WHITE PAPER

SECURED TIME SYNCHRONIZATION

by GORGY TIMING

SHARED TALENTS

OF FRENCH EXPERTS IN TIME/FREQUENCY

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Design: Emmanuel ANDRILLON

PREFACE

Dear readers,

Since the XVIIIth century, clockmakers have contributed to the growth in commercial exchanges and then, physicists started to master time measurement precise enough for scientific use.

Today, the explosion of the digital economy that produces more than half of trade transactions is bringing a new revolution. Fortunately, French Observatories produce time scales precise to 10^{-15} seconds which means an error of only 1 second in a 300 million years period of time.

France is the technological birthplace of the world's Time/Frequency industry. Especially as the SYRTE (Paris Observatory, CNRS, UPMC, and LNE) delivers a legal time built on the UTC international time scale (Coordinated Universal Time).

Within new digital organizations, time synchronization allows not only to distribute time to clocks but also to synchronized devices (the Internet of Things) and machines with no concern about distance with a precision that can reach a few nanoseconds, depending on the applications.

Although high precision time production is perfectly mastered by the Observatories of Paris and Besançon, the actual technological challenge is to master the security and traceability of the date and time from their source to the final user. This is key to fighting cyberattacks that interfere with the time message.

Time cybersecurity… a new challenge.

In 2013, Maurice Gorgy brought together French laboratories and Companies working in the Time/ Frequency industry on an ambitious project: SCPTime®.

This collaborative research project has been approved by the Grand Investments Commission within the scope of the Investissements d'Avenir program and signed by the French Prime Minister on June 2nd 2014. This project is partially financed by BPIFrance (big collaborative projects) and has been certified by Minalogic.

This white paper has been written in collaboration with our SCPTime® partners.

It is composed of 2 parts: the first one explains the evolution of time scales and the second part gives the elements of security and traceability of the SCPTime® project.

The aim is to help each of us understand what is at stake linked to time security and traceability in today's digital economy.

Enjoy reading.

Please don't hesitate to send your comments and thoughts to: info@scptime.com

Nicolas GORGY
Team leader SCPTime®

01

TIME PRODUCTION

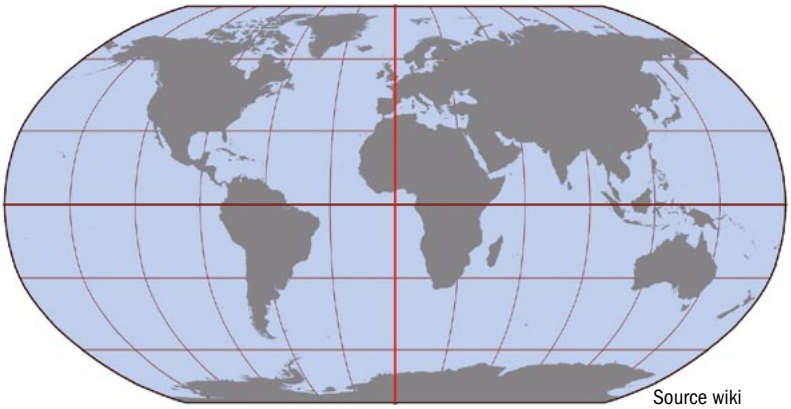
Time is today a universally known concept
and the increasing precision of time dissemination
is multiplied by 10 every decade
and has reached 10^{-18}.

EVOLUTION OF TIME PRODUCTION

1875, Greenwich Mean Time (GMT).

The International Geographical Convention proposed that railroad times around the world should be aligned with a single meridian. In 1882, Greenwich was adopted by the United States.

The Conference of Rome in 1883 divided the globe into 24 zones, each measuring 15 degrees of longitude, and the legal time was to be instituted according to the central meridian of each time zone. The Conference of Washington in 1884 adopted the Greenwich meridian as the reference meridian, and Greenwich Mean Time (GMT) was rapidly accepted by many countries who had not attended the conference



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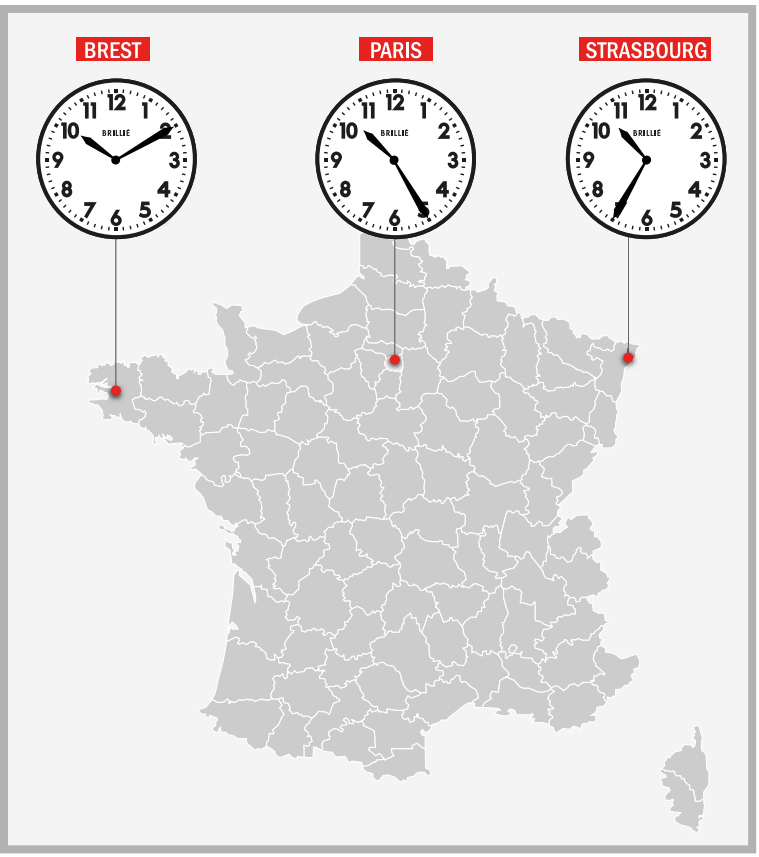

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1912, the International Time Office (BIH).

The BIH, was created and housed in the Paris Observatory. Its goal was to determine the parameters which defined the Earth's position and rotation for analyses purposes by observation stations. Now that political will had succeeded in setting standard time, the only thing left was to standardize it across the country. This began in the biggest French cities and towns. Most of them were still showing two different times: Parisian and local, with differences of a few minutes between two French towns located only a few kilometers away.

1929, a clock with a constant pressure.

This high precision clock designed by the French manufacturer Leroy is installed in an underground room, 5m down under the library of the Besançon Observatory in order to guarantee a stable temperature.

Along with other observatories it makes up a time network.

Leroy high precision clock

1956, the Universal Time (TU).

The International Committee of Weights and Measures (BIPM) offered a new definition of the second also known as “tear-off calendar seconds”. Universal Time is defined as the Greenwich average solar time plus twelve hours: when it is 12PM TU, it is 12AM GMT. Based on the Earth rotation, its measurement is done by observing the exit of stars of our solar system every day. This brings a precision up to a microsecond. The duration of a second is the fraction of 1/86400 of an average terrestrial solar day. This duration is close to the average heartbeat of a human being at rest. In France, the legal time is given by the addition of two hours in summer and one in winter to the TU reference.

But soon enough, astronomers noticed that TU is not precise enough.

The Earth's rotation is constantly subject to too many unexpected occurrences: tides, hurricanes, moon movements, etc. Astronomers decided to keep the orbital movement of the earth around the sun as a new time scale. The notion of “tear-off calendar seconds” is established in order to take into account Earth's rotation imperfections. The observation of the Sun longitude in the sky during the year as given in 1952 by the International Astronomic Union was proposed.

1967, the defintion of a second.

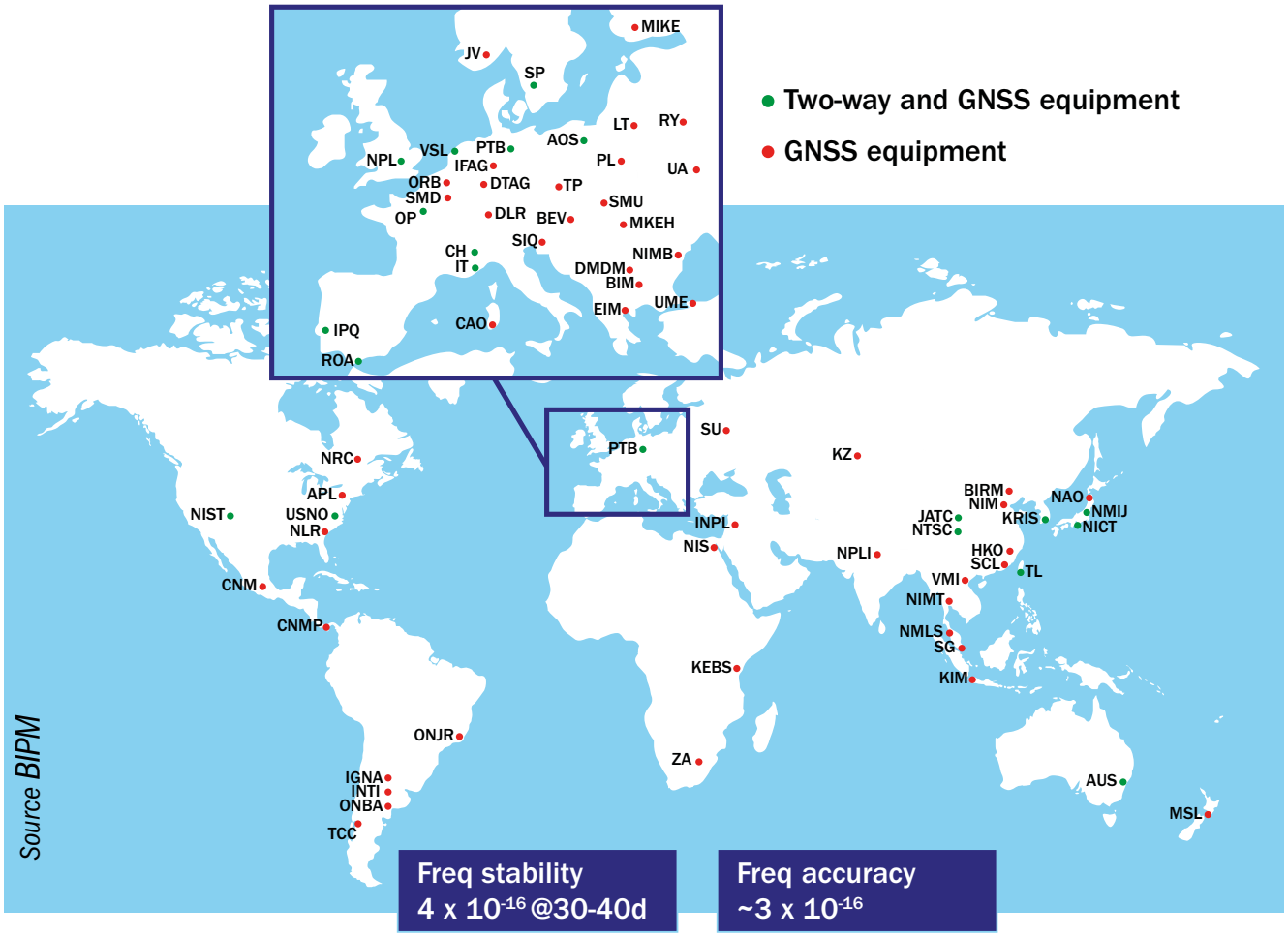
During the 13th Weights and Measures conference, the second was defined as *“the duration of 9.192.631.770 periods of the radiation corresponding to the transition between hyperfine levels F=3 and F=4 of the fundamental state 6S1/2 of a cesium 133 atom”*. This atom has an extremely stable isotope providing a way to define a perfect oscillation.

This meant that the division of a second, thanks to the Cesium 133 stability gave an accuracy never reached before by the definition of time made by astronomy.

When an electron changes its energy level, it produces oscillations of a remarkable stability, perfectly identical throughout the world and totally constant.

1971, the International Atomic Time (TIA).

"Paper" time scale built by the BIPM from comparisons of 400 commercial clocks (70 laboratories) and the exactitude and the long term stability ensured by high stability laboratories clocks.



The 14th Weights and Measures conference decided that the International Atomic Time is the time spotting coordinate based on the indications of atomic clocks working in many locations according to the definition of a second, time unit of the international unit system. **The International Committee of Weights and Measures is in charge of the calculation of the TAI.**

This committee gathers data from about 400 clocks in 70 laboratories. The calculation is done thanks to an algorithm that calculates a weighted average of the clocks reading. The purpose is to get a good stability in the long term. The exactitude of the time scale is ensured by regular comparisons between all these atomic clocks.

1972, the Coordinated Universal Time (UTC).

The International Committee confirms that this definition refers to an at rest reference cesium atom and to a temperature of 0 Kelvin.

Time could now be accurately the same all over the world. A second is divided in 10 million periods with the cesium atom. Then came the task of binding all laboratories that had such clocks (today through satellite signal exchanges) to check all together the exactitude of the International time also known as International Atomic Time (TAI).

Average time drifts a little from this absolute standard. Thus, in the night between June 30th and 1st July or between 31st December and 1st January, when necessary, a correction of a second is done on the request of the International Earth Rotation and Reference Systems Service that replaced the BIH in 1987. It is the Coordinated Universal Time (UTC), and since 1970, 36 seconds had to be added to the Universal Time. The last adjustment of the "leap second" occurred in the night of June 30th to July 1st 2015 at 2AM.

Only the UTC(k) built by organizations that signed the MRA (Mutual Recognition Arrangement) are able to take part in the UTC metrological connection, certified and traceable.

