# Better times for smart grids

## Mastering synchronization challenges in energy networks

### From one-way energy distribution to the intelligent power grid

The way energy is generated and distributed is changing. As today's large power plants are boosted by multiple sources of energy generation from wind farms to small-scale private solar-power panels, traditional operational strategies require a major rethink. To support these changes, the one-way distribution network needs to evolve into an intelligent power grid. All active sites must be integrated into the operational control system, and substations will become essential monitoring and control points. For secure and reliable operation of the power grid, we need a real-time assessment of its health and immediate notification in the event of problems. What's more, measurements need to be precisely timestamped to enable accurate analysis of network status and fast localization of any fault.

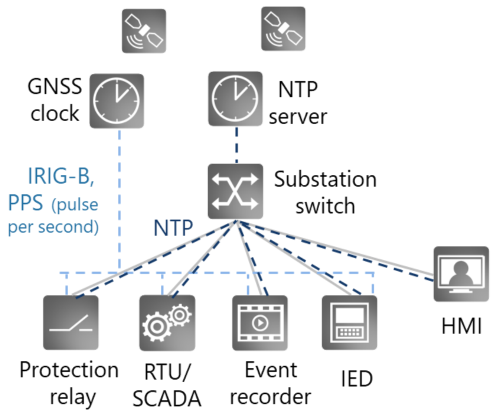



Figure 1: Legacy timing at substations

### Timing at a substation

Timing at substations has historically been provided by dedicated timing systems that use separate cabling and specific protocols such as IRIG-B. 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 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.

Regulators are now categorizing power networks as critical infrastructures. Using a purely satellite-based sourcing of time to substations is creating an unacceptable risk. Interference, jamming and spoofing could degrade accuracy of time, with negative impact on the operational integrity of the power grid. In the worst case, this could lead to power outages.

## Timing over packet networks

Packet networks based on IP and Ethernet are now widely available. We can use these packet network technologies for delivering time to substations and remote sites in a power grid. Network Time Protocol (NTP) is frequently used for distribution of time over packet networks, mitigating the risk of GNSS outages. Figure 1 shows a substation using IRIG-B as well as NTP for synchronization in a complementary way, combining high accuracy with high availability.

## Highest time accuracy is essential for efficient operations

With an increasing level of operational sophistication, greater accuracy is needed in power grid monitoring and localization of faults. Substations require microsecond accuracy with phasor measurement units as well as sample value merging units. Portable wave fault locators require a similar precision for accurate localization of any fault. Those requirements have been specified with IEC 61850, which addresses communication networks and systems for power utility automation.

While GNSS-based timing can provide this accuracy, NTP cannot. NTP needs to be replaced with the more sophisticated Precision Time Protocol (PTP).

## How PTP makes a difference

PTP can be implemented with physical hardware timestamping to minimize delay and achieve very high accuracy required by these essential substation systems. This creates a significant improvement over software-based NTP solutions.

PTP is complemented by timing functions in the packet network transport equipment. Transparent clocks (TCs) compensate for packet processing delays in packet switches. Boundary clocks (BCs) combine a grandmaster (GM)-function with clock recovery to eliminate delay and packet delay variations. With these two mechanisms, the packet network becomes time aware and improves the quality of PTP delivery. In short, the packet network needs to be built for PTP for delivering accurate frequency, phase and time services.

