Time Synchronization in the Electric Power System

Achievement: identified and articulated what power system engineers and operators need to know about the role and emerging importance of high-quality timing sources in routine and mission-critical grid applications. We articulated architectures and guidelines for how to get timing right and adopt best practices for timing, systems, and equipment that provide the correct, consistent time needed for emerging mission-critical applications, such as closed loop wide-area controls and real-time operator decision support.

Significance and Impact: PMUs need access to reliable Coordinated Universal Time (UTC) to allow synchrophasor applications to time-align the voltage and current time series data for analysis and coordinated activity over a wide geographical area. Most of the PMUs in North America acquire timing data from GPS. Since GPS signals are weak, they are inherently vulnerable to both human-caused and natural disruptions.

Research Details:

- Identify the options for reliable delivery of precise, accurate time signals for wide-area device and data synchronization
- Document problems of current position, navigation, and time (PNT) solutions
- Identify specific, near-term solutions and mitigations that can address multiple failure causes (redundant timing sources, better installation and maintenance practices, detection of bad or anomalous time signals, specs for good-quality equipment, etc.)
- Identify and share how-to information for these solutions
- Recommend longer-term research needs (timing problem detection, equipment interoperability, standards updates, etc.) within grid sector and beyond

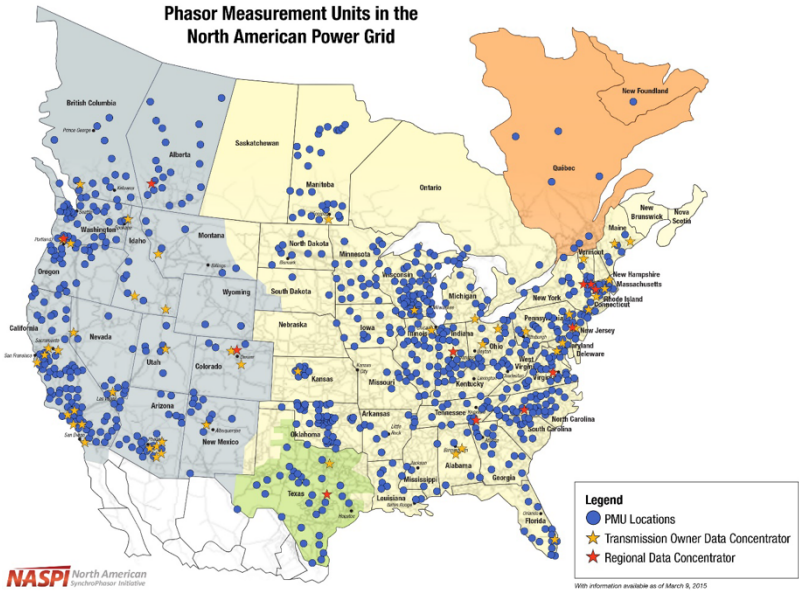

Figure 1. Almost 1,800 PMUs were installed across North America in 2015.

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Overview:
The power system uses precision timing for grid monitoring and situational awareness, to coordinate the operation and integration of a variety of grid assets, and for grid protection and operation. Because power systems are so large and often geographically separated, power data acquisition systems need to share a common time source. In some advanced applications, clocks need to be precisely synchronized to a common reference to enable the integration of diverse data types and sources and assure that decentralized, parallelized analysis and control actions are effectively coordinated and implemented. Information about time is used to understand how relationships and conditions change over time, to identify and understand specific events (whether an individual lightning strike or the sequence of events for a system collapse), and to understand dynamic and transient grid events.
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