Timing in financial trading

Compliance by precise, traceable and verifiable synchronization

OSCILLOQUARTZ
An ADVA Optical Networking Company

Fairness, security and efficiency in financial trading

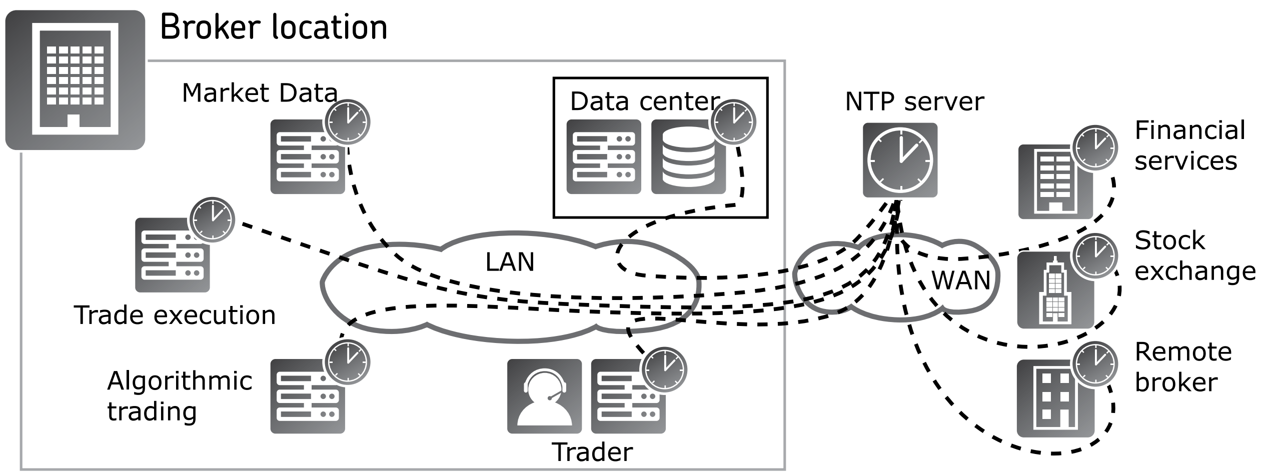
Transparency is key in financial markets. For every transaction, it's essential to have reliable data about who placed it, how it was processed and when exactly it was executed. Authorities need to be able to correlate information about each and every reportable event in order to prevent trading irregularities and market abuse. This data is also invaluable in tracking down failures in the highly complex trading system.

Legacy timing architecture

Accurate timestamping of every transaction is a vital part of operating financial markets in a fair, secure and efficient way. Responsible authorities are developing and implementing legal frameworks defining regulatory requirements for precise timekeeping in trading venues as well as with their partners and participants. At present, financial applications are typically synchronized to a business clock by network timing protocol through a data network.

Legal frameworks

In the EU, the European Security Market Authority (ESMA) has defined transparency requirements including timestamping accuracy for reported events. The Markets in Financial Instrument Directive (MIFID II) defines in the Regulatory Technical Standard RTS 25 a time accuracy of 100µs synchronized to UTC for algorithmic and high-frequency trading. A similar ruling was defined by the US Security and Exchange Commission (SEC) with Rule 613.



Limitations of present time distribution

Network Time Protocol (NTP), which is commonly used to provide timing in financial trading environments, is a well-established, widely adopted protocol which can typically provide an accuracy in the order of tens of milliseconds. But this technology cannot meet the new, stringent timing requirements of recent rulings from SEC and ESMA.

New methods are needed which either improve the timing accuracy of the presently applied NTP protocol or which introduce new means for distributing timing in financial trading applications.

Fairness, security, stability	Legacy time delivery
• Holistic view for identification of fraudulent action	• Legacy Network Time Protocol (NTP) is software based
• Precisely time-stamped, auditable transaction records	• Delivery over standard IP networks suffers from delay impairments
• 100µs accuracy for algorithmic and HF trading	• Realistically achievable accuracy of several 10s of ms

Precision Time Protocol is superior to NTP

Today, NTP is widely applied to distribute time over public or private IP networks. This technology has significant shortcomings when timing precision is mandatory and will not be able to provide sufficiently accurate and trustworthy timing in financial markets.
When introducing a new technology for time distribution, it's also vital to monitor the quality of the timing network. This enables reporting compliance to the new ESMA and SEC regulatory requirements. A new time distribution technology in combination with synchronization assurance and long holdover oscillators will be key to timekeeping in financial markets.

