



National Physical Laboratory

A complete guide to time stamping regulations in the financial sector



MiFID II makes new demands on accurate time stamping for financial organisations

The National Physical Laboratory (NPL) looks at existing solutions and at why a new approach is necessary.

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In financial markets, timing is critical

Accurate and traceable time is vital for today's financial markets. In a world of high-frequency trading where fortunes can be made or markets crashed in a fraction of a second, absolutely accurate time stamping is essential to determine exactly who made what trade, and precisely when.

Banks and high-frequency traders can execute orders on stocks and futures exchanges in milliseconds, or thousandths of a second. Some already trade in microseconds (millionths of a second) and even nanoseconds (billionths of a second).

To put this into perspective, the average time it takes to simply click a mouse button is around 150,000 microseconds. Or 400,000 microseconds for a blink of an eye.

To keep track of this activity, data packets are time stamped as they move through financial networks. But with this level of accuracy, even the smallest errors will make time stamping meaningless. If organisations work without reliable access to a single standardised clock and a reliable common reference time they cannot provide a synchronised time stamp. Transactions across locations and stock exchanges are impossible to audit and wrongdoing difficult to detect.

Organisations are currently using a range of solutions that cannot provide the accuracy required or, even more worryingly, meet the requirements set out in MiFID II.

NPL worked on the feasibility and requirements for the accurate time stamping of trades for MiFID II RTS 25. This guide therefore represents the view of the leading authority in this field and introduces an effective solution to a vital need.

MiFID II has made precise timing a regulatory requirement

MiFID II, the latest revision of the Markets in Financial Instruments Directive, was designed to ensure fair competition between Europe's financial venues and to protect investors and consumers across the EU. Among many other things, it drastically tightens rules on the time stamping of transactions.

It sets out exacting new standards in RTS 25, the regulatory technical standards on clock synchronisation. Time stamping accuracy must improve to within one millisecond for standard electronic trades, while high-frequency traders will need accuracy within 100 microseconds.

All recorded times must also be traceable to UTC.

The RTS 25 regulations

MiFID II requirements for clock synchronisation are set out in Commission Delegated Regulation (EU) 2017/574, commonly known as RTS 25. They require firms and venues to time stamp events accurately to Coordinated Universal Time (UTC) and to an appropriate level.

Article 4 of RTS 25 also states:

“Operators of trading venues and their members or participants shall establish a system of traceability to UTC. They shall be able to demonstrate traceability to UTC by documenting the system design, functioning and specifications. They shall be able to identify the exact point at which a time stamp is applied and demonstrate that the point within the system where the time stamp is applied remains consistent. Reviews of the compliance with this Regulation of the traceability system shall be conducted at least once a year.”

The requirements are demanding and may require considerable investment and re-engineering of existing systems, but the costs of failing to meet them will be higher still.

Those non-compliant with MiFID II will risk fines of up to five million euros, or 10% of global turnover. These requirements became fully enforceable on 3 January 2018.

Global timekeeping

Time stamps created by different systems or networks can only be compared if they are based on the same reference.

There is no single master clock for the world; the consequences of it failing would be a disaster. Instead, the globally agreed standard for accurate timekeeping is provided by 70 time laboratories around the world as the average of some 500 atomic clocks. The International Bureau of Weights and Measures (BIPM) based in Paris computes a single worldwide reference time scale, known as Coordinated Universal Time, abbreviated in all languages as UTC. Each institute contributing clock data to the BIPM maintains its own instance of UTC, known collectively as the UTC(k) time scales. These national time scales are adjusted so that they remain close to UTC, usually within one microsecond, and in some cases below 10 nanoseconds.

In the UK, the instance of UTC is provided by the National Physical Laboratory and known as UTC(NPL).

By accessing UTC, users can create precisely accurate time stamps, traceable to UTC. MiFID II requires time stamping to be accurately traceable to UTC.

What does MiFID II require?

Under MiFID II, all time stamping must be accurately linked to UTC. But different types of trading will require different levels of accuracy.

High-Frequency Trading (HFT): 100 microsecond precision

High-Frequency Trading (HFT) market participants must be time stamped to 100 microsecond precision (one microsecond equals one millionth of a second).

Non-HFT: One millisecond precision

Non-HFT algorithmic participants must be time stamped to one millisecond (one millisecond equals one thousandth of a second).

Human trades: One second precision

Human trades, executed over the phone or online, will be recorded to a one second standard.

Providing traceability

By accessing UTC, it is possible to provide time stamps to these exacting standards. But it is not enough simply to have an accurate time source, or even to provide accurate time stamping. To be MiFID II compliant, users must be able to demonstrate and document the performance of every link on their network, all the way from UTC to the time stamping itself on every reportable event.

Time traceability requires:

A continuous chain of comparisons with known uncertainties, all of which must be documented. The uncertainty of each link in the traceability chain must be measured or otherwise determined, for example in a calibration carried out by an accredited institute.

Timing equipment to be calibrated so that unknown internal delays do not bias output.

Equipment to be monitored continuously so that any fault or anomaly can be detected and the time output not used until the equipment is working correctly again.

Calibration evidence and monitoring results to be archived so that the status of the timing equipment at any point in time can be verified at a later date.

MiFID II therefore imposes not just technical standards, it sets up a requirement for continuous monitoring and administration on financial network operators. Compliance requires an understanding of the traceability chain and the uncertainty of every link from UTC to the time stamp, together with an archive of the evidence to demonstrate this knowledge.

Creating this data and maintaining records means a major additional burden for system administrators and, with some types of system currently in use, it cannot be achieved at all.

Accessing time

UTC can be accessed in several ways, with a variety of time signals and services. Financial organisations are attempting to use a number of these solutions. But not all can deliver the accuracy, traceability and proof of traceability required.

Atomic clock

A caesium atomic clock would require initial calibration, and even then could not indefinitely provide the accuracy and traceability required by MiFID II.

With a standalone clock it is impossible to identify errors or drift.

NTP servers

The Network Time Protocol (NTP) is provided over the internet and large numbers of servers can be found online. The system can provide traceability, as the latency to each endpoint is continuously measured and corrected by the protocol, provided that only known, traceable servers are used.

However, NTP can only provide synchronisation over wide-area networks to tens of milliseconds, so will not meet MiFID II requirements for accuracy.

Standard-frequency & time signals

Several countries operate radio signals providing access to a UTC(k) timescale.

The accuracy of the signals varies from tens of milliseconds down to tens of microseconds, depending on the modulation and on variations in the signal propagation.

Accuracy will generally be below MiFID II requirements.

Global Navigation Satellite System

The Global Navigation Satellite System (GNSS) and other navigation satellite systems depend on accurate time to function and can provide an accurate time signal. However, any GNSS-based timing solution is vulnerable to interference causing a loss of reception of the weak satellite signals.

GNSS can be subject to a wide range of errors, including multipath reflections of the satellite signals, solar storms and delays in antenna cables or receiver hardware. It is also vulnerable to jamming and hijacking of the GNSS signals.

Traceability requires a continuous chain of comparisons with known uncertainties, all of which must be documented. It is difficult to obtain traceability reports for GNSS-based signals.

These factors mean that although GNSS is being used by some financial service providers, additional evidence such as calibration reports and continuous monitoring of the solution is needed to satisfy the traceability requirements of MiFID II.

UTC(k) delivery over fibre

NPLTime Certified[®] and similar services disseminate UTC-traceable time over managed fibre links using the Precision Time Protocol (PTP version 2, defined in the standard IEEE 15882008). PTP is a dissemination method developed for local area networks and is capable of achieving accuracy better than 100 nanoseconds.

PTP can deliver synchronisation over longer distances using telecoms fibre networks, employing dedicated channels or PTP-compatible switches. As with NTP, the latency to each endpoint is continuously measured by the protocol and the offset corrected.

This means that it can support MiFID II compliance at the time stamp of the customer distribution system. The only major risk to this type of service is of the fibre link being physically severed. However, local holdover mechanisms can be put in place to maintain the service whilst the repair is provided and connection restored.

Creating a solution

The exacting requirements of MiFID II mean that new and improved technology is required to ensure that they can be met.

To provide the completely reliable time references required, the National Physical Laboratory drew on its expertise in maintaining the country's time scale, UTC(NPL), for more than four decades.

The requirement was for the development of a service providing precise time over optical fibre, which would meet all the requirements of the new regulations for accuracy and traceability. It would also need to provide the highest standards of robustness and the absolute dependability essential for financial markets.

Creating this data and maintaining records means a major additional burden for system administrators and, with some types of system currently in use, it cannot be achieved at all.



This service provides a UTC-traceable time signal, with accuracy certified to the end point. As the UK's National Measurement Institute, NPL is perfectly placed to deliver such a timing standard to the financial sector.

NPLTime Certified®

The **NPLTime Certified®** service provides a certified precise time signal delivered over optical fibre via our distribution partners, and accurate to within one microsecond. This lets users be fully compliant with MiFID II time stamping requirements and eliminate the risks associated with other timing signals.

NPLTime Certified® delivers absolute time, directly traceable to UTC and certified via a resilient terrestrial system. There is no danger of the interference or inaccuracies which are inevitable with GNSS-derived signals, and the possibilities of jamming or spoofing are not subject to the vulnerabilities of GNSS-derived signals.



The result is a system that provides the complete answer to the needs of MiFID II.

The expert solution

NPLTime Certified® represents the state-of-the-art solution to deliver time and enable time stamping to the agreed level of accuracy.

Accuracy: NPLTime Certified® is delivered with an SLA of one microsecond to UTC. This not only ensures synchronisation with the reference time, it ensures synchronisation with all other users. This allows users to have full confidence in data timing and provides enhanced forensic and playback capability.

Traceability: Continuous monitoring and audit of traceability to UTC is provided as part of the service. To achieve this standard, NPLTime Certified® is monitored and maintained 24/7 up to the point of entry to a user's network. It is therefore directly traceable and certified to UTC at the point of provision.

This means that the burden of providing traceability to a point is removed; NPLTime Certified® is inherently compliant. It also eases the workload for users' infrastructure teams and allows them to focus on internal business systems.

Having the support of the UK's only provider of UTC(k) significantly reduces the burden of auditing, forensic reporting and algorithmic optimisation. It further reduces the demand on system administrators by ensuring that multi-location implementations can be simply and securely synchronised.

Resilient: The signal is equipped with a highly-accurate backup signal, provided by a bespoke NPL caesium clock solution. Should a fibre link go down, this system will still be able to provide the capability required for over a month.

Confidence: It will also give users the confidence that they are using the industry standard service. As it has been designed around the requirements of MiFID II, it provides the simplest way to provide complete compliance.

Availability: NPLTime Certified® was initially developed for the financial services sector of the UK. However, because of its superior accuracy, traceability and ease of adoption, it is capable of providing a solution anywhere in the world where there is optical fibre.

As a result of partnering with strategic managed service providers, NPLTime Certified® is also available in key financials hubs across Europe.

Find out more

NPLTime Certified® is set to become the standard industry solution. For more information, please contact one of our experts.



The National Physical Laboratory's research facility in Teddington, south-west London

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NPLTime Certified® is



Accurate and compliant

NPLTime Certified® is delivered with a one microsecond SLA – ensuring synchronisation with the reference time, and with all other users.



Traceable

NPLTime Certified® is monitored and maintained 24/7 up to the point of entry to your network. It is therefore directly traceable and certified to UTC at the point of provision.



Secure

Fibre optic links eliminate GNSS jamming, spoofing, urban canyon effects and solar storms to ensure resilience and security.



Simple to set up

NPLTime Certified® is delivered by leading network partners. No roof access is required, and the system is compatible with private datacentres or a third party datacentre.

About NPL

At NPL, the home of the UK's national time scale, we provide the only precise time dissemination solution that is directly and physically connected to UTC.

The National Physical Laboratory (NPL) is located in Teddington, south-west London. As the UK's National Metrology Institute, it is the only precision timing centre in the UK and responsible for maintaining the national time scale, UTC(NPL).

The group of atomic clocks at NPL keeps the nation's time accurate to within a few nanoseconds (billionths of a second) of UTC. This is used to provide a firm basis for precision time measurement across all sectors of business and industry in the UK.

NPL is the home of atomic time and operates one of the world's most accurate atomic clocks, NPL CsF2, which is accurate to one second every 158 million years.

NPLTime Certified® is an extension of many decades of time dissemination expertise, giving industry direct access to reliable timing straight from the source.



Image for illustrative purposes only.

NPLTime Certified®

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