

# **The Role of Synchronized Wide Area Measurements for Electric Power Grid Operations**

Pacific Northwest National Laboratory, U.S. Department of Energy

Position Paper for the National Workshop – Beyond SCADA:  
Networked Embedded Control for Cyber Physical Systems (HCSS-NEC4CPS)  
November 8-9, 2006

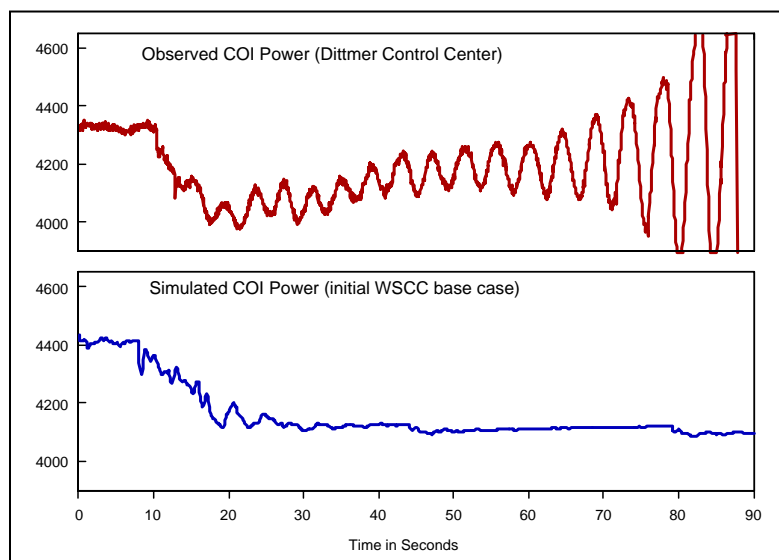
## **Background**

In 1995 the U.S. Department of Energy (DOE) launched the Wide Area Measurement System (WAMS) Project to determine the information needs of the emerging power system and to develop guidelines for deploying the technology to meet those needs. WAMS evolved as an advanced measurement technology to collect information not available from contemporary supervisory control and data acquisition (SCADA) technology.

The WAMS technologies are comprised of two major functions: obtaining the data, and extracting value from it. Getting the data is accomplished with a new generation of data recording hardware that produces high quality and high volume recordings that are virtually continuous. In this respect a WAMS is analogous to the aircraft flight recorder, assuring that even the subtlest beginnings of dynamic interactions and events can be examined for their root causes. Inputs to these monitors are often taken from pre-existing analog sources, in which the electrical utilities have a vast investment. However, the emerging technology of choice is a highly flexible digital system in which messages stream continuously from data sources across the entire power system. Measurements are precisely synchronized against the satellite-based Global Positioning System (GPS), and are readily merged to form integrated views of power system behavior. The initial data source for this system is the Phasor Measurement Unit (PMU), which provides high quality measurements of bus angles and frequencies in addition to more conventional quantities. However, the network is a generic one that can accommodate high speed data from control systems and low speed SCADA data from energy management systems. Such extensions are major elements of the DOE WAMS effort.

Extracting value from this measured data is a critical element of the WAMS effort. Data is extracted and analyzed using several signal analysis tools and algorithms. This includes tools for interactive batch processing of response data from power system monitors or simulation programs, filtering options, several kinds of advanced signal analysis routines, and graphical user interfaces. These tools provide the virtual instrumentation necessary to measure electric power system performance, enhance the ability of system engineers and planners to design and control system operations, and better manage these assets.

A noteworthy contribution made by the WAMS technologies was demonstrated during the failure of the Western power system on August 10, 1996. The results of this breakup, when compared to the dynamic information being provided by WAMS led to several strategic undertakings by the electric utilities. The data fully supported that there is an over-reliance on the current models and that the models were inadequate in predicting system response. Planning tools were also redesigned to better incorporate all the data necessary to adequately plan power system scenarios. One of the greatest benefits realized was that the data contained precursors, which if had been properly analyzed, could have allowed proactive switching of generating resources. This could have either eliminated or drastically reduced the impact of the initial line failure. This capability still remains a research area of interest.



Comparison of measured and simulated grid performance during the August 10, 1996 western grid breakup. Model validation and calibration is one of the primary objectives that WAMS is continuing to address.

In 2001, the Secretary of Energy recognized WAMS as one of the 100 most significant scientific and technological accomplishments by the Department in the 20<sup>th</sup> Century with an *Energy 100* Award. Through support of the DOE Transmission Reliability Program, the success of WAMS in the western power grid is now being extended into the eastern Interconnection through the Eastern Interconnection Phasor Project (EIPP) launched in 2003. Through collaboration with participating utilities, the project involves facilitating the installation and networking of PMUs and joint task teams to conduct off-line analysis and planning activities. The vision calls for delivering value within the operations environment using new inter-regional information and measurement systems. The North American Electric Reliability Council (NERC) will assume the role of facilitator for this effort beginning in 2007, with the DOE role becoming more focused on the long term research, development, and demonstration activities.

### Path Forward

As WAMS technology migrates from a specialized instrumentation system toward greater utilization in supporting real-time grid operations, and as SCADA systems become more sophisticated, there is a pathway toward convergence. While it is unlikely that there will be a single measurement technology for all future power grid applications, we see an opportunity to utilize advanced SCADA technology (for example, faster sampling rates and time-stamped measurements) for WAMS data applications, and WAMS technology for power system applications that historically have only used SCADA data for their input, such as state estimation and contingency analysis.