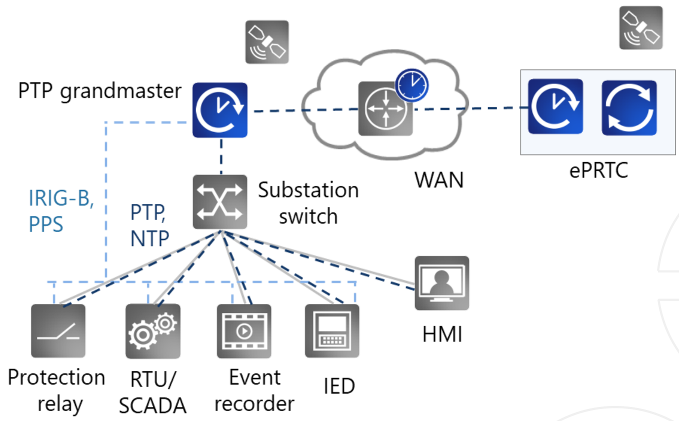



Figure 2: Seamlessly introducing highly accurate PTP timing

## Operational and information technologies

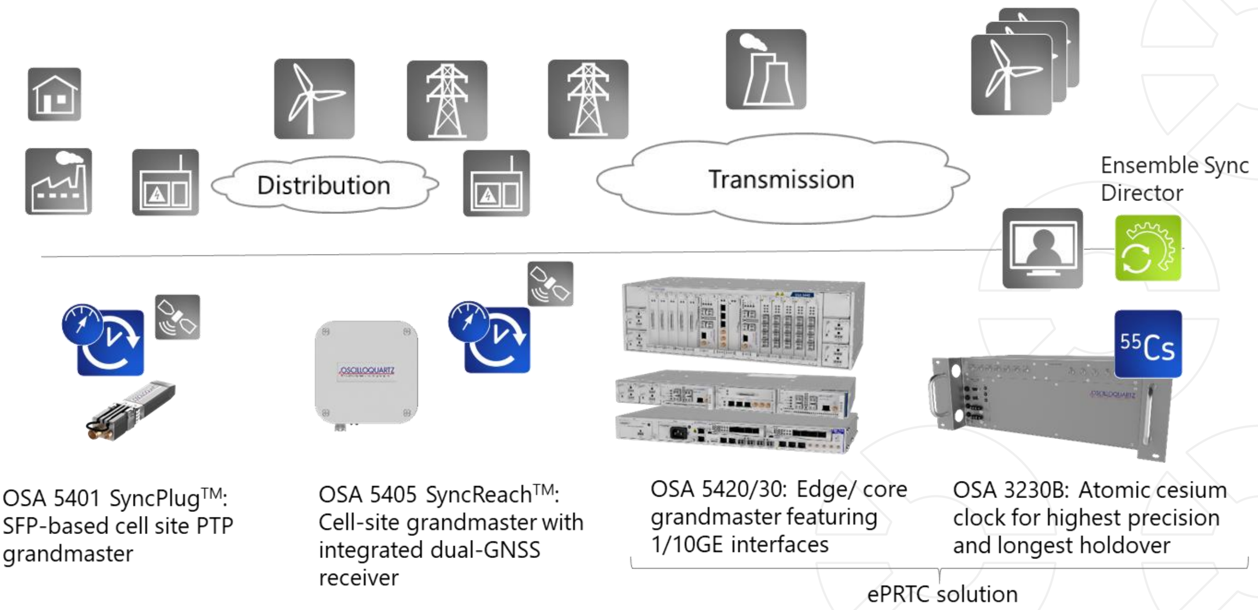
Energy companies consider it good practice to separate operational technology (OT) and information technology (IT). This separation includes the highly specialized teams designing and implementing OT and IT. However, both teams must cooperate as the IT network frequently provides bearer services for 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, it can only be provided by IT networks specially enhanced with PTP capabilities. An IT network which is not time-aware and designed for the transport of PTP packets will most likely not be able to deliver PTP with the required accuracy.

Figure 2 highlights the best practice for migrating from legacy timing to future-proof PTP for scale, precision and availability. A local PTP grandmaster is the source of legacy NTP and IRIG-B timing. It also delivers highly precise synchronization with PTP. The grandmaster clock is synchronized from satellites but also with PTP from a central core clock for security and vulnerability mitigation. This core clock needs to provide highly accurate frequency and time information, even in the event of extended GNSS unavailability. As outlined above, the packet network is time-aware and provides very accurate frequency, phase and time synchronization.

## ADVA solution overview

ADVA offers a comprehensive portfolio of synchronization solutions for migrating substations to IP-based timing while supporting legacy timing signals. A very compact, zero-footprint, SFP-based grandmaster can easily convert any non-timing-aware device into a PTP-enabled application. Compact grandmasters combine NTP, PTP, Sync-E and IRIG-B interfaces with multi-constellation, multi-band GNSS receivers for migrating legacy synchronization networks to future-proof, high-performance timing solutions. Ultra-stable primary reference time clocks in the core of the network are the reliable foundation of any timing architecture, while providing secure mitigation of GNSS vulnerabilities such as jamming and spoofing.




The OSA 5420 is an essential component for timing excellence in energy distribution networks. It supports the widest range of interfaces as well as multiple PTP profiles including power profile, and can be applied as a gateway between telecom and enterprise timing networks. What's more, in the core of the network, our OSA 5430 and OSA 5440 in combination with our cesium atomic clocks provide unique standards-compliant enhanced primary reference time clock (ePRTC) accuracy.

## Better times for power networks

IRIG-B and NTP have served our industry well in the past. But those technologies will not lead us into the future. They are not suitable to synchronize substation systems that require very high synchronization accuracy and reliability. This is what PTP was developed for. With market-specific adaptations known as PTP profiles, PTP complements and replaces legacy timing protocols in the enterprise market. ADVA has optimized its synchronization portfolio to meet the specific requirements of power utilities. Most importantly, we have integrated legacy timing and PTP interfaces in combination with gateway functions between power and telecom profiles. All these innovations make this product family a perfect solution for migrating existing power utilities timing networks to modern IP based timing aware synchronization solutions.

In order to meet stringent availability and security requirements, our timing solution is enhanced with a comprehensive set of synchronization assurance features. This includes Syncjack™ technology for continuous monitoring, testing and assurance of timing accuracy. With our solution, network elements also provide GNSS spoofing and jamming detection. In combination with AI-assisted analytics, problems in the synchronization network are detected even before services are affected. This unique capability is essential for mission-critical operations.