TRUSTED TIME

NPL*Time*®

Leon Lobo
Strategic Business Development Manager at the UK's National Physical Laboratory

To a greater extent than ever before, modern society is dependent on the accurate measurement of time. While most of us rarely deal with anything smaller than fractions of a second, critical elements of the UK's infrastructure require accuracy to the sixth decimal place.

Front cover photograph:
Strontium ion optical clock
©National Physical Laboratory

As the UK's National Measurement Institute, the National Physical Laboratory (NPL) has been responsible for maintaining the country's time scale for more than four decades. The NPL time scale, called UTC(NPL), is used as the basis for time all across the UK and contributes to the international time scale, Coordinated Universal Time (UTC). We contribute to UTC formulation with 7 atomic clocks – 4 hydrogen masers and 3 caesium clocks. In addition, our caesium fountain, CsF2, accurate to 1s in 158M years, ensures that the duration of the second in the international timescale is correct.

In addition to managing the nation's time scale, NPL also has the remit to distribute it to the UK. The NPL time scale has been disseminated over radio waves, via dial-in, across the internet and through satellites, and NPL is now launching a service to provide connectivity over optical fibre.

This new service, called NPL*Time*®, delivers a precise time signal directly traceable to UTC and certified via a more resilient system than ever before. Currently, most people get their time via satellites such as the GPS constellation. These systems not only have their own intrinsic inaccuracies, but are also extremely vulnerable to interference. Malicious as well as inadvertent disruption has damaged GPS connections in the past, as have aspects of cosmic weather such as solar storms and flares.

The transmission of NPL*Time*® via fibre makes it impervious to attacks such as these, and generally much more difficult to disrupt. The network is also equipped with a highly accurate back-up signal, provided by another of our caesium clocks located in Docklands. Should a fibre go down, this system will provide the capability for over a month.

A further weakness inherent in current systems is that at any given moment, those consuming time via different sources may well be recording entirely different times. This lack of a common accurate clock in different locations is similar to the problem we had before Greenwich Mean Time was adopted across the country. These disparities, of the order of microseconds, can have dramatic consequences in areas where synchronicity is important.

... a unified time signal will be of tremendous benefit ...

NPL*Time*® allows consumers to make use of a reliable signal while feeling confident that all their peers are using it as well. A centuries-old dream will finally be realised – everybody will be on the same time. This common clock is particularly important in the Financial Sector where trading now occurs in the millions of trades per second.

TRADING TIME

Inaccuracies of the order of microseconds may seem insignificant in daily life, but in the high-frequency world of financial trading even the tiniest of delays can cost millions of pounds. It is truly remarkable that in such a high-stakes environment, there is no common clock across different markets. This makes transactions across locations and stock exchanges almost impossible to audit and any wrongdoing difficult to detect.

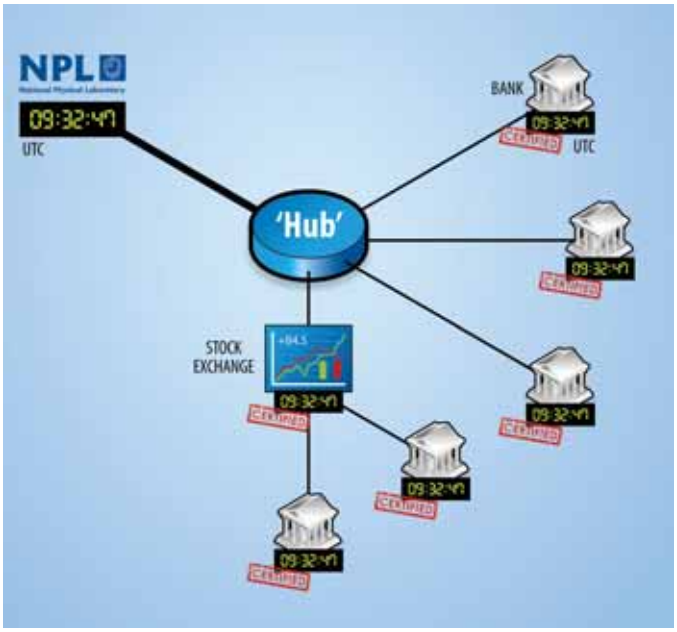
One particularly widespread effect is the so-called negative delta, which occurs if data leaving one location for another is marked by the receiving system as having arrived at an earlier time than was noted at the point of departure. Needless to say, this further complicates forensic analyses and necessitates complex adjustment systems to correct disparities. The NPL*Time*® system takes away from the user the need to manage or correct the signal they receive, providing a trusted time with synchronisation at the microsecond level.