Highly precise timing with Precision Time Protocol

In short, NTP has had its day with timing distribution in financial markets. This however does not mean, that protocols cannot do the job. Precision Time Protocol (PTP) is a more powerful and precise way of disseminating time information over packet networks. PTP has been selected as time protocol in many industries including telecom, power and broadcasting, all of which require stringent time accuracy. It combines hardware-based processing of timestamps with additional timestamp processing in the data network. Time is not just transported over a network; network nodes engage in the dissemination process by compensating for delays in transparent clock mode or even recovering time by means of a local oscillator and acting as a down-stream clock source. A device fulfilling this function is known as a boundary clock. As PTP packets can also be exchanged at a much higher rate compared to NTP, this allows for more frequent timing information from the master clock.

Assuring synchronization delivery

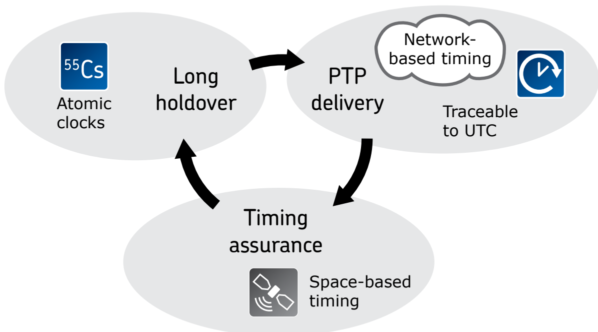
SEC and ESMA rulings require a time-stamp accuracy of 100µs for high-frequency and algorithmic trading. This needs to cover accumulation of time errors all the way from a reference clock over PTP transport in the WAN and LAN up to processing of time information in financial appliances. There are various impairments in a data network which can have negative impact on the precision of timing information. Monitoring tools need to assure compliance with required timing accuracy. With PTP, probes can be implemented for monitoring the performance of PTP flows and comparing recovered timing information against precise GNSS-sourced time.

NTP shortcomings

1. Timestamped IP packets are delayed as they travel through the data network. Latency can vary in an unpredictable way. Asymmetric delay makes it impossible to calculate exact time at the client side.
2. NTP packets are typically processed by software. This method is slow and creates significant delay. It also suffers from high delay variances, which create a high level of uncertainty.

Improving resilience with oscillators featuring extended holdover

With the strict time-stamping requirements imposed on financial transactions by the ESMA and SEC, the availability of precise timing information becomes mandatory for executing transactions. Loss of traceable timing information would require the interruption of trading activities. Assurance of precision therefore needs to be combined with assurance of availability. Adding local oscillators with long holdover times to the timing architecture allows trading activities to continue during periods of unavailability of an externally supplied timing signal. The local clock can now be used as a business clock leveraging the long holdover times. Oscillators might be equipped with temperature-controlled crystal or atomic frequency standards such as rubidium or cesium.



Trinity of timing accuracy in finance

Towards future-proof timekeeping for financial institutions

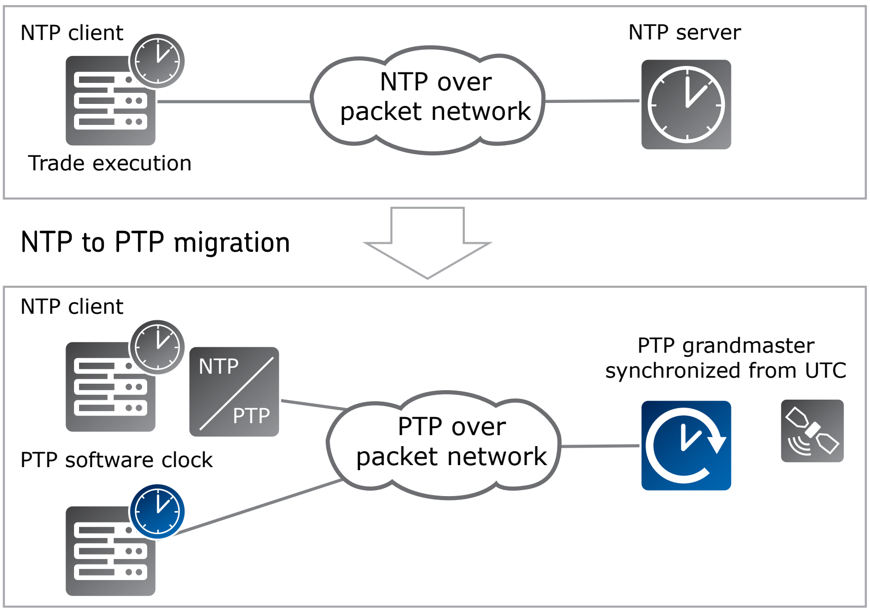
Trading venues, investment firms, and other financial market participants will need to revisit their time distribution systems in order to meet regulatory requirements. They will have to analyze the capabilities of the present system, investigate ways to improve timing precision and consider new requirements such as synchronization to a common clock. For cost reasons, it's preferable to keep existing network infrastructures in place and augment them with synchronization functionality rather than replace the complete IT network with timing-optimized gear.