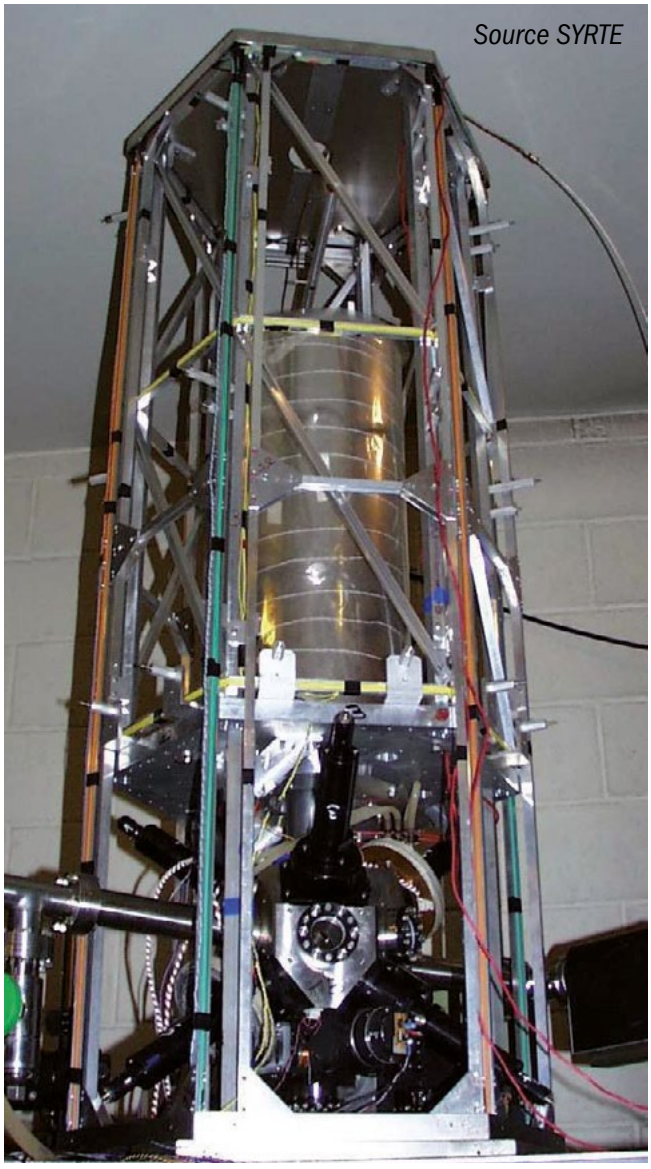
1995, the atomic fountain clocks.

In France, in the Paris Observatory, the Time-Space Reference System Laboratory (SYRTE) works on several concepts of atomic clocks cooled down by laser. The French physicist Claude Cohen-Tannoudjil (Nobel Prize for Physics) showed in the early 80's that is it possible to cool down atoms by submitting them to a laser radiation.

The exactitude of the "cold atomic fountains" is about 10^{-16}, which means a variation of a second for every 300 million years. Many laboratories are now getting these kind of clocks. The SYRTE has developed 3 of them.

For 50 years the second has been the duration of 9.192.631.770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.

The definition of the second at international level is defined by the General Conference on Weights and Measures (CGPM).



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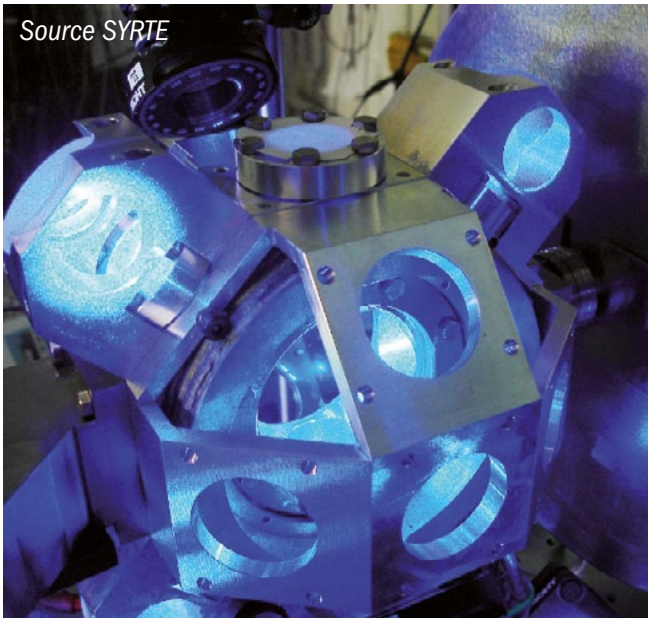

Source SYRTE

2013, the optical strontium clock.

In France, the SYRTE has built 2 optical network clocks working with strontium atoms (ultimate limit 10^{-18}). These clocks have a very stable connection with the three cesium primary standards of the Paris Observatory.

The definition of the second is currently based on cesium: an optical radiation has a frequency 100.000 times higher than with cesium.

Thus, when the new clocks will be fully certified, It should allow for a new international definition of the second.

2017, era of the commercial master clock: the cold atom technology.

Within the framework of the SCPTime® project, Muquans has developed a very high-performance master clock call MuClock. This clock is designed for metrology labs, as well as for the rail and air transport industries and for military and space facilities.

MuClock is the first commercial atomic clock of the world based on a disruptive technology that uses quantum physics discoveries in the field of atom laser cooling. This technology has been developed in closed cooperation with the SYRTE lab of the Observatory of Paris. It is based on the query of a rubidium atom cloud previously cooled down to a temperature of a few µK, very close to the absolute zero. MuClock can thus deliver stability and accuracy performance unequaled on the Time/Frequency market.

The performance enabled by this solution is the following:

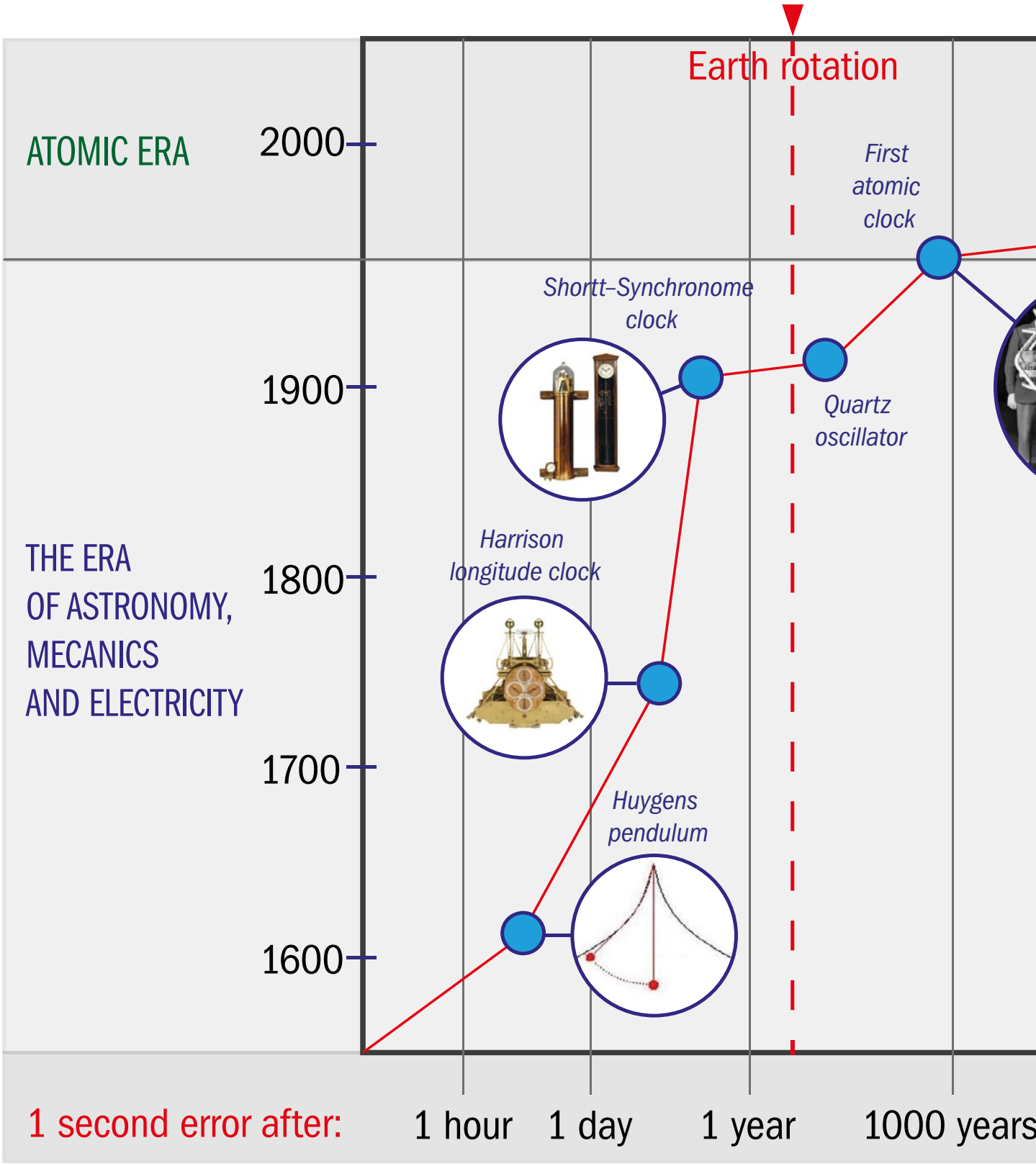
Short-term stability	3.10^{-13} à 1 s
Long-term stability	1.10^{-15}
Accuracy	$< 5.10^{-15}$
Temperature range	22-28 °C


MuClock atomic clock

UTC time is the world reference.

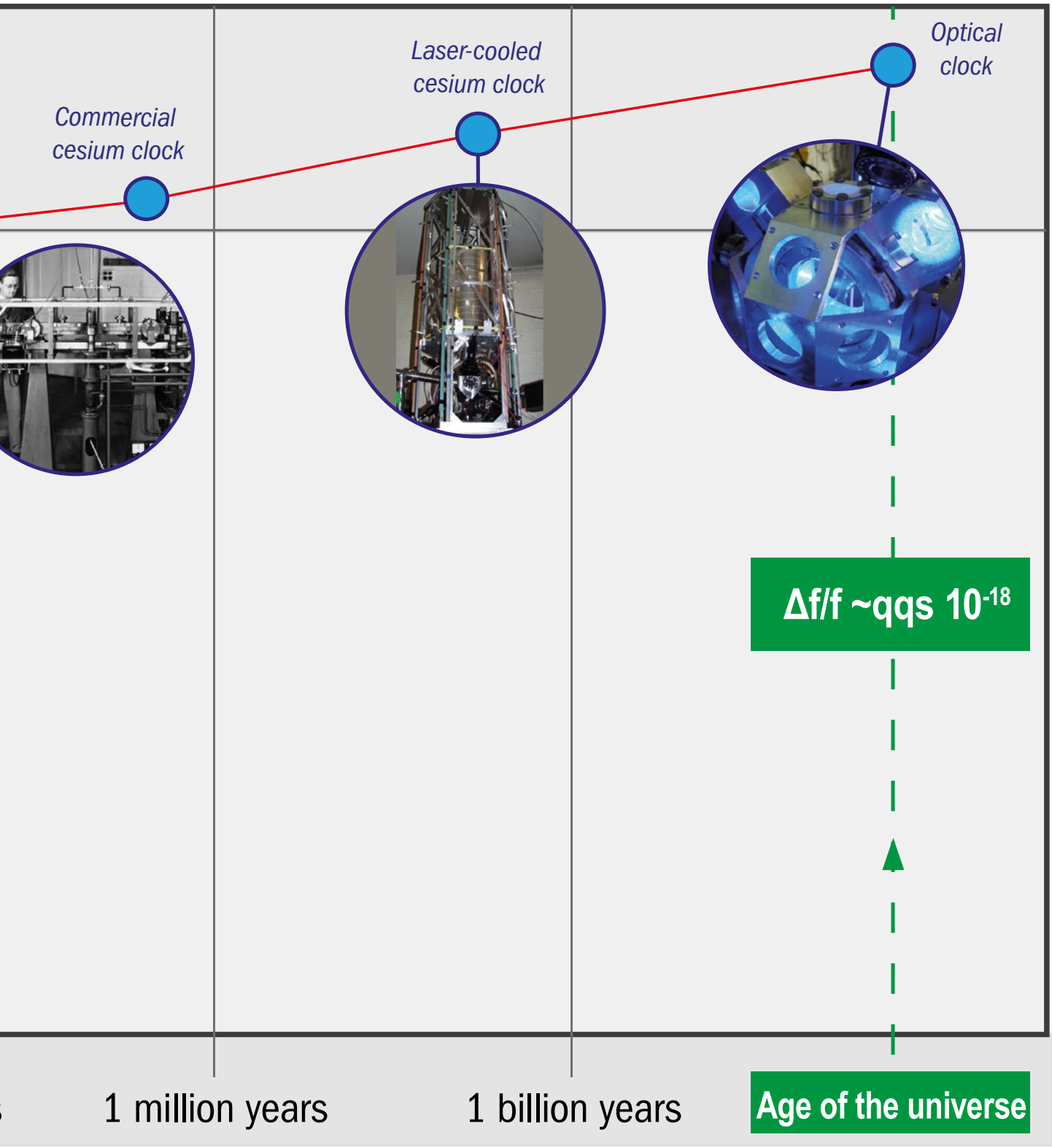
METROLOGY AND TIME PRODUCTION:

This diagram shows the historic development of technologies and accuracy levels.
The accuracy of time dissemination constantly rises at **a rate of 10 every decade**.



A LONG HISTORY ...

Source SYRTE SCPTime® partner



02

TIME SYNCHRONIZATION

Radio or satellite time synchronization ensures a high accuracy is maintained in quartz time bases.

