

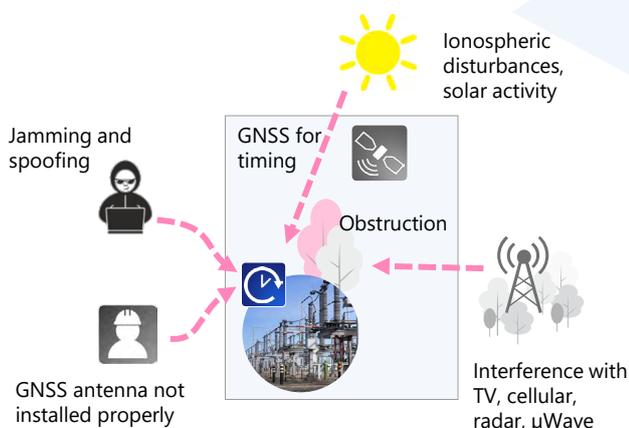
Transport of precise time over optical channels

Synchronizing critical applications

Robust synchronization is key to efficient and reliable communication networks and enterprise applications. For operators of critical infrastructure, improving the availability of satellite-based timing is crucial. Transport networks offer an efficient way to deliver accurate and highly reliable timing. However, to achieve the highest levels of accuracy, they need timing-aware packet forwarding devices that precisely compensate for any forwarding delay, as well as optical transport systems compensating for asymmetric delay caused by fiber dispersion.

Mitigating vulnerabilities of satellite-delivered timing

Satellite-based timing is frequently applied as source of precise synchronization. Mobile operators use GNSS receivers at base stations, power utilities use them at substations and financial institutions deploy them in their offices. But satellite-based timing is subject to vulnerabilities and disturbances. Obstructions can temporarily impact the quality of the GNSS signal. Malicious jamming or spoofing attacks as well as unintentional interferences from other radio systems can disturb the satellite signal. Today, operators and enterprises rely on GNSS, despite its vulnerabilities and shortcomings. But concern among these companies is growing, along with regulatory pressure to mitigate the business continuity risk resulting from poor synchronization. Luckily, there is a highly reliable way to mitigate GNSS vulnerabilities. Cesium atomic clocks can provide highly accurate time even during long periods of satellite unavailability and this precise time can be delivered over transport networks to other core and edge sites.



Challenges of highly precise synchronization

- GNSS receivers are subject to vulnerabilities such as jamming and spoofing
- The accuracy of GNSS receivers is impacted by ionospheric disturbance and solar activity
- Network-delivered synchronization suffers from delay variations and asymmetric delay caused by switches and routers
- Wavelengths propagate at different speeds over fiber causing asymmetric delay

Precise time over optical networks

Backing-up GNSS-based timing with network-delivered synchronization is the most promising approach for securing the operation of critical infrastructures such as communication service providers, energy companies, financial institutions, among many others. A few ultra-stable PRTCs with cesium atomic clocks at core sites are delivering precise time information over transport networks even during extended periods of GNSS unavailability. Those transport networks need to treat the timing packets with specific care. Packet devices must support highly precise boundary clock class D functionality for the most accurate processing and forwarding of PTP packets. In addition, the optical transport system needs to eliminate asymmetric delay by transmitting bidirectional PTP flows over closely spaced wavelengths using a common fiber and by compensating any residual static asymmetrical delay numerically.

Optical timing channel for accurate PTP transport

Our Oscilloquartz scalable grandmasters with multi-band, multi-constellation GNSS receivers can be equipped with bidirectional transceivers for single fiber applications at 1.6µm wavelengths. With boundary clock class D accuracy, the sync devices forward PTP packets with the highest levels of precision. What's more, our FSP 3000 open optical transport systems deliver PTP flows at ultra-low asymmetric delay over a fully integrated, bidirectional 1.6µm channel. The combination of highly accurate PTP packet processing and optical transport optimized for the lowest asymmetric delay creates an ultra-precise synchronization overlay that mitigates any GNSS issues. By delivering precise timing from a few high-performance core clocks, our optical timing channel (OTC) solution also avoids the cost of deploying expensive GNSS-disciplined core clocks across many sites.

Streamlining operations

Networks with many sites might use several thousand GNSS receivers and each one is at risk from defects and malicious action. What's more, as devices are often not well integrated into management systems, troubleshooting can be cumbersome. Getting permission for antenna installation can also be a problem, while installation and cabling can be a difficult undertaking. Our optical timing channel solution removes all of these issues, saving significant operational cost. Network delivered timing avoids the need for GNSS receivers and related antenna at each and every site. A common management system provides full transparency with real-time synchronization quality information and visibility of all components of the solution from optical transport to the GNSS antenna, grandmasters and boundary clock devices.

OTC solution components

- Scalable grandmaster with boundary clock class D accuracy
- Multi-band, multi-constellation GNSS receivers
- ePRTC and PRTC class B core clocks
- Transparent DWDM transport over timing channel
- Compensation of asymmetric delay
- Common management system
- AI/ML-power GNSS spoofing and jamming detection

Making synchronization networks robust

There are various ways to make sync delivery resilient. A clock can process PTP flows from several grandmasters, choosing the one with the highest accuracy using the BMCA (best master clock algorithm). This approach also restores operation of the synchronization network in case of network and grandmaster defects. However, there are still single-point-of-failure scenarios, which can only be addressed by fully redundant carrier-grade timing equipment. With OTC, ADVA and Oscilloquartz are offering the only hardware-protected synchronization solution. Their unique combination of transport and synchronization competence assures accurate synchronization for mission-critical operations, even under the most stringent conditions.