Migration from NTP to PTP

An essential step for meeting regulatory requirements for timing accuracy in trading networks is the transition from NTP to PTP. The NTP server is replaced by a PTP grandmaster, which synchronizes to accurate time delivered by a GNSS-disciplined oscillator. Presently, data networks installed in trading venues will in many cases meet delay and delay variation requirements for transport of PTP packets. A critical component when innovating timing networks is migrating the NTP clients to PTP. There are two different approaches, either installing new interface cards with PTP support in servers or, alternatively, applying PTP to NTP protocol conversion close to the client. With the latter, PTP improves the end-to-end delivery performance. Additionally, the NTP client can be supported by a highly precise 1PPS external synchronization signal provided from the NTP-PTP gateway.

PTP software clients

An NTP/PTP gateway is an excellent solution for converting PTP to NTP in front of a closed hardware appliance. However, there are also open financial software solutions that run on standard servers. With this method, a PTP software client can be installed on the server to directly synchronize the internal business clock with time information received from PTP packets. The advantage of this solution is that it does not require an additional gateway. This removes the need for additional rack space and ensures that power consumption is minimized .

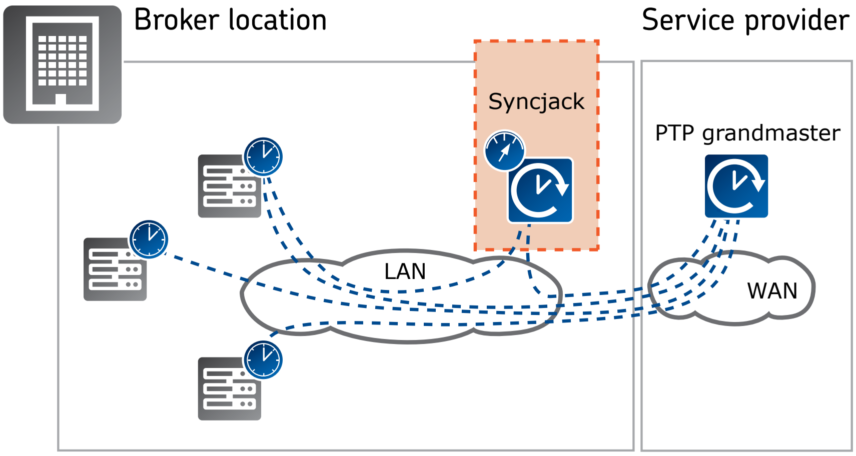


Monitoring quality of synchronization

As discussed, time distribution over packet networks might suffer from congestion and network failures. It's good practice to constantly monitor synchronization quality by comparing recovered PTP timing signals with time derived from a GNSS signal. Such timing assurance functionality can be provided by synchronization probes installed in the network. Financial institutions that monitor and continuously record the accuracy of their PTP-supplied timing are well prepared to comply with regulatory requirements. Regulatory authorities might even demand such measures going forward. What's more, synchronization assurance provides immediate failure notification. With this information at hand, counteraction can be initiated even before trading activities are affected.

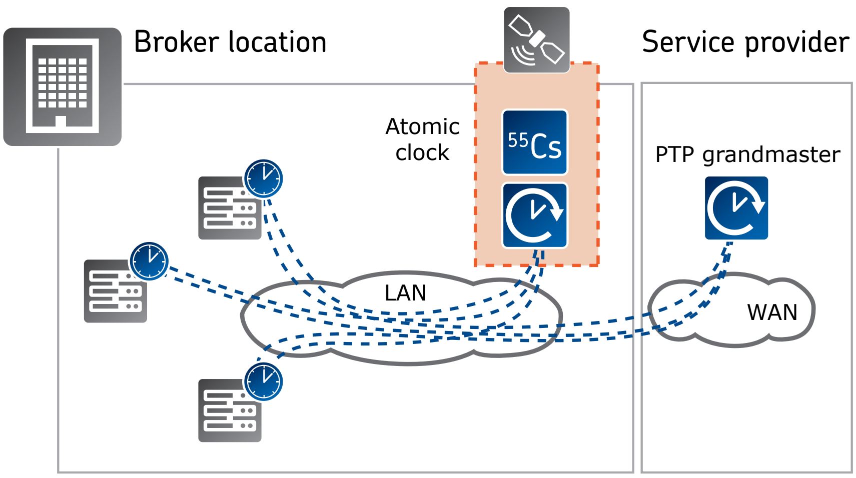
In addition to the time probing function, packet delay and packet delay variations should be monitored. This information indicates critical problems early in the process, which might result in inaccurate timing delivery at a later point. Again, any issues can begin to be resolved before they impact trading activities.