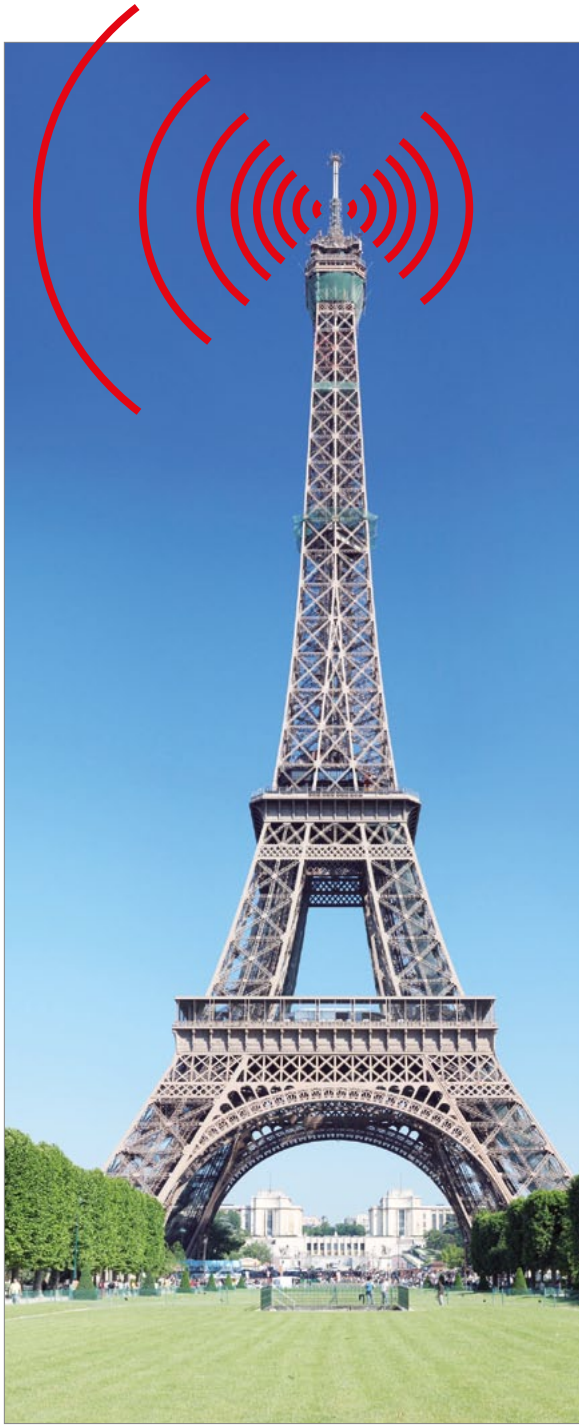
It also prevents the drift of clocks or other devices over the long run.

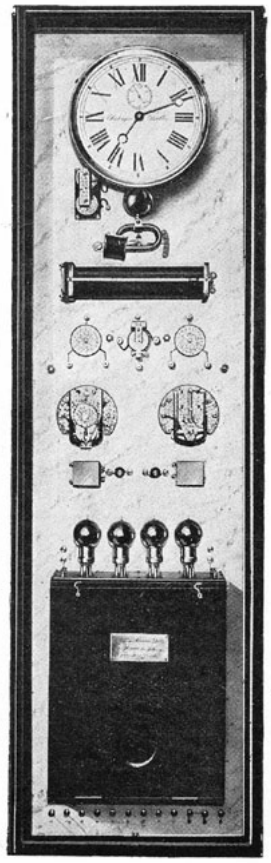
EVOLUTION OF TIME SYNCHRONIZATION

Quartz time bases of master clocks, time centers and time servers have to be synchronized on external time sources coming from Herztian time signals. This prevents any drift in time of the internal oscillator in order to increase its precision performance.

1910, the radio transmitter of the Eiffel Tower.

The first regular world time distribution system was installed on the Eiffel Tower and used to broadcast to sailors at sea. In a bid to save his tower from being dismantled, Gustave Eiffel offered Captain Gustave Ferrie the opportunity to install the antenna, which at that point was on the Champ de Mars, at the summit. With an eye to increasing the performance of his experimental military installation, Captain Ferrie accepted and, in 1908, installed an antenna aimed 90° from the Seine. This enabled the army to communicate during the First World War. At the same time, a number of different experiments helped set up a French radio-telegraphy network. Wireless Telegraphy providers increased their power and, in 1910, the first ever time signals were broadcast with a range of 2600m over 115 kHz. Power was increased once again, and in 1917 it reached 150kW, extending the range of the signal to 8000m. From the first years of the Wireless Telegraphy broadcasts, Commandant Camille Tissot proposed broadcasting time signals at regular intervals from the Paris observatory to enable sailors to calculate their position accurately while at sea.



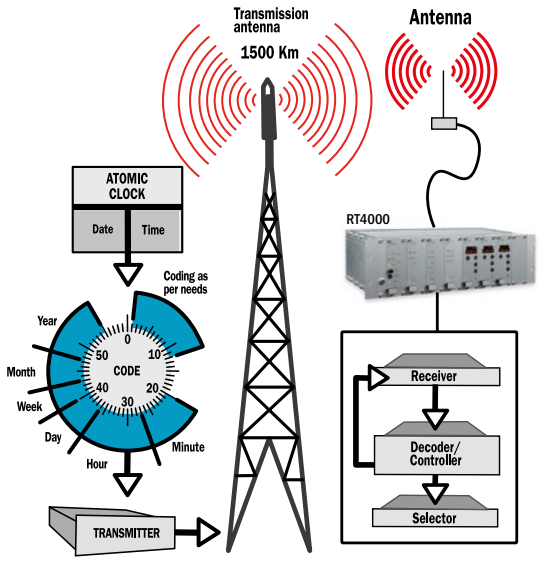


The Brillié® balance-wheel regulator was synchronized with TSF wireless telegraphy broadcasts.

Brillié® designed and manufactured an amplifier which automatically adjusted the accuracy of their balance-wheel regulators using TSF (wireless telegraphy) time signals.

This hertz synchronization process enabled clocks to be readjusted several times per day and avoided having to set them manually.

Brillié® is a trademark of GORGY TIMING.



Principle of a radio synchronization

In 1931, Prangins (Switzerland) transmitter.

It broadcast the Swiss legal time, under the responsibility of the Federal Institute of Metrology (METAS). This time code modules by telegraphy (carrier signal of 75 kHz with a strength of 25 kW). This signal could be received up to a 1500km distance around Prangins. The transmitter stopped emitting in 2011and the installation has been demolished.

In 1938, the France Inter transmitter (France).

The Allouis transmitter in the Cher broadcasts a "France Inter" time signal on the same carrier signal as France Inter radio programs. After being used and destroyed by the Germans during World War II, the transmitter was rebuilt and commissioned by the French Radio Electricity Society on October 19th 1952.

In 1950, the MSF transmitter (England).

The English system of time transmission through radio waves is located in Rugby (England, 60 kHz). The reach of this signal is about 1500km.

In 1959, the DCF77 transmitter (Germany).

The German transmission system of legal time is broadcast by radio waves. It was commissioned by the Physikalisch-Technische Bundesanstalt (PTB) and initiated by the Government. The transmitter is located in Mainflingen, near Frankfurt. It has a cesium atomic clock, a highly precise time with a theoretical one second "mistake" over a million years. Information is transmitted in big waves through a transmitter of 30kW with a reach of 1500km and so is receivable in many European countries.

France Inter transmitters

In 1994, the France Inter transmitter (France).

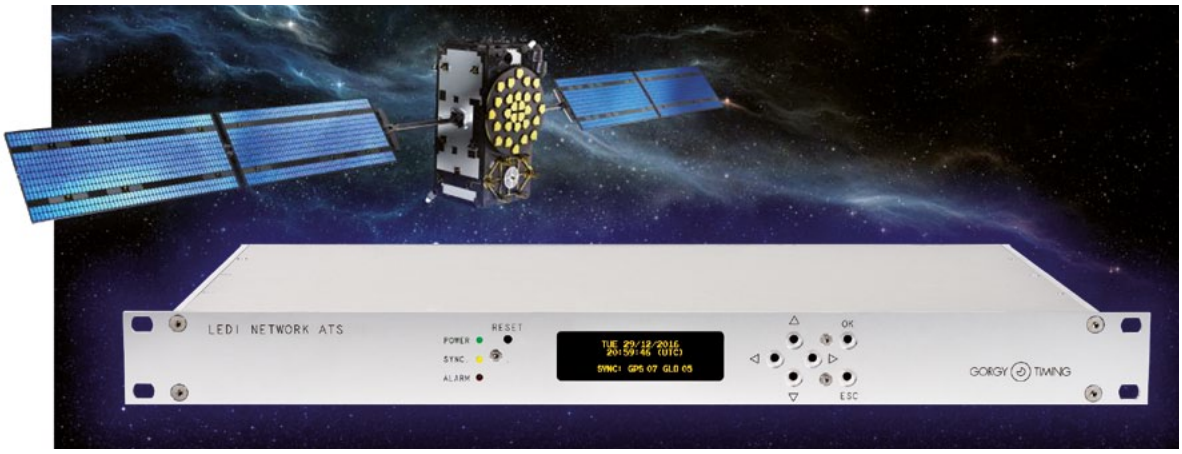
The strength of the Allouis transmitter was boosted up to 2000kW in 1994. This radio synchronization system was based on the atomic clocks of the LNE (the National Metrology Laboratory) of the Paris Observatory.

Several Medias announced the ending of this transmitter by the end of 2016. It would be preferable for the Time/Frequency industry, to keep it transmitting time signals until 2020.

There are some other kinds of transmitters around the word that broadcast time signals, for example:

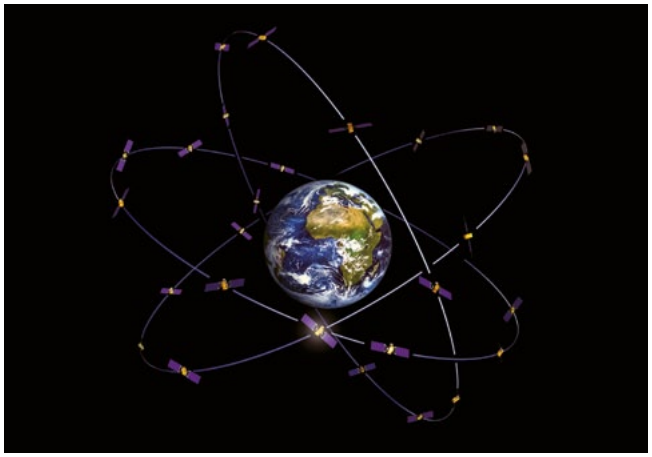
- **JJY in Japan, Kyushu (60Khz)**
- **WWWVB in the USA, Colorado (2.5Mhz)**
- **BPM in China, Xl'an (25Mhz)**

In 1995, a synchronization signal from a constellation of satellites.



In 1995, the American GPS system was fully operational with a total constellation of 24 satellites. At this time, it was the only completely efficient and functional satellite synchronization system. According to the GS specifications, **time transfer reaches a precision under 40ns** in 95% cases with a typical value of 12ns. Today, this constellation is composed of 31 satellites.

In 1996, the GLONASS system (Russia) also became fully operational. Nevertheless the system had many technical problems and it was only in 2011 that it was fully functioning again with improved precision.



The Galileo constellation will be made up of 30 satellites (of which 3 backups) distributed among 3 orbital plans tilted by 56° in relation to the equatorial section. © CNES

In 2015, the BEIDOU system(China) covered the entire Asian area with 15 satellites. Its final extension is planned for 2020 with an international coverage and 30 satellites. Performances of this constellation are to become equal to the ones already in service and the one coming (GALILEO).

2016 and the European GALILEO constellation.

The system began offering its firt services with 18 geostationary satellites.

GALILEO intends to be differentiated from its competitors by a greater accuracy of the time signal and a greater resistance, thanks to 20 civilian ground stations already distributed around the globe.

GALILEO is a civil system from the European Space Agency (ESA), unlike GPS and GLONASS, which are military devices. This is a real strategic advantage on a global scale.

The GALILEO constellation will be completed by 2020, counting 30 satellites that cover the whole Earth.

GPS is not a UTC source and is therefore not recognized as a traceable time.

2016, the mixing of time synchronization and syntonization (frequency).

Most of the time servers of the time synchronization market are set up according to Hertzian time signals coming from GPS satellites.

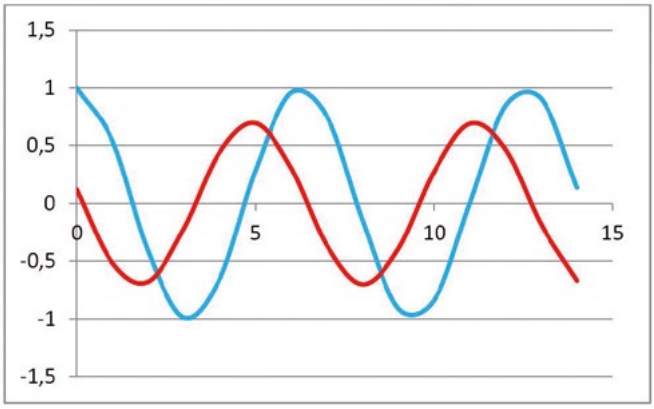
Today, demanding users wish to free themselves from their dependence on the GPS satellite-based synchronization, which is 100% technically controlled by the American army.

Time synchronization is a key element of cybersecurity parameters. Jamming or spoofing attacks of Hertzian synchronization (radio or satellite) systems can cause incidents or even accidents in rail and air transport, as well as in banking transactions (high-frequency trading).

GORGY TIMING offers a secured solution that consists in interfacing time servers with a reliable, known time source, e.g. the UTC time of an Observatory atomic clock.

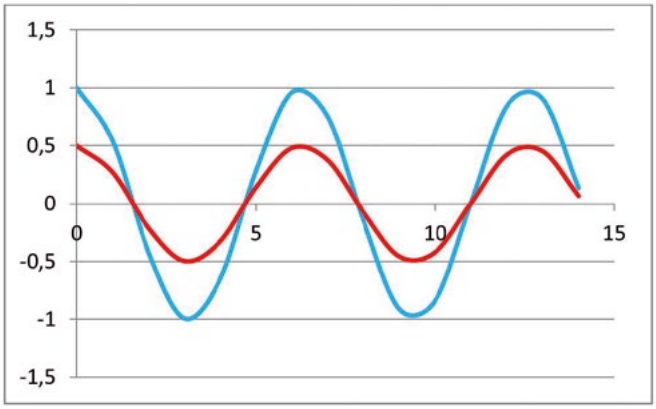
Mixing time synchronization (giving the complete time message) dependent on syntonization (very highly stable frequency) provides a very high level of accuracy (reaching a few nanoseconds) to the server's internal clock. this mix ensures ensures a high degree of protection against cyberattacks.

The oscillator of the server time base is either a cesium micro-oscillator, or a rubidium one, to maintain the high accuracy in Hold-over mode.



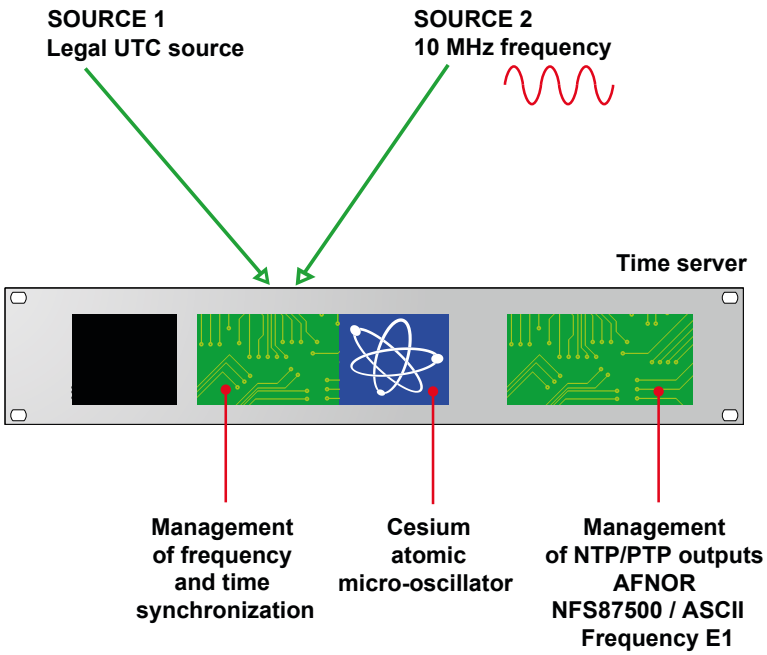
Out-of-phase signals

Syntonized, in-phase signals



Syntonization to a frequency

With a 10 MHz frequency signal, the clock time base receives 10,000 signals per second.



En 2017, arbitration-secured synchronization.

Time servers usually just pick up the time from a GNSS satellite system. This emitted time is highly accurate but the time message is received through Hertzian waves and can be jammed or spoofed by motivated attackers.

An arbitration module has been developed and patented by GORGY TIMING. It can compare and control several synchronization input sources, that are selected according to applications. The security of the sent time message prevails over its accuracy.

Both sources 1 and 2 of input synchronization can come from:

- GNSS satellites (GALILEO, GPS, GLONASS, BEIDU);
- protocols (NTP^{GT}, PTP, PTP White Rabbit).

The time server internal clock's source 3 is fitted with :

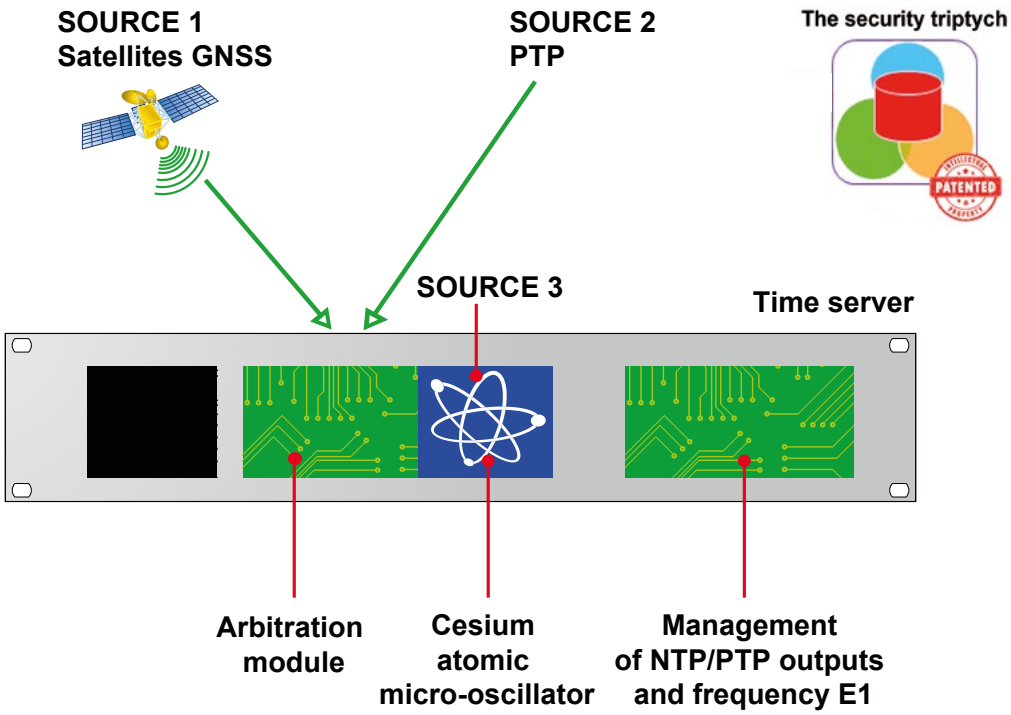
- a quartz oscillator OCXO (heated) or
- a cesium atomic micro-oscillator.

If sources 1 and 2 agree, the oscillator is enslaved to this common time reference.

If both input sources disagree, the cesium micro-oscillator acts as an arbitrator, qualifying the right source and rejecting the drifting-frequency one.

The time server accuracy depends on the 3 sources selected.

The accuracy can range from an accuracy to millisecond to one to nanosecond, according to applications: industry, army, banking, telecommunications, energy, rail or air transport.



This synchronization mode guarantees the highly secured transmission of the time message to the final user.

03

BROADCASTING OF TIME

Transporting coded time messages with special cables is no longer adapted to the needs of today's connected world.

Network Time Protocol (NTP) is now the main means to broadcast a time message through IT networks.

EVOLUTION OF TIME BROADCASTING

1879, pneumatic broadcasting of time.

In 1879, large-scale time broadcasting was a pneumatic process. Victor Popp and Ernest Resch developed an ingenious system.

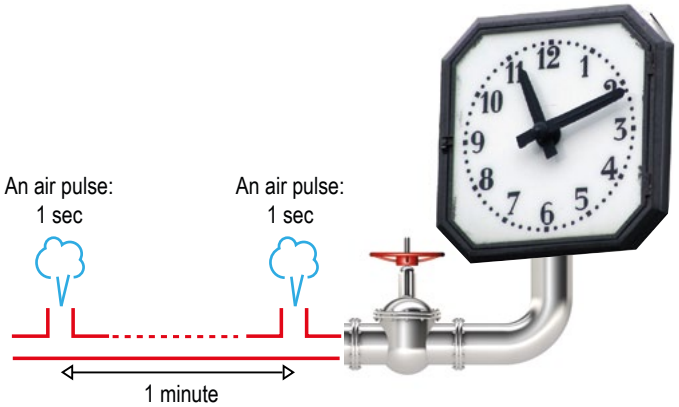
8,000 clocks were gradually set up in Paris, all linked by around 30 miles of tubes that go through the Paris sewage system.

A compressed air production station, called L'usine POPP, emits one air pulse per minute in the tubes that link all the networked clocks, which all gain one minute at the same time.

The French state funded this innovative concept and the public and monumental clocks were fitted in town halls, police stations, schools, parks and some of the streets of Paris.

Usine POPP of the Compagnie des horloges pneumatiques (pneumatic clock company)

*Passage Verdeau, Paris IX*ème



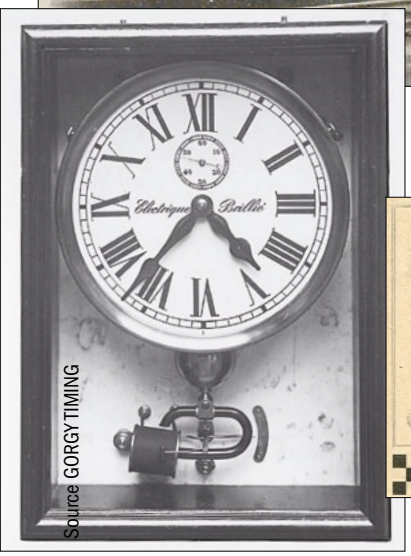
*Octagonal clock **Brillié®**, Ville de Paris*

1922, electric pulse time distribution.

All companies have schedules to follow and objectives to meet. Trains, planes and boats must all leave on time, and to achieve this, they need the same time to be displayed on every clock in every one of their buildings.

Ateliers Brillié Frères® in Levallois Perret outfitted the national railway service for their Parisian operations in 1922. They provided a number of companies with high-performance electrical regulators, whose operation was ensured by a pendulum maintenance impulse. This was produced by the attraction of a reel, through which a brief current passes onto a magnet attached to the pendulum. A contact, connected to the pendulum rod, sends an electromagnetic pulse just before reaching the apex of its swing. In certain models, synchronization modules sent orders remotely to other regulators whose balance wheels oscillate in harmony with the master clock. Some systems offered "time adjustment or automatic settings using wireless telegraphy". The Ateliers Brillié Frères® catalog circa 1936 advertised the following: *"Compared to ordinary mechanical clocks, Brillié® time distribution offers the following benefits: Elimination of the need for rewinding, an accurate time display and rigorous synchronization between all of your different clocks. This sets all of your clocks at the same time, just by adjusting the clock regulator. The master clocks provide a highly accurate time and they work extremely regularly. A single regulator can set as many secondary clocks as you like using contacts to send a current down the line to the receiver clocks every thirty seconds. In this way, they will always display the same time, which will always be that of the master clock."* The Brillié® type 1565 electrical regulator became extremely popular both in France and around Europe.

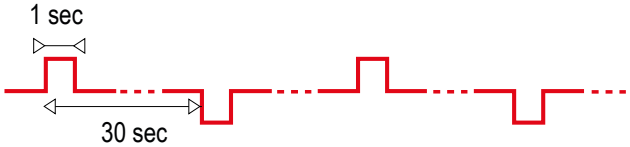
Horloges Brillié®
Gare du nord, Paris



The balance-wheel regulator Brillié®

A striking innovation from the Brillié® brand: was the master clock also known as the balance-wheel regulator. This clock synchronizes a number of receiver pendulum clocks such as the large-scale clocks on rail platforms, town halls or those installed in factories. The unique feature of this regulator is **its low electricity consumption**: with a single Féry battery, you could run this master clock for several years

This autonomous masterclock had a drift of a few minutes per week and had to be put back on time monthly.

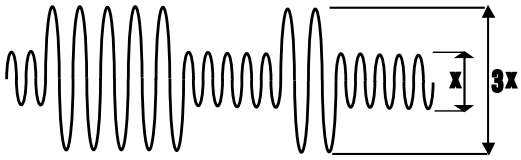


Half minute pulse output to monitor receptive clocks plugged in a series.

1976, 1000Hz binary code time distribution.

GORGY TIMING was the first company in the world to create a new way of distributing time with a specific 1000Hz binary time code, enabling the control of 1200 new digital clocks in Radio France Paris with a single telephone line.

This 1000Hz code is in the range of audio frequency; it does not disturb any other lines and is not vulnerable to industrial parasites. The Gorgy Timing® time center transmits a full time and date message to receiver clocks every second. Each line circuit can synchronize more than 250 clocks over 40km, using a single telephone line.



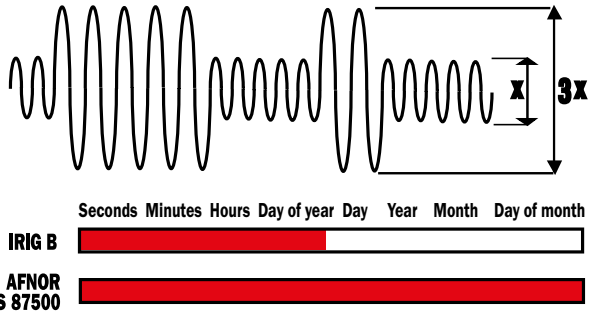
1000Hz frequency code

Binary code time center
Aéroport de Roissy

1985, Standardization of the AFNOR NFS 87500 TIME CODE.

For two years, GORGY TIMING has worked in partnership with design offices at the SNCF, Radio France, Paris Airports and the CFHM to set a standardized time code. Together, they opted to use the code in use at the time by Gorgy Timing® at Radio France. This would become the standardized AFNOR NFS 87500 in 1987.

This is still the most widely used time code in the international transport market (airports, railroads, subways). It is also widely referred to as "French code" by American military personnel



modular time center

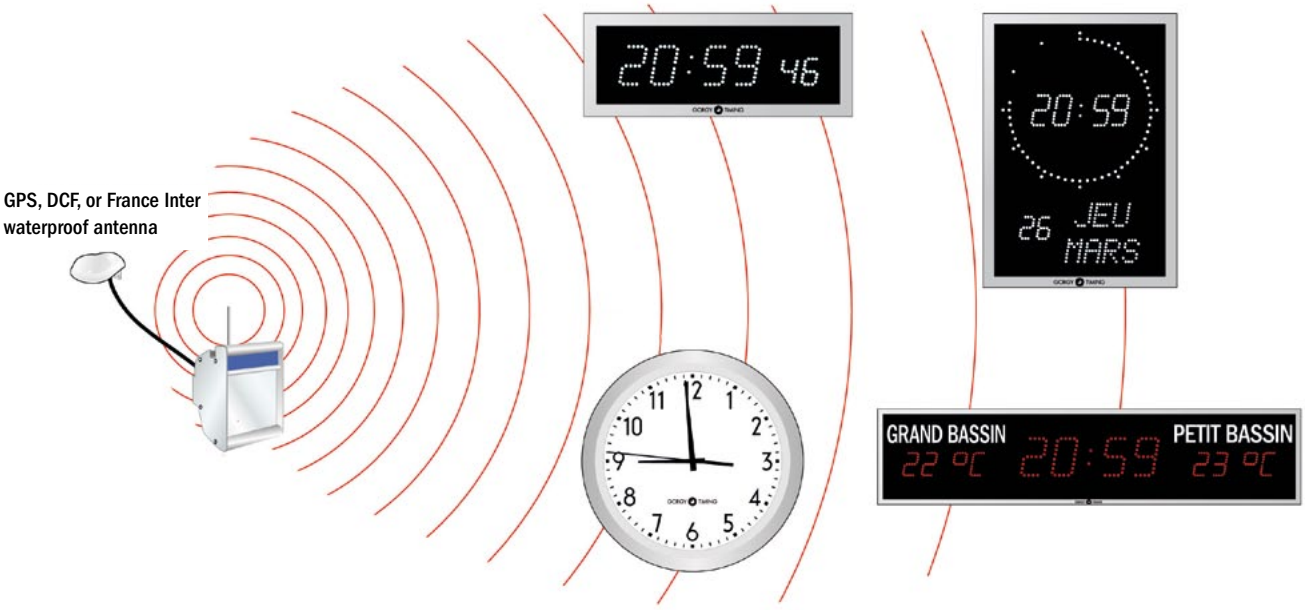
TGV clocks in the train station of Lyon Saint Exupéry airport

In 1993, the first AFNOR NFS 87500 analog clock, GORGY TIMING designed and manufactured a special TGV clock in collaboration with architects from the SNCF. They are monitored with the AFNOR NFS 87500 time code with a permanent time setting.

1998, DHW 869MHZ radio time distribution.

This time distribution mode is unidirectional and wireless. It allows to synchronize clocks over wide distances up to 250m (for longer distances repeaters are required).

The unidirectional signal quality is conditioned by the building structure.



2002, time distribution through NTP (Network Time Protocol)

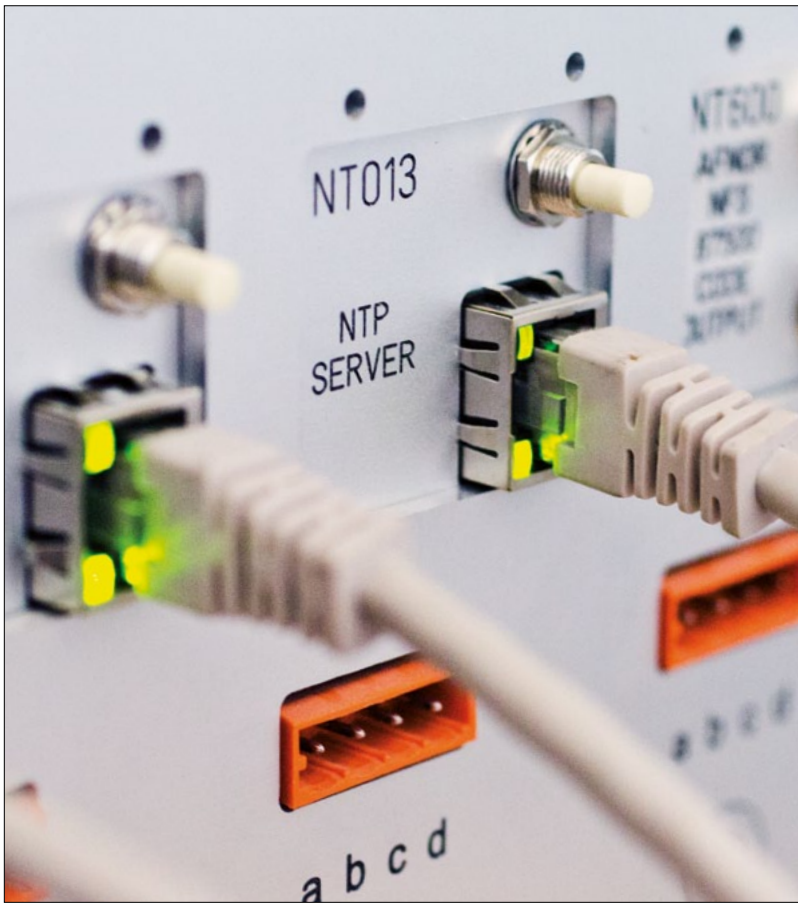
Until now, time distribution has meant only displaying time on a clock display or of synchronizing a computer with a serial ASCII code. This is now outdated and time synchronization on communication networks (Ethernet, Internet and wireless Wi-Fi, WIMAX) through NTP has begun.

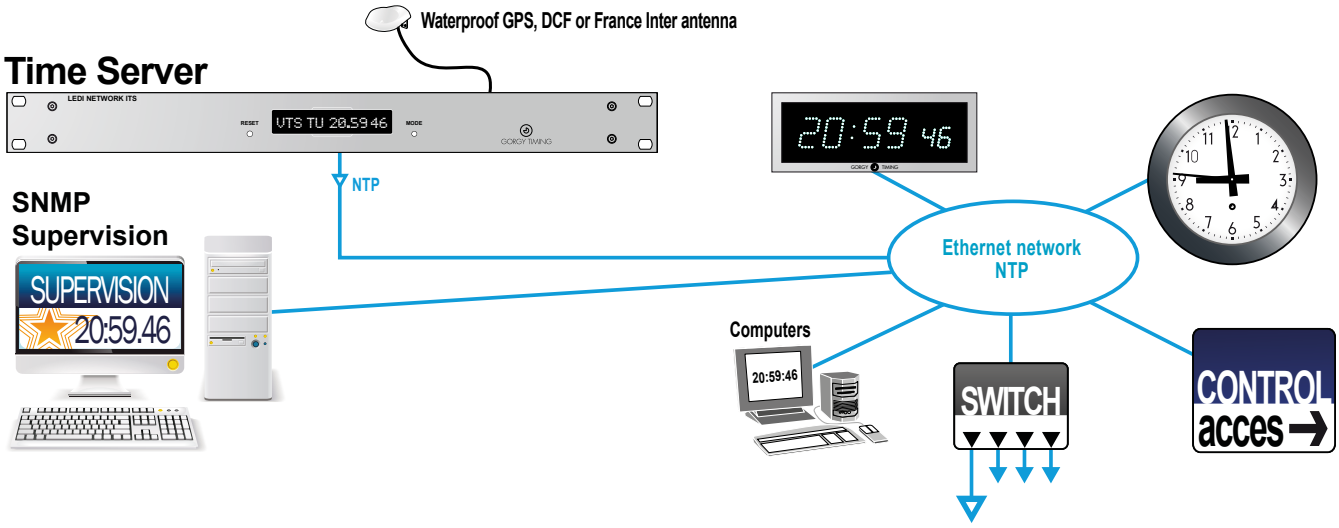
The standardized NTP protocol is the more and more common protocol in time distribution. Its bidirectional time message makes traceability and remote control possible

Its impact is strong and irreversible. The nature of synchronization exchanges is wider, faster and distances are no longer an obstacle thanks to communication networks.

NTP allows to synchronize clocks, computer systems and includes IoT without interface over long distances.

It can also stamp a date on events precisely. The NTP synchronization, easy to set, fits all sizes of time installations. **The use of computer networks for time message transmission helps to reduce specific cable installations**.





2013, Wi-Fi/NTP^{GT} synchronisation.

This new bidirectional wireless diffusion mode associates two internationally renowned standards: Wi-Fi and NTP^{GT}.

It ensures a time distribution in high security conditions and precision.

This wireless diffusion mode replaces the 869 Mhz radio code for two reasons:

- *No need to add another electromagnetic pollution in a building already equipped with Wi-Fi.*
- *It offers a real bidirectional time code to control remotely the whole time installation and and to trace all connected computer devices.*

As each clock has its own IP address, it is possible to supervise all of them individually and remotely.

For installations of 5 to thousands of clocks, GORGY TIMING developed a specific software on an Android Tablet with automatic and instantaneous remote settings of each clocks in the devices list connected to the Wi-Fi.

The set up is simple and intuitive. It will only take few minutes to configure a hundred clocks instead of several hours with a classic Wi-Fi module.

Only NTP/PTP protocols or Wi-Fi are bidirectional and allow a traceability of the time message.

2014, time broadcasting via PTP (Precision Time Protocol).

The time protocol PTP has been developed by the IEEE (Institute of Electrical and Electronics Engineers) to synchronize clocks on local networks (e.g. Ethernet).

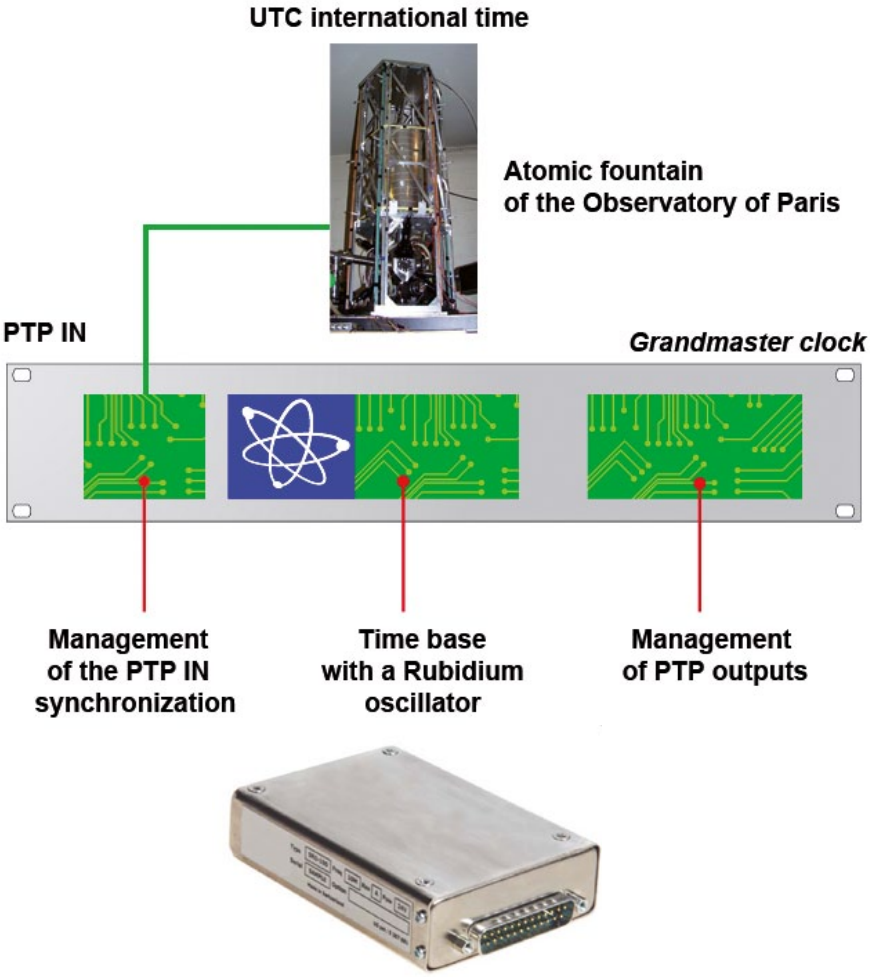
GORGY TIMING develops **PTP grandmaster**, a high-end time server designed to produce and disseminate the secured time **SCPTime®**.

For the PTP output, a further security layer has been added thanks to the expertise of the LNE (French national trial lab), and this supplementary layer is crucial to address cybersecurity challenges.

The PTP input synchronization enables a high stability for the Grandmaster's internal clock, that is below 10 nanoseconds. The PTP output can be used to synchronize clocks or connected objects to below a microsecond over long distances via networks such as Ethernet, thanks to a precise drift correction and the compensation of the transmission period. The bidirectional PTP protocol enables time message traceability and certification.

The PTP Grandmaster is equipped with a rubidium oscillator that provides high accuracy (10^{-11}) in Hold-over mode.

It has been developed to meet the needs of area control centers, radio/TV broadcasters, telecom networks, metrology labs and military facilities.



2017, broadcasting of certified time Box NTP BiaTime®.

It took GORGY TIMING several years to develop this professional time server procuring a strong industrial product that has made the company an important player in the international market.

The BOX NTP BiaTime® aims at broadcasting a certified, traceable time message that comes from a country's legal time (for France, it comes from the SYRTE of the Observatory of Paris) to a final user, within an accuracy to a millisecond, whatever the distance.

Here are some of the features of the compact NTP^{GT} time server:

- Intuitive and easy installation and operation for users.
- Adequate accuracy to a few milliseconds.
- Time information traceability, via a Data Center or Big Data.
- Remote setup and maintenance.
- Secured NTP^{GT} protocol.
- A price that most can afford to pay.
- Multilingual international product.

Biatime® B is designed for small networks or parts of decentralized networks, where around twenty hardware devices are networked: solicitors, insurance companies, businesses, administrations, schools, hospitals...

2017, time broadcasting by a time server Grandmaster.

The cutting-edge Grandmaster time server works on a nanosecond scale.

Its time base accuracy is guaranteed by a cesium atomic micro-oscillator.

This micro-oscillator was developed within the framework of the SCPTime® collaborative project, by the Femto lab from Besançon, and the manufacturers Syrlinks and Tronics.

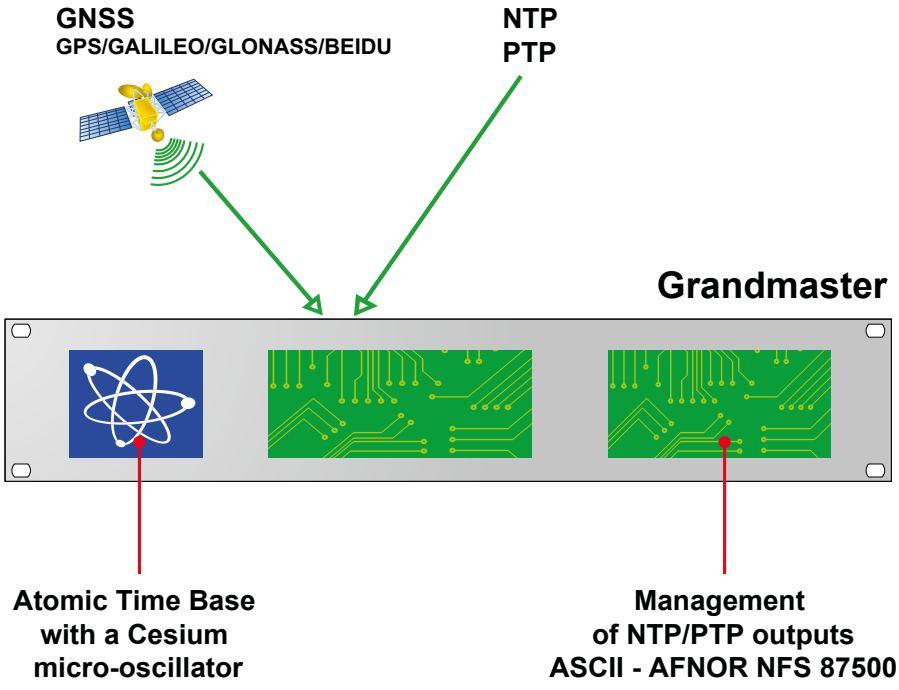
The time base accuracy can range from a nanosecond to a microsecond in the long term, depending on the synchronization source that is used.

In the Hold over mode, the micro-oscillator can keep up within an accuracy to a microsecond for 48 hours or to 100 microseconds for 10 days.

The Grandmaster server was developed to operate under harsh conditions, between -25°C and +70°C.

Thanks to the centimetric oscillator, the technology can be embedded in a compact rack of 19”1U. Its small size is a further advantage on the Time/Frequency markets.

This time server is fit for very demanding applications in terms of cybersecurity: trading rooms (high-frequency trading), area control centers, metrology labs, telecom networks (5G) and military facilities.



04

THE SCPTime® PROJECT

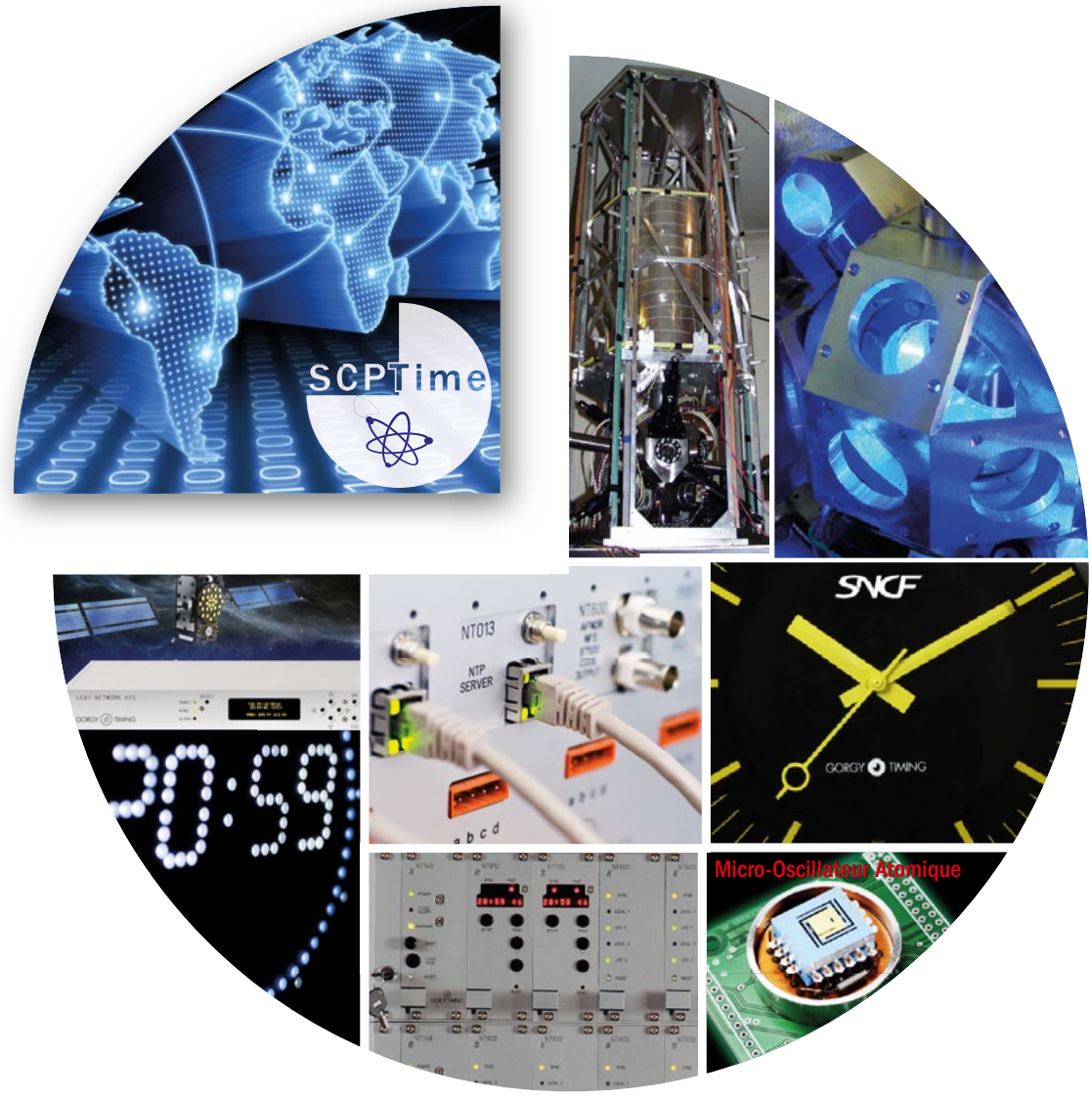
The SCPTime® collaborative project aims at bringing ultra-accurate time out of national observatories and metrology labs, to industrialize and broadcast it with a high level of security and traceability, over long distances, to final users.

The ultimate goal is to serve the digital economy with complete confidence.

In the fast moving world
where objects get connected...

SCPTime®

by GORGY TIMING



Secured, certified, accurate and traceable time

The development of technologies and cybersecurity
to serve time synchronization

SCPTime®
THE FIRST TIME OPERATOR

A collaborative innovation of French experts in Time/Frequency

WHY SCPTime® ?

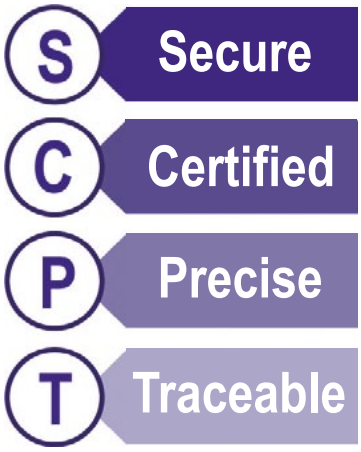
- SCPTime®: an appealing collaborative project
- Cybersecurity in the digital economy
- The risks of GNSS synchronization
- The risks of radio synchronization
- The risks of wireless broadcasting
- The risks of NTP broadcasting

- Reponses:
  - The SCPTime® architecture
  - The SCPTime® technology

AN APPEALING COLLABORATIVE SCPTime® PROJECT

In a digital world, time plays a crucial role in cybersecurity and regulatory environments. proof of the correct source and its effective use in synchronization have become essential.

European and French regulatory trends are to gradually be expanded to all industries. This implies providing proof that synchronization has effectively been done, at the right reference time (UTC-based legal time) according to the required accuracy, which depends on user applications (from an accuracy of a second to a nanosecond). The time path must be traceable, from the production source to the destination, with an acknowledgement that it has been received.



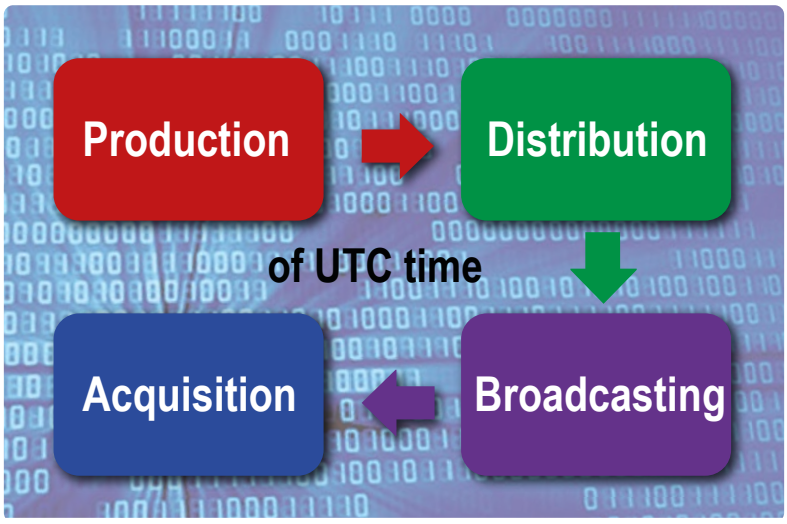
SCPTime® is aimed at all sector using IT resources. It can be calibrated according to the real expectations of the various time uses, that can range from that of a state solicitor (certified second) to those in high-frequency trading (certified microsecond). The SCPTime® broadcasting level considers the increasing constraints laid by regulation and professional practices and is adapted to any community of interest.

Faced with the exponential growth of data needing to be processed, particularly due to the development of connected objects, a complete and very precise dating is needed. The restoration of transactions over time is now vital. Through its BIG DATA system, **SCPTime®** can restore the time pattern of profession-specific transactions for a chosen period.

SCPTime® offers a total traceability of time and the related security to provide an accurate and certified time.

SCPTime® is available in a closed network version: reference time is provided by an innovative industrial quantum atomic clock that is calibrated via a multi-satellite application.

SCPTime® stands out because it is so easy to use.



SCPTime® ensures time security and traceability through a certificate (audited by an accredited body) complying with the European official documentation.

The storage in SCPTime®'s Big Data makes legal responses easier and can be used as evidence. SCPTime® is the first device in the world that brings a complete response to the time challenge of the digital era. It is available for various applications (companies, governmental and non-governmental bodies) from 2017.

CYBERSECURITY IN THE DIGITAL ECONOMY

Today, the SCPTime® concept is a system that traces the time message, from the UTC time source to the final user.

It is the only system in the world that 100% guarantees the time signal continuity in bidirectional mode:

- Prooving the UTC origin of the UTC reference time.
- Certifying the synchronization operations.
- Providing a full traceability of the time message path over long distances.
- Informing the final user in case of momentary interruption, insufficient performance or synchronization malfunction.
- Switching to an internal atomic micro-clock in case of synchronization malfunction.
- Providing a certified precision, ranging from the subsecond to a few nanoseconds according to applications.
- Copying the same cybersecurity concept in each country.

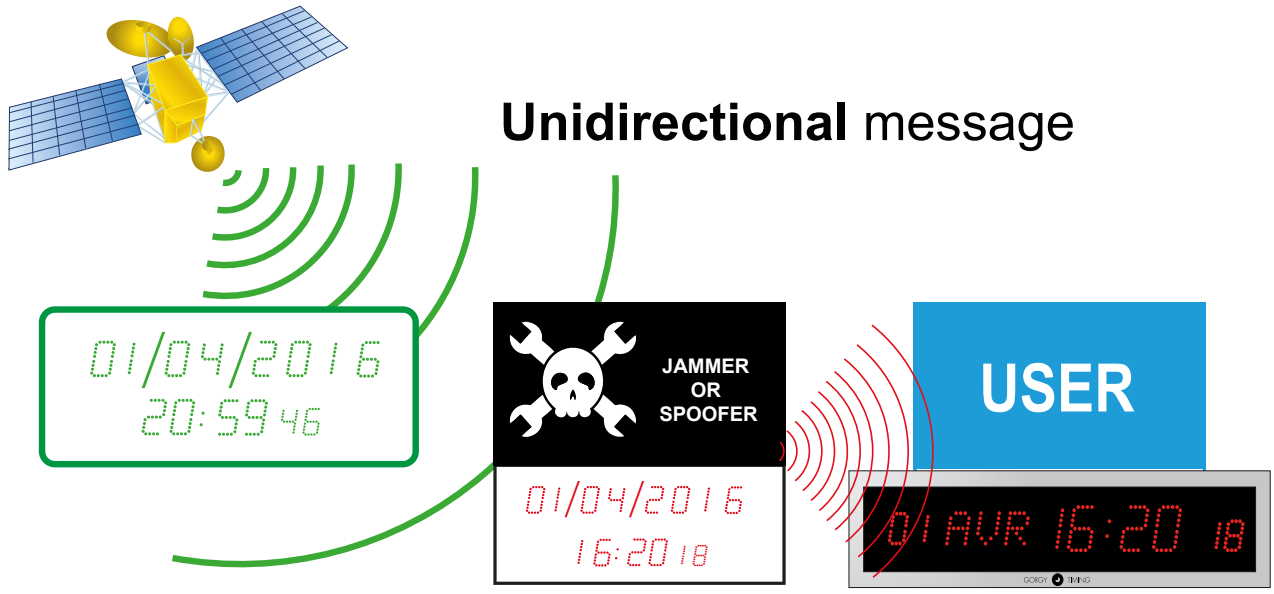
THE RISKS OF GNSS SYNCHRONIZATION

The time bases (which are usually made of quartz) of time servers must be periodically readjusted by an external source to prevent the internal clock drifts over time.

These periodic readjustments according to GNSS satellites or to national radio transmitters can be very risky, as shown by the two below examples:

DATE and TIME of reference: 01/04/2016 20:59 46

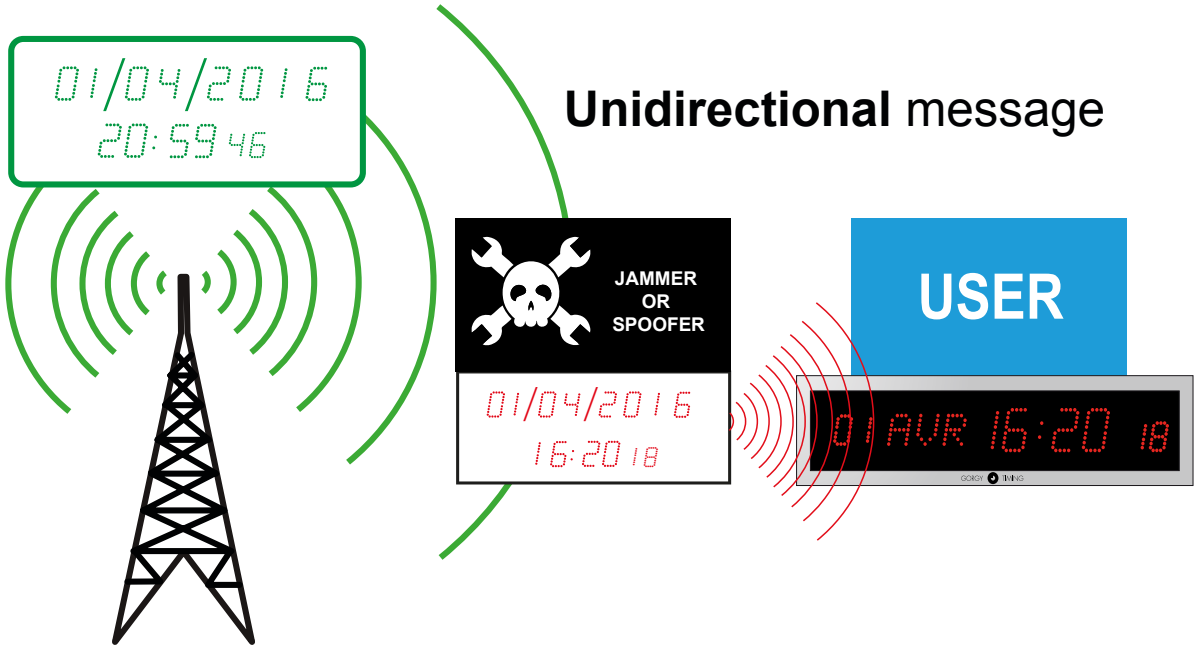
A - GNSS broadcasting via GALILEO (Europe), GPS (USA), GLONASS (Russia), BEIDOU (China) - World coverage



GALILEO (Europe), GPS (USA), GLONASS (Russia) and BEIDOU (China) satellites transmit a complete, highly-accurate time message every 12 minutes, to synchronize time servers.

A unidirectional time message lacks traceability, and therefore its authenticity cannot be guaranteed. It can easily be jammed, or even spoofed, willingly by a motivated attacker before reaching the user.

B - Traditional Hertzian broadcasting, by time radio transmitters: Allouis/DCF/MSF - World coverage

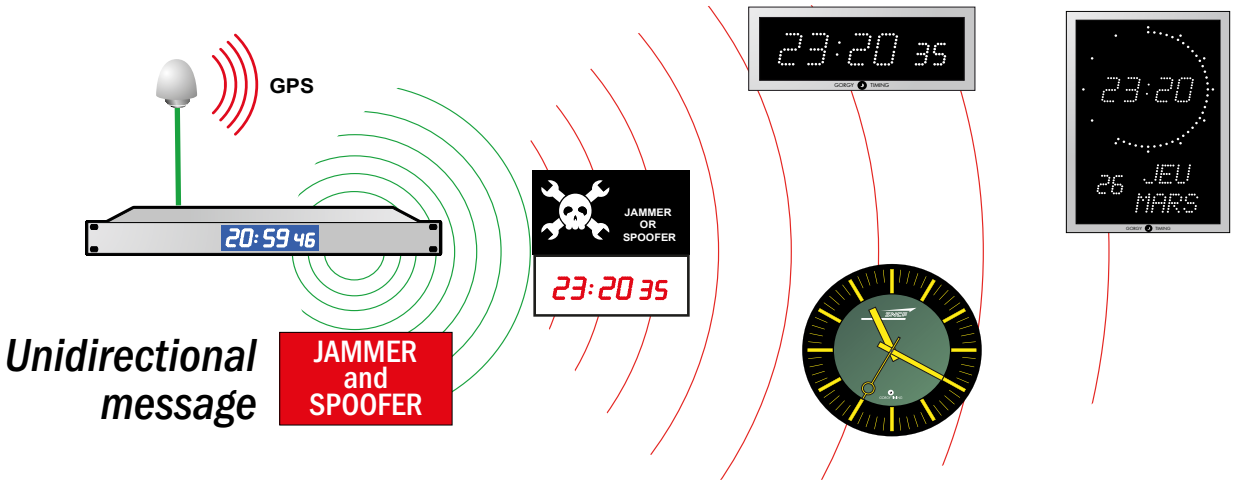


The Allouis (France), DCF (Germany) and MSF (England) radio transmitters transmit each minute, via Hertzian waves, a complete unidirectional time message aiming at synchronizing time servers.

A unidirectional time message lacks traceability, and therefore its authenticity cannot be guaranteed. It can easily be jammed, or even spoofed, willingly by a motivated attacker before reaching the user.

THE RISKS OF WIRELESS BROADCASTING

Time message wireless broadcasting, 869 MHz

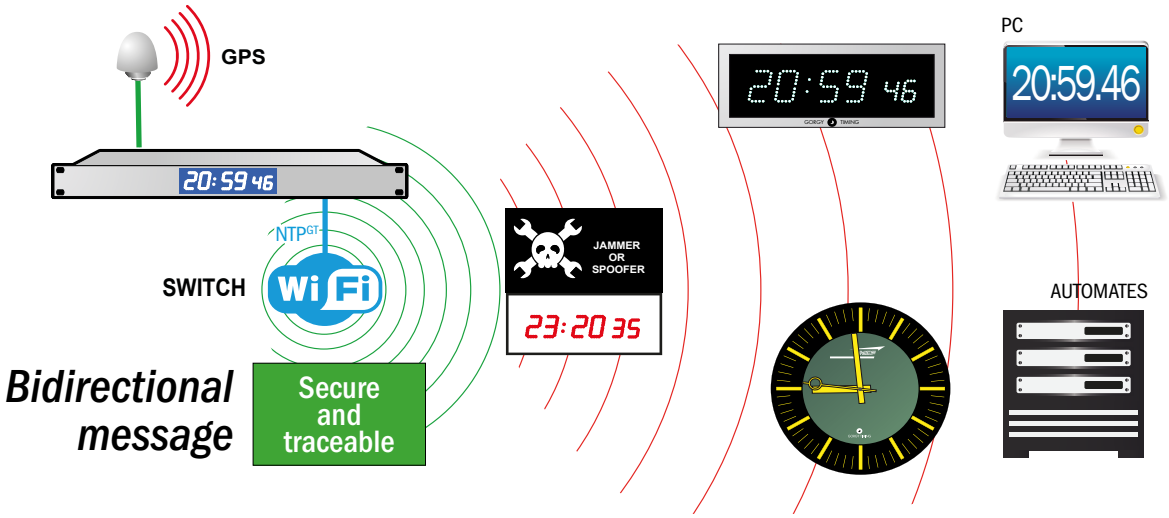


The wireless broadcasting of time messages can be used to synchronize a clock network in a given facility. Hertzian broadcasting requires no cabling work between clocks.

The risks of unidirectional broadcasting

A unidirectional time message lacks traceability, and therefore its authenticity cannot be overseen nor guaranteed. It can easily be jammed, or even spoofed, willingly by motivated attackers.
The 869 MHz signal has a low range of around 820 feet, and repeaters can easily be spoofed

Time message wireless broadcasting Wi-Fi/NTP^{GT}



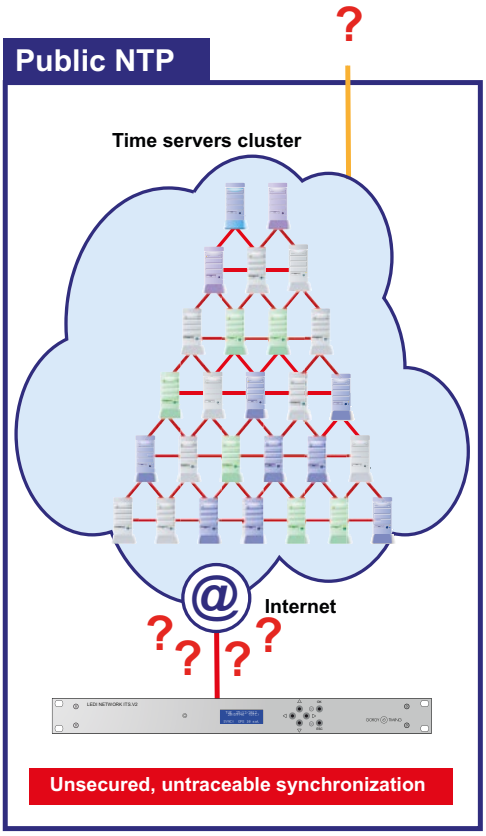
This new broadcasting mode of the Hertzian time via the compatible protocol **SCPTime®** ready NTP^{GT} via Wi-Fi can be used to synchronize networked clocks but also all an organization's hardware and connected objects.
An Android tablet very much facilitates its implementation and the remote setup of clocks and IT devices.
All the connected devises are remotely overseen and monitored.

The advantages of bidirectional broadcasting

The bidirectional time broadcasting mode enables the supervision and traceability of the source time message.
Any attack by a malicious third party can be detected. Connected peripherals (clocks, PC, timeclocks...) will operate in Hold-over mode, based on the accuracy of their quartz time bases, until the recovery of a correct time message.

THE RISKS OF NTP (NETWORK TIME PROTOCOL) BROADCASTING

Two NTP synchronization and broadcasting modes are at risk:

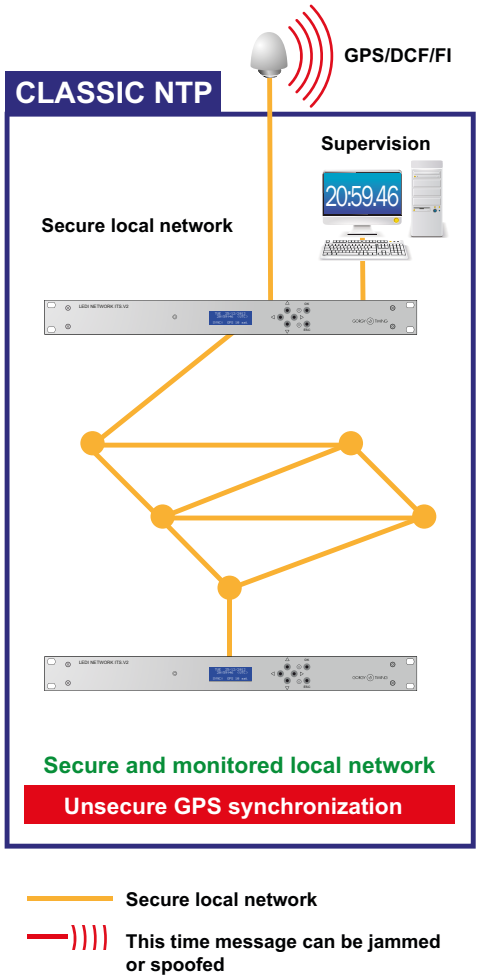


The Public NTP mode

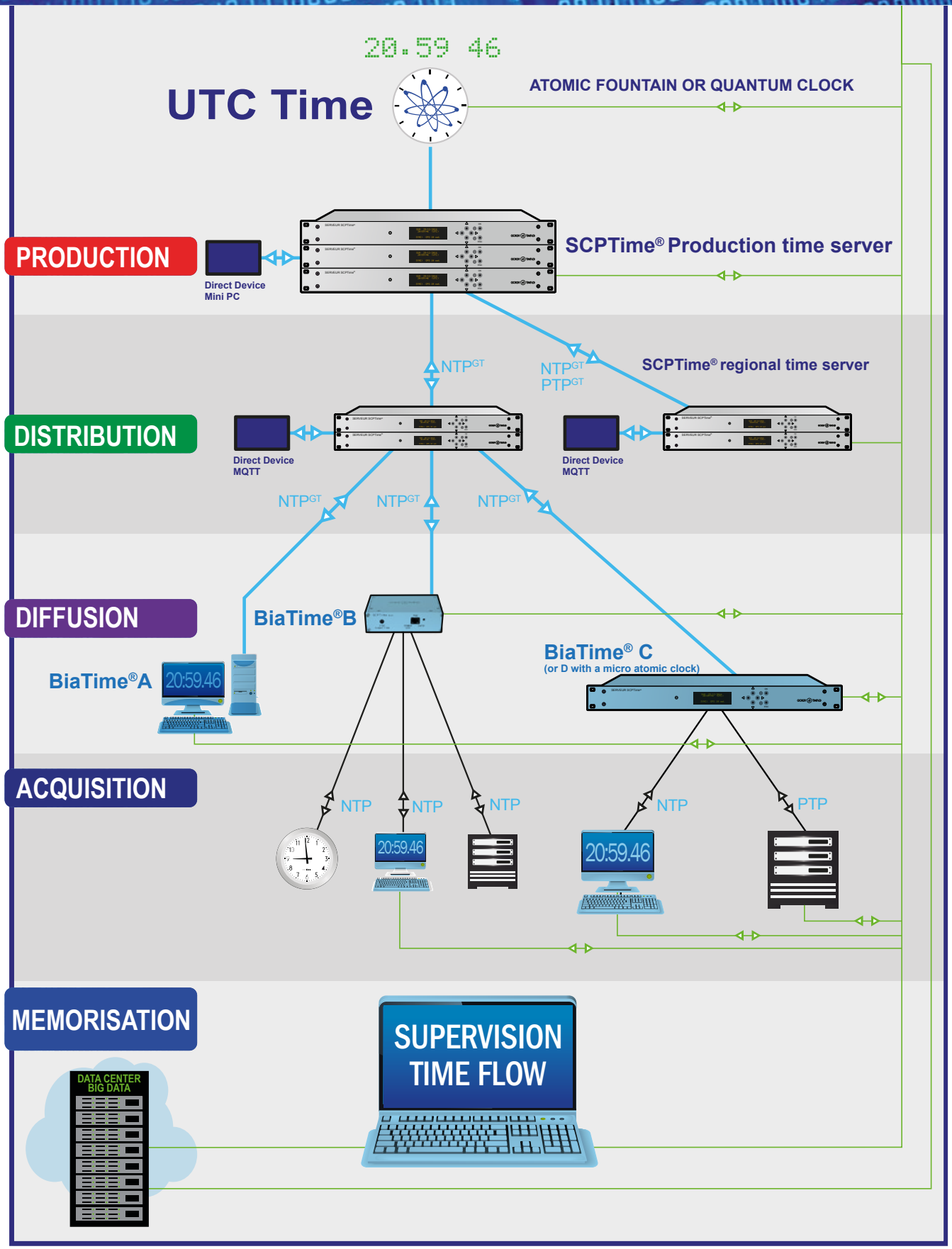
Synchronizing a time server cluster running in public NTP mode is highly risky.
These are huge virtual clusters combining several thousands of time servers distributed throughout the world and easing connections between these.
However, they cannot bring a legal evidence of the time source, since random servers which broadcast time are not accredited.

The Classic NTP mode

In a local network, the NTP can be run in two modes:
broadcast mode or client/server mode.
In the first mode, the time information is unidirectional and thus uncontrolled.
In the second mode, there is a bidirectional exchange between both systems, which is therefore traced and secured.
For both modes, hardware devices are run on Stratum 1 which is generally GPS synchronized.
Any attack targeting the GPS signal introduces a cascading error on the whole sync chain, up to the final hardware device.

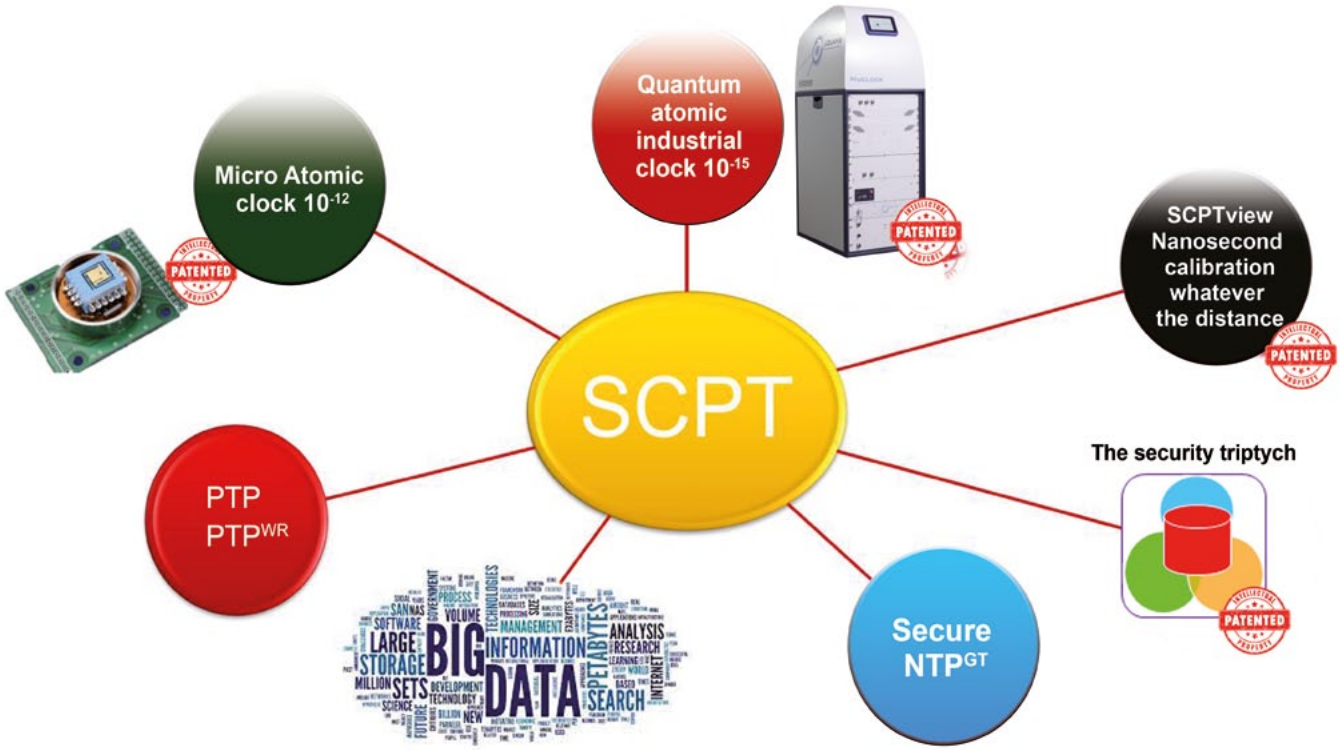


RESPONSES: SCPTime® ARCHITECTURE
FOR A COUNTRY OR A REGION



RESPONSES: THE SCPTime® TECHNOLOGY

The SCPTime® project has made it possible to develop innovative technologies grouped under the SCPT concept.



The industrial quantum clocks

The industrial quantum clock MuClock has been developed as a substitute to replace the time-producing atomic fountains to provide a local production source within a frequency accuracy to a 10^{-15} second range that allows demanding users to work in a closed network in the long run or that allows countries to have their own, independent UTC time production device.

The atomic micro-clock

The cesium atomic micro-clock developed in **SCPTime®** is embedded in **BiaTime®** hardware and in the networked servers **SCPTime®** to operate in the high-performing Hold over mode and to contribute to an autonomous, continuous time monitoring

The security triptych

This security triptych aims at controlling several synchronization input sources and ensuring the security of the transmitted time message. Contradictions are detected by the Arbitration or Triptych technologies during the comparison of external sources and internal references.

These technologies help in anticipating problems thanks to their exceptional responsivity, within less than a nanosecond.

SCPTview

Based on the Common View principle to guarantee a UTC time synchronization, the SCPTview technology makes it possible to compare deviations. It has been codeveloped by the Observatory of Besançon and GORGY TIMING for SCPTime® applications, so that the calibrating process can certify the compliance with the UTC time for SCPTime® applications.

The PTP protocol

The PTP time protocol is used for synchronization through networks for its high performance, both locally and at a city-wide scale. The used PTP is characterized to the highest levels by observatories' atomic clocks or fountains.

A PTP^{WR} version (PTP White Rabbit) developed at the CERN is also compatible with SCPTime®. It delivers higher performance for specific applications.

NTP^{GT} = secured NTP

NTP^{GT} is compatible with the NTP standard and has an additional security layer specifically developed for SCPTime®. The received time message is checked and is used only if validated.

Big Data

From time production to SCPTime® use, time data is escalated through SCPTrace®, the supervision flow. The data is fully stored and analyzed calling on technologies such as NOSQL and Datanalyzers SCPT.

These processes enable an afterward check of the operating state to ensure the logical and legal restoration of events dated according to SCPTime®, as well as the issuing of certificates of legal and professional compliance.

UTC INTERNATIONAL TIME

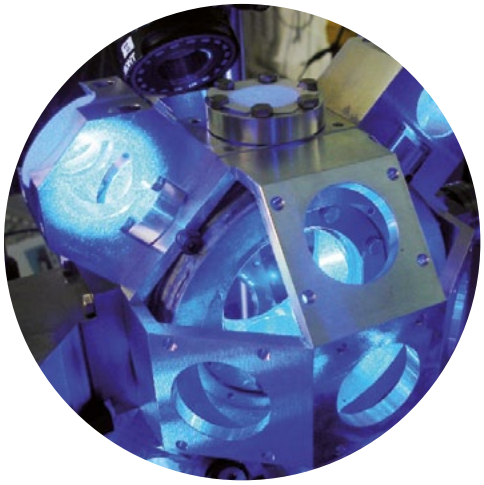
The timescale UTC (Universal Time Coordinated) has been adopted as the international time base.

The Universal Time Coordinated UTC has been elaborated by the BIPM (International Bureau of Weights and Measures). It results from a comparison of more than 400 atomic clocks distributed in more than 70 metrology labs around the world.

A country's legal time is defined from the UTC international reference to which a number of hours is added or subtracted, which depends on the time zone.

By way of example, the French (mainland) legal time is obtained by adding one hour to the UTC time in winter and two hours in summer.

For countries where atomic clocks are connected to the UTC timescale, SCPTime® can be synchronized to those metrology references within an accuracy that can reach 10^{-15}.



Laser cold, trapped strontium atom optical atomic clock, SYRTE
(Copyright: A. Willaume/Observatory of Paris)

MuClock quantum clock

For countries that do not have any atomic clock, SCPTime® will provide a MuClock quantum clock developed by Muquans within the framework of the **SCPTime®** project.

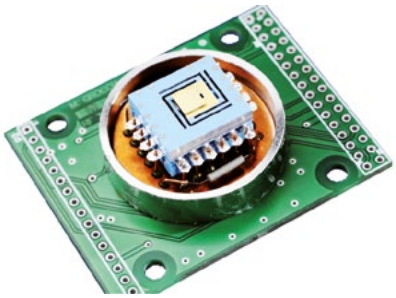
MuClock will be periodically calibrated via the multisatellite SCPTview codeveloped by the Laboratoire Temps/Fréquence of the Observatory of Besançon and GORGY TIMING.

SCPTview will help checking and readjusting MuClock, both periodically and randomly, to maintain the 10^{-15} precision, thanks to the multi-satellite calibration principle with the atomic fountains of the reference Observatory.

SECURED TIME PRODUCTION, SCPTime®

The time production service SCPTime® is located closest to the legal reference of each country (which, in France, is the SYRTE, *Observatory of Paris*).

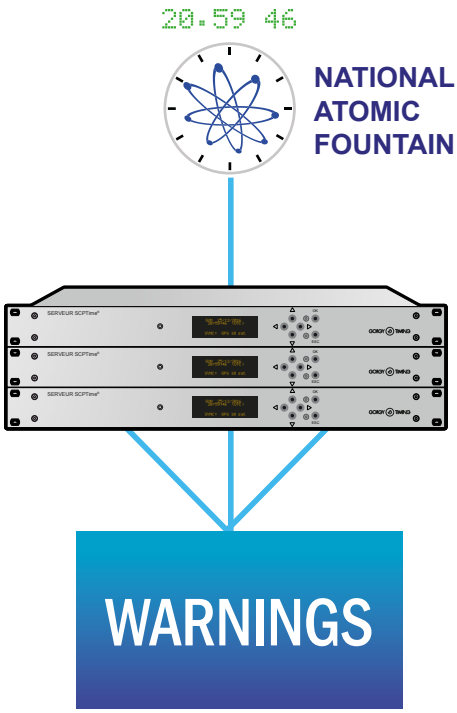
The system ensures a permanent and secure legal time production. To achieve this, several time servers are run redundantly and use a cesium atomic micro-oscillator.



Cesium atomic micro-oscillator

Synchronization and time broadcasting operations are stored and monitored via the collection and analysis of consolidated information in a specific warning system.

The secured production service transmits the UTC time to the various regional distribution servers **SCPTime®**.



THE SECURED WHITE RABBIT PTP (WR-PTP) TIME

The challenge of high precision (Cable network VS satellite network)

Although using the GNSS satellite network involves risk, it gives access to a high level of precision. SCPTime aimed to offer the same precision through the cable network..

The Observatory of Paris has taken on this mission.

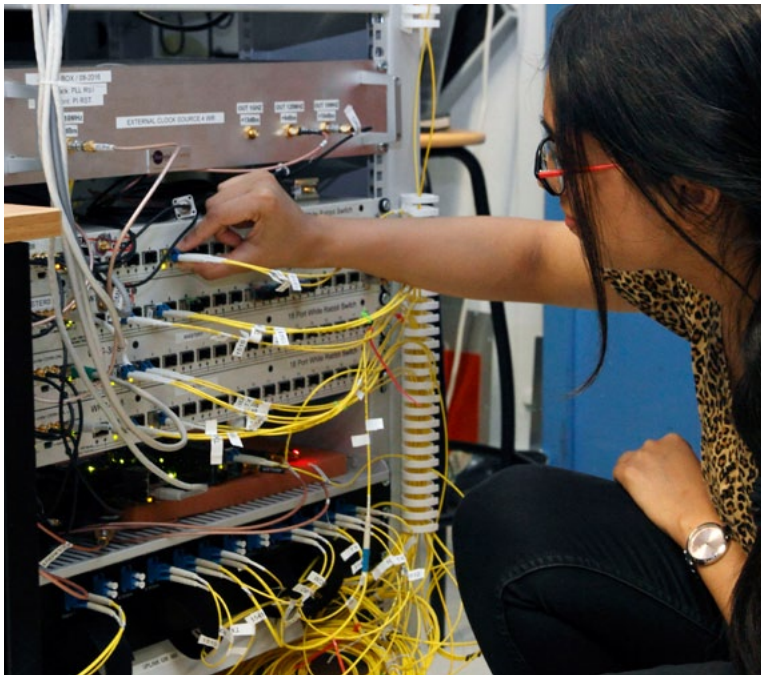


Illustration : An experimental 500 km White Rabbit link in the testing phase at the Observatory of Paris. Credits : Pascal Blondé, LNE-SYRTE, Observatoire de Paris

The scientific origin of the White Rabbit

In 2006, the White Rabbit adventure began at CERN, motivated by the development of the LHC. White Rabbit (WR-PTP) is an Ethernet packet synchronization protocol over a telecommunication network that has been developed by more than 60 engineers.

White Rabbit devices are remotely manageable and can operate in any range of wavelengths used in optical fibre telecommunications. White Rabbit equipment typically provides 10 MHz and PPS user output signals.

WR-PTP and SCPTime®

The Paris observatory studied the performance of a White Rabbit link on an architecture which is 100% compatible with SCPTime using an active long-distance communication network.

The results showed:

- Time stability of the user output is less than a ns.
- The range goes up to a 1000 km.

The stability performance of a WR-PTP link can be up to 100 times better than that of a high-performance GNSS receiver.

SCPTime® is able to provide users requiring a traceable source with the highest precision and maximal independence with respect to GNSS signals.

SECURED TIME BROADCASTING SCPTime®

