

WHITE PAPER / **ENERGY NETWORK SYNCHRONIZATION**

OVERCOMING SYNCHRONIZATION CHALLENGES IN TODAY'S ENERGY NETWORKS

BY **Jaime Jaramillo** AND **Dustin Williams, PE**

With network technology advancing to accommodate new power generation, reliable and accurate synchronization is becoming vital. To make the experience seamless, utilities need to invest in equipment that can provide a real-time assessment of grid health as well as immediate notifications for events.



Advancing technology and new methods of generation are changing the way power is distributed. By deviating from the traditional power grid operation strategy, renewable energy solutions are creating a dynamic environment with multiple sources of energy generation. This shift to a smart grid will extend the need to support multiple large power plants to also include wind farms, and small-scale and large-scale private solar power generation sites. To accommodate these additions, the one-way distribution network needs to evolve into an intelligent power grid capable of supporting ever-changing power flows.

The grid evolves with substation integration for transmission monitoring and operation. And with any network technology improvement comes the need for reliable and accurate synchronization. For secure and reliable operation of the power grid, utilities will need a real-time asset health assessment and immediate event notification with time-stamped measurements for quick localization of any fault.

CURRENT CONCERNS FOR TIMING REQUIREMENTS

Timing at substations has historically been provided by dedicated timing systems that use separate cabling and specific protocols. Such time code protocols deliver time information from a local clock, which physically connects with each intelligent electronic device (IED). The time is coded as a digital data stream frequently supported by a pulse per second (1-PPS) signal for precise alignment of the time code information. In many cases, the Global Navigation Satellite System (GNSS) is used for synchronizing the local time to a global reference.

However, with regulators currently categorizing power networks as critical infrastructure, using a purely satellite-based sourcing of time to substations is creating potential risks. Interference, jamming and spoofing could impact the accuracy of time, with negative impact on the operational integrity of the power grid. In the worst case, this could lead to power outages.

Different timing protocols have their own benefits. Network time protocol (NTP) provides time of day (TOD) to substations that can be used to time stamp

information such as event time or syslog time. Packet networks based on internet protocol (IP) and Ethernet are now widely available, and largely use NTP for delivering time to substations and remote sites in a power grid. The one drawback of NTP is the lack of frequency and phase source; therefore, a protocol is still needed to provide frequency synchronization and phase synchronization. While GNSS-based timing can provide this frequency accuracy, NTP cannot.

More precise applications that require frequency synchronization and phase synchronization can use precision time protocol (PTP). By using PTP, a network can provide an increasing level of operational sophistication with higher accuracy in monitoring the power grid and localization of faults.

HOW PTP CAN MAKE A DIFFERENCE

PTP can be implemented with physical hardware timestamp to minimize delay and achieve the elevated accuracy required by substation systems. It is also complemented by timing functions in the packet network transport equipment. Transparent clocks compensate for packet processing delays in packet switches. Boundary clocks combine a grandmaster function with clock recovery to eliminate delay and packet delay variation.

With these mechanisms, the packet network becomes time aware and improves the quality of PTP delivery. In short, the packet network needs to be built to be PTP aware so it can deliver high accuracy frequency, phase and time services needed by new smart grid technologies.

PTP EFFECTS ON OPERATIONAL AND INFORMATION TECHNOLOGIES

Utilities often separate operational technology (OT) and information technology (IT), and the specialized teams that design and implement them. However, both teams need to cooperate as the IT network frequently provides bearer services for the OT communication.

The introduction of PTP is creating a new field and new opportunities for close cooperation between OT and IT teams. While precise time is key to operational control and performance, it can only be provided by IT networks

specially enhanced with PTP capabilities. An IT network that is not time aware and not designed for the transport of PTP packets will likely not be able to deliver PTP with the required accuracy for smart grid systems.

A new design consideration includes a local PTP grandmaster as the backup of the centralized timing source. With this configuration, the local grandmaster serves as the legacy NTP server and provides highly precise synchronization with PTP and inter-range instrumentation group (IRIG)-B timing in the case of network congestion or outages. The grandmaster clock is synchronized from satellites locally as a backup but also synchronized with PTP from a central core clock for security and vulnerability mitigation.

CONCLUSION

Smart grid technology and demands on the electric system are rising. From electric vehicles to renewable power generation, PTP is critical for the reliable synchronization of devices and seamless cooperation of all different sectors of the grid.

BIOGRAPHIES

DUSTIN WILLIAMS, PE, is a senior project engineer in the Transmission & Distribution Group at Burns & McDonnell. He specializes in telecommunications and network engineering with experience in MPLS WAN, substation LAN, and SONET network design and implementation. Dustin earned a Bachelor of Science in electrical and computer engineering from the University of Missouri-Columbia.

JAIME JARAMILLO is senior director of business development at ADVA Optical Networking OSA. With extensive experience driving solutions, sales and services across domestic and international markets, Jaime focuses on delivering new levels of quality and creating new opportunities for customers of ADVA's synchronization technology across North and South America.

ABOUT BURNS & McDONNELL



Burns & McDonnell is a family of companies bringing together an unmatched team of engineers, construction professionals, architects, planners, technologists and scientists to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities with offices, globally. Founded in 1898, Burns & McDonnell is a 100% employee-owned company and proud to be on *Fortune's* list of 100 Best Companies to Work For. For more information, visit burnsmcd.com.

ABOUT OSCILLOQUARTZ



Oscilloquartz is a pioneer in time and frequency synchronization.

We design, manufacture and deploy end-to-end synchronization systems that ensure the delivery and assurance of highly precise timing information over next-generation packet and legacy networks. As an ADVA company, we're creating new opportunities for tomorrow's networks. For more information, visit oscilloquartz.com