Last but not least, it's also necessary to remotely monitor the performance of all slave clocks comprising the timing infrastructure with a synchronization probe and identify internal issues in the time processing units .



Improving resiliency

Even with well-designed synchronization network architectures, there is risk for failure and outages. This might be caused by a jammed GNSS signal, a network failure, network congestion or even manual error. Resiliency of time distribution networks can be significantly enhanced if systems are put in place to locally bridge unavailability or faulty PTP signals. A local clock using a temperature-controlled crystal oscillator or atomic oscillators referring time from rubidium or even cesium frequency standards can supply accurate time for days, weeks and even months. Even in case of massive problems in the synchronization network, trading and fulfilling regulatory requirements for timestamped recording are not affected. A well designed synchronization network combining local clocks with sufficient holdover capability with GNSS- and network-based timing provides precise timing with ultra-high availability. An ePRTC (enhanced primary rate reference clock, ITU ITU-T G.8272.1) provides a time signal traceable to a recognized time standard with enhanced accuracy. Combining a cesium atomic clock and a GNSS receiver, this standards-compliant solution perfectly meets availability requirements of financial institutions.



Time as a service (TaaS)

Financial markets and their institutions have different options when it comes to synchronizing their business clocks. They can self-provide timing from an onsite GNSS receiver synchronizing a precise clock. However, GNSS is subject to disturbances. Also the infrastructure itself – atomic clocks, grandmasters, antenna cables and receivers – can fail. Such failure might require a site to cease operation, severely impacting current and future business. Alternatively, timing can be provided as a service by a communication service provider, an operator of a metrology network, or the operator of the hosting data center. In order to protect against outages, such time as a service (TaaS) should be backed up with onsite satellite-based synchronization. It's good practice to combine both methods .

TaaS demarcation

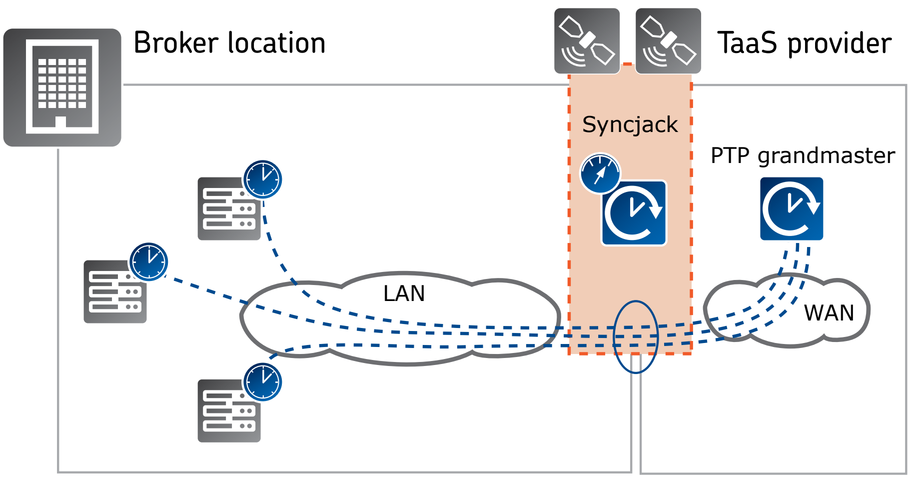
TaaS providers deliver accurate, traceable and verifiable time synchronization. They need to provide auditable proof of the quality of their services. For this purpose, a timing demarcation device installed at the hand-off point continuously compares the time information in the PTP traffic with highly precise satellite-based timing verifying the quality of the TaaS service and triggering immediate action if any deviations occur.

Implementing time-providing networks

Providers of TaaS will source many customers with precise and highly available synchronization. They need to implement a resilient and scalable synchronization architecture based on redundant PTP grandmasters, accurately sourced from GNSS-disciplined atomic oscillators. Failure or unavailability of a specific GNSS system can be resolved by concurrently processing signals from multiple satellite technologies such as GPS, Glonass, BeiDou or Galileo. Multiple, geographically separated grandmasters can independently provide PTP-timing in a highly redundant way.

