NASPI North American SynchroPhasor Initiative

Synchrophasor System Benefits
Fact Sheet

"It's like going from an X-ray to a MRI of the grid."

Terry Boston, CEO PJM Interconnection

What is a synchrophasor?

Synchrophasors are precise measurements of the electricity grid, now available from grid monitoring devices called phasor measurement units (PMUs). PMUs measure voltage, current and frequency at high speeds of 30 observations per second, compared to conventional monitoring technologies (such as SCADA) that measure once every 4 seconds. Each phasor measurements is time-stamped according to the universal time standard, so measurements taken by PMUs in differing locations or with different owners can all be synchronized and time-aligned. This lets synchrophasor measurements be combined to provide a precise, comprehensive view of an entire interconnection. Monitoring and analysis of these measurements let observers identify changes in grid conditions, including the amount and nature of stress on the system, to better maintain and protect grid reliability.

Why should we care about synchrophasors?

Phasor data can be used for a wide variety of applications that maintain and improve bulk power system reliability.

<u>Wide-area monitoring</u> -- High-speed, real-time synchrophasor data and analysis are essential to gain wide-area visibility across the bulk power system for entire interconnections. Phasor data are collected and fed into processing applications that allow grid operators to understand real-time grid conditions, see early evidence of changing conditions and emerging grid problems, and better diagnose, implement and evaluate remedial actions to protect system reliability. The U.S.-Canada investigation into the 2003 Northeast blackout recommended that synchrophasor data systems be installed immediately across North America for this purpose, hypothesizing that had such a system been in operation the August 14, 2003 blackout preconditions could have been identified, understood and mitigated without the subsequent grid collapse. Phasor systems are being used for wide-area measurement systems (WAMS) in the Eastern and Western Interconnections of North America and in China, Quebec, Brazil, Iceland and elsewhere.

<u>Real-time operations</u> -- Phasor data are being used increasingly by individual utilities to manage real-time grid operations. In California, phasor data drives the automated control of SCE's SVC device for reactive power support; BPA uses phasor data for real-time stability and controls. BPA, AEP and TVA are working to incorporate real-time phasor

data into their state estimation tools, to get more accurate and higher sampling rates than their SCADA systems can provide. After Hurricane Gustav struck the Gulf Coast in 2008, Entergy used its PMUs and analytical tools to manage both system separation and islanding and later system restoration. The California ISO and ERCOT will be looking at phasor data to better monitor real-time intermittent generation and integrate those resources economically while protecting bulk power system reliability. Current research will soon improve operators' understanding of inter-area oscillatory modes and how to damp and stabilize frequency oscillations.

Power system planning – The Western states are leaders in using phasor data for power system planning. High-speed data collected by PMUs are valuable for calibrating system simulation models (both static and dynamic) and improving models that characterize individual generator performance.

Forensic analysis -- Phasor data are also essential for forensic analysis of disturbances and blackouts on the grid. Because PMUs collect and store high volumes of high-speed, time-synchronized data about conditions across an interconnection, those data can be compiled quickly and analyzed to determine the sequence of events and what caused the disturbance. Phasor data were essential in the recent investigations of blackouts in Europe (2004), Florida (2008) and elsewhere.

Smart grid – The smart grid will use distributed sensors and measurement techniques with digital communications and controls and distributed computing technology and analytics to optimize the efficiency, reliability and safety of electricity production, delivery and use. At the transmission and generation level, synchrophasor systems are the single most effective technology element to realize and implement the smart grid, because synchrophasor systems collect, distribute, and analyze critical data and convert it in real time into information and insights that improve grid automation and operation. It is expected that using phasor data to manage grid operations could improve transmission efficiency and utilization by increasing line throughput and reducing line losses.

What are the elements of a synchrophasor system?

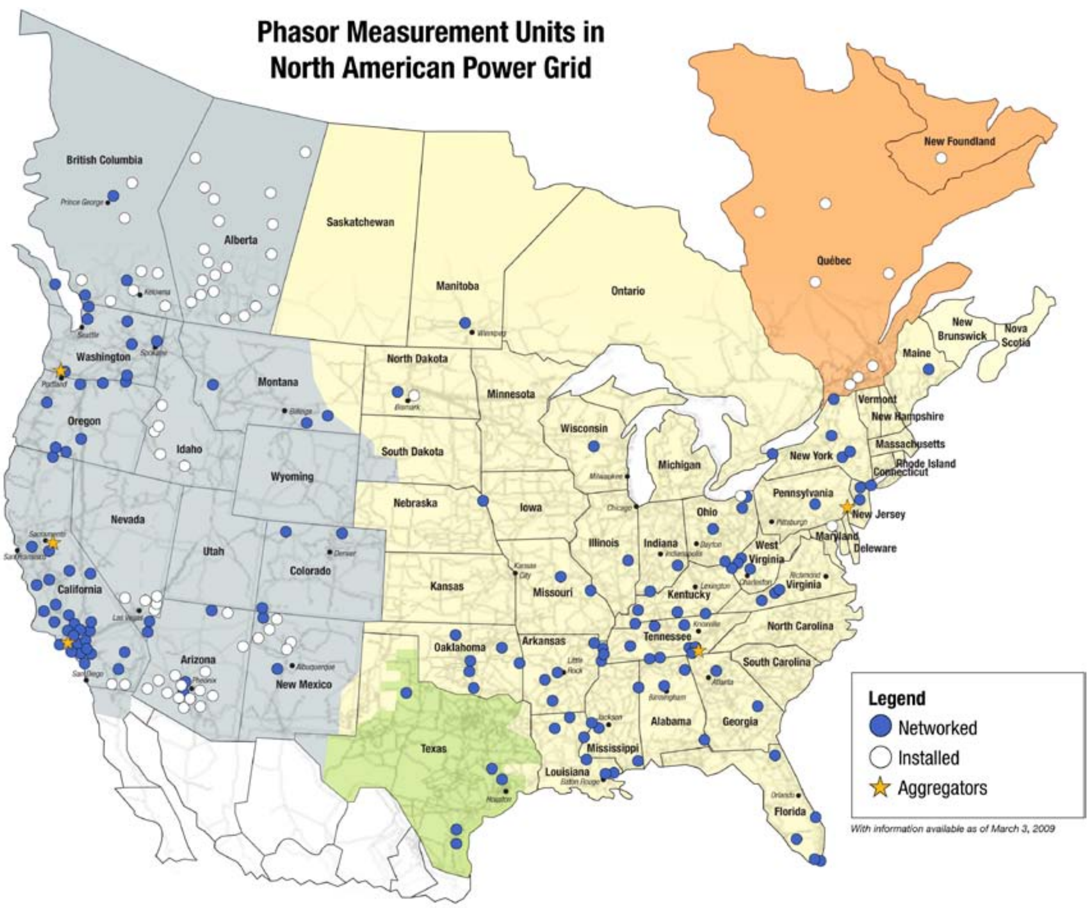
A synchrophasor system includes phasor measurement units (PMUs) to collect real-time data and a communications system (such as a private utility line, the public switched telephone network, or the internet) to deliver the data from many PMUs to a local data concentrator (usually hosted by the utility that owns the PMU). Concentrated data are relayed on a wideband, high-speed communications channel to a higher-capability phasor data concentrator (PDC), that feeds the consolidated data from all the PMUs into analytical applications such as a wide-area visualization tool, state estimator, and alarm processors. These applications feed the phasor data-based information (such as a real-time, grid condition dashboard) out to control room operators, system operations planners, and others. The PDC also delivers the phasor data files into a data historian for archival purposes; it is expected that the widely used COMTRADE Standard C37.110 will become the default file format for phasor data.

What's a phasor measurement unit?

Phasor Measurement Units (PMUs) are devices that measure grid conditions from 6 to 60 samples per second. Specialized, stand-alone PMUs have been manufactured for decades, but PMU functionality has been built into many electronic relays and digital fault recorders that are already installed on the grid. PMUs are most often installed within transmission substations and can be placed at generator busbars.

Most PMUs can collect between 8 and 45 analog inputs; the minimum information collected for wide-area visibility includes location, time, frequency, current, voltage and phase angle relative to some known reference point on the grid. Most PMUs collect and relay data at no less than 30 times per second; in contrast, SCADA data are measured every 5 seconds. IEEE Synchrophasor Standard C37.118-2005 describes the functional requirements for PMUs and basic data measurement and verification requirements; work is under way to refine this standard for dynamic measurements and to verify compliance and interoperability among commercially available PMUs.

More than 200 PMUs are already installed and networked throughout North America and more are expected to be installed soon.



What's the history of phasors?

PMUs were first developed in the 1990s. The 2003 Blackout Investigation recommended accelerated deployment of phasor technologies and time-synchronized data collection to enhance wide area visibility and reliability across the grid. In response, the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability accelerated research into how to collect phasor data and use it for wide-area visualization. DOE worked with industry to start the Eastern Interconnection Phasor Project (EIPP), which joined Western Interconnection phasor efforts to create the industry-led North American SynchroPhasor Initiative (NASPI).

Today NASPI is funded from the North American Electric Reliability Corporation, with significant contributions of time and expertise from across the utility, vendor, consulting, national laboratory and academic communities. The Department of Energy continues to fund research, development and deployment projects to expand the understanding of and uses for phasor data.

Why should utilities install PMUs and participate in NASPI?

Bulk power system reliability is a shared responsibility within an interconnection, and every industry participant should act in ways that promote grid reliability. Installing PMUs and sharing phasor data with others in the interconnection contributes valuable information that can protect grid reliability, and can give the host utility better information and tools to manage operations and utilize assets within its own footprint.

As North America transitions toward grid modernization and the smart grid, synchrophasors will become an essential and mandatory element of every bulk power system participant's reliability responsibility. Regulators are recognizing the great value that synchrophasor systems provide for reliability and are approving cost recovery for phasor-related asset investments.

For additional information on phasors

For additional information please visit www.naspi.org or contact one of the following individuals:

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Also see NASPI's Synchrophasor Technology Roadmap (http://www.naspi.org/phasortechnologyroadmap.pdf) and Synchrophasor Applications Table (http://www.naspi.org/phasorappstable.pdf)