Such a solution would be long overdue. On 3rd June 2013, Thomson Reuters released the day's manufacturing data 15 milliseconds earlier than expected, resulting in $28 million worth of trades for those quick enough to exploit the gap. Two months later, the German derivatives exchange Eurex was forced to shut down for an hour after experiencing "an incorrect time synchronisation within the system".

Fortunately, the use of fibre connections across the financial sector means that the new signal could be implemented

with very little difficulty. NPL has signed distribution agreements with trading technology company Intergence and TMX Atrium, the low latency infrastructure arm of TMX, the Canadian stock exchange.

As our data management systems make the transition to digital, having all systems running on the same clock will allow each to be connected to every other. In the NHS, for example, this will allow for increased



Through these, NPL provides users with a trusted timestamp, regardless of how many locations the trades cross.

Widespread adoption may be accelerated by the keenness of regulatory bodies to implement absolute traceability of time to UTC, as guaranteed by NPL in the UK. The European Securities and Markets Authority is considering regulations which would constrain trading firms to microsecond accuracy, while both the SEC and the FCA are currently debating the problem in the United States.

WIDER APPLICATIONS

In addition to the need for NPL*Time*® in the financial sector, the system is equipped to provide support across a wide range of other industries. From telecommunications networks to energy providers, and from media outlets to the NHS, the ability to have a unified time signal will be of tremendous benefit.

reliability in the capturing and transferring of individual patient details, as well as in the sharing of so-called big data.

While microsecond accuracy may be less important in an institution such as the NHS, having a trusted time source is extremely important. A 2012 survey conducted at four prestigious American hospitals found that only 3% of 1,700 devices checked were accurate to within three seconds. The average error was an astonishing 24 minutes. Interoperability of systems, accuracy of Electronic Health Records and legal liability, billing systems and financial implications, as well as accurate elapsed time measurement using multiple systems, are all dependent on trusted traceable timestamps.

When you don't have confidence in your time, you no longer have a reference. This is particularly important when the timing system is used for the validation of data, which places the institution's integrity on the line. Conflicting signals could lead to automated time stamps being out by hours or even days – substantial inaccuracies in the analysis of patient data. With the assistance of NPL, everything inside our hospitals would run on the same time – from the computers powering the data processing system to the clocks ticking away on the walls.

CRITICAL INFRASTRUCTURE TIME

Another key area where reliability of the time signal must be prioritised above all else is the UK's national infrastructure. Covering transportation, government services and security, these represent systems essential for the functioning of the country.

Currently, most of these vital institutions still get their times from GPS or other GNSS satellites. Not only are these signals inherently vulnerable to attack, but as a recent report by the Royal Academy of Engineering pointed out, such an outage would be more damaging for those who depend on satellites for timing than those who use them for navigation.

... everything inside our hospitals would run on the same time ...

Part of the problem is that GPS signals are very weak, reaching Earth with roughly the same intensity as light from a lamppost placed on the moon. This means that any signal produced in the same frequency band will easily drown them out, a disruptive technique known as jamming. Portable jammers, while illegal to use in this country, are simple devices that create broadband noise in the GPS frequency range. Even though the power output is only milliwatts, this is more than enough to drown out the microwatt-level GPS signal for an entire city block. Jamming of this kind is rarely used maliciously, with most disruptions occurring inadvertently by vehicle tracking systems being disrupted by individuals eager to prevent their employers knowing their exact locations.

More dangerous still is GPS spoofing, which occurs when the signal is effectively hijacked and replaced by one giving false information. Nowadays, specialist software and hardware exist that allow a user to receive the GPS signal and rebroadcast it with greater power, so that any receiver will automatically latch on to it. If the time reading is then changed slowly enough to override the systems' internal safety checks, the signal can be temporarily pulled away and then corrected with no-one being any the wiser.

While a few high-profile jamming and spoofing cases make it to the headlines, what is more worrying is the number kept under wraps in order to maintain public confidence in the system. The advantage of the NPL*Time*® fibre network is that it gives complete independence from GPS, allowing the country to operate regardless of natural or man-made disruptions.

NPL is currently forming a consortium of critical national infrastructure users who could benefit from such an alternative solution in order to see it delivered as a capability.

NPL*Time*® offers a trusted time, certified at the end user, to be consumed with the confidence that it is fully traceable to the international timescale (UTC) and delivered by the National Physical Laboratory, an organisation with a heritage in time.