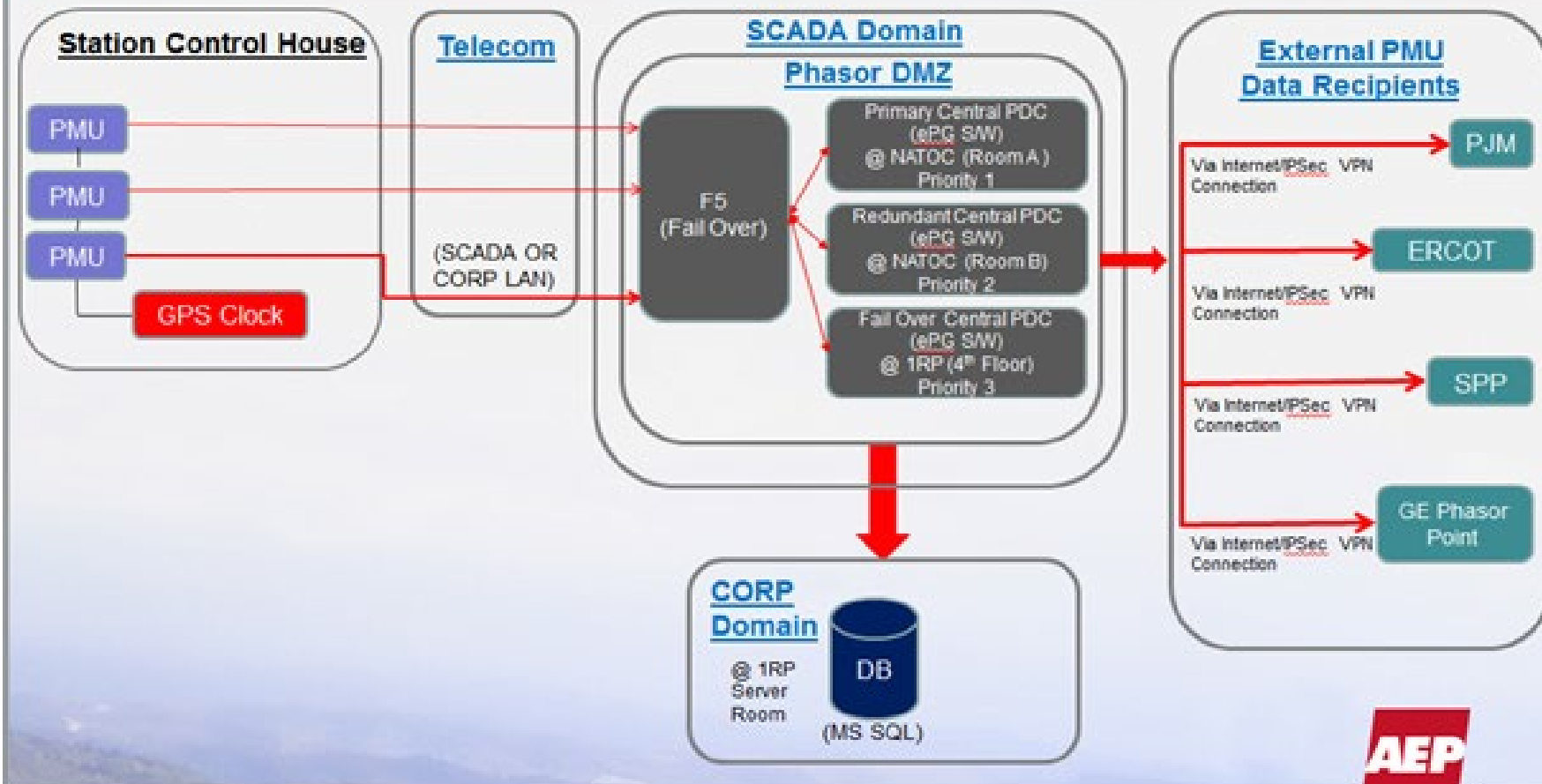
Pre-2018 AEP PMU System Architecture

AEP PMU System Architecture



Current AEP PMU System Architecture

AEP PMU System Architecture



PJM PMU DATA Quality Recommendations

	Current RTO Recommendations	Future Improvements
Latency	Current readings at maximum latency of 500 milliseconds	Improve to 350 milliseconds over next 2-5 years
Data Quality	Handshake agreement @ 95% uptime for good data	Improve to 99% over next 3-5 years

Long term strategy for PMU DATA

1. Telecom strategy – fiber modernization at substations
2. Direct connection to PMUs vs. server structure
3. Improve process and review with field on hardware issues
4. Improve PMU data quality and availability to stakeholders
5. Create PMU standard based on stakeholder requirements
 - P&C and Telecom standards
6. Develop a benefit case for extending usage of PMU data
7. Develop a strategy and algorithm for PMU placement
 - Share with stakeholders, P&C, Telecom
 - Need identification into current projects
 - Identify critical stand alone projects

PMU CONTACTS

ATST TSAM PMU SYNCHROPHASOR TEAM

Email address: PMU@aep.com

Manager: Carey Schneider, Email: cmschneider@aep.com

Engineer: Brady Johnson, Email: bajohnson2@aep.com

Engineering Technician: Adam Veno, Email: aveno@aep.com

QUESTIONS?