Protocol transformation

PTP can be applied and configured for different applications and network scenarios. So called PTP profiles describe how this protocol is applied in specific use cases. There are PTP profiles for enterprise networks and service provider networks. A PTP gateway function might need to be applied at a network boundary. For security reasons, there should also be sophisticated access control functions protecting the enterprise from malicious attacks. For seamless migration from NTP to PTP, a PTP-NTP gateway can be applied at the handoff-point.



Solution outline

Oscilloquartz is supporting the finance market and its TaaS providers with a comprehensive product portfolio for the delivery and assurance of precise synchronization. Existing networks can now be seamlessly upgraded from legacy NTP to highly precise PTP. Oscilloquartz's unique portfolio provides efficient means to improve the resiliency of synchronization networks by introducing long-holdover atomic clocks as well as redundant GNSS concepts .

Our OSA 5401 Syncplug™ small-form factor pluggable can upgrade legacy transactional systems and IT network elements with IEEE 1588v2 PTP and Synchronous Ethernet functionality for precise synchronization in the most space-restrictive environments.

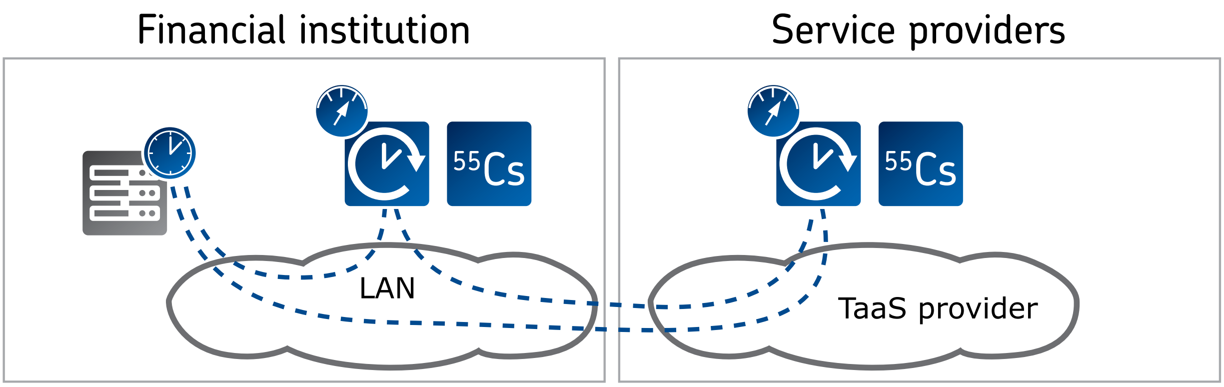
The OSA SoftSync™ can be installed on a generic server. It processes NTP and PTP packets for precise synchronization of local clocks. For high accuracy, NIC-assisted time-stamping is supported.

GNSS can be accessed even in deep urban canyons with our OSA 5405 SyncReach™ PTP grandmaster. With its unique dual GNSS receivers, it delivers the accurate timing that financial institutions require.

Our OSA 5420 Series, a family of IEEE 1588v2 PTP grandmaster devices with sophisticated Syncjack™ assurance functions, can universally be applied by TaaS providers as well as with financial institutions.

The OSA 5430 provides enhanced holdover capabilities with a modular design, featuring 10Gbit/s and 1Gbit/s interfaces. In combination with an atomic clock, the OSA 5420/30 is adeal for application in ePRTC configurations.

With atomic clocks, synchronization networks can survive outages of satellite- and network-based time supply for weeks and even months. Our field-proven OSA 3225 cesium atomic clocks are designed to combine the highest accuracy with the most compact design.



OSA 5401 SyncPlug™: SFP-based on-site PTP grandmaster
OSA SoftSync: NTP/PTP software client

OSA 5405 SyncReach™: Onsite gandmaster with integrated dual-GNSS receiver

OSA 5420/30: Edge/core grandmaster featuring various oscillator options, NTP gateway, 1/10 GE

OSA 3235B: Optical atomic cesium clock for longest holdover

Assuring regulatory compliance with highly precise, robust and trustworthy timing solutions

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Version 08 / 2018

About ADVA Optical Networking

ADVA Optical Networking is a company founded on innovation and driven to help our customers succeed. For over two decades our technology has empowered networks across the globe. We're continually developing breakthrough hardware and software that leads the networking industry and creates new business opportunities. It's these open connectivity solutions that enable our customers to deliver the cloud and mobile services that are vital to today's society and for imagining new tomorrows. Together, we're building a truly connected and sustainable future. For more information on how we can help you, please visit us at: www.advaoptical.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 Optical Networking company, we're creating new opportunities for tomorrow's networks. For more information, please visit us at: www.oscilloquartz.com and www.advaoptical.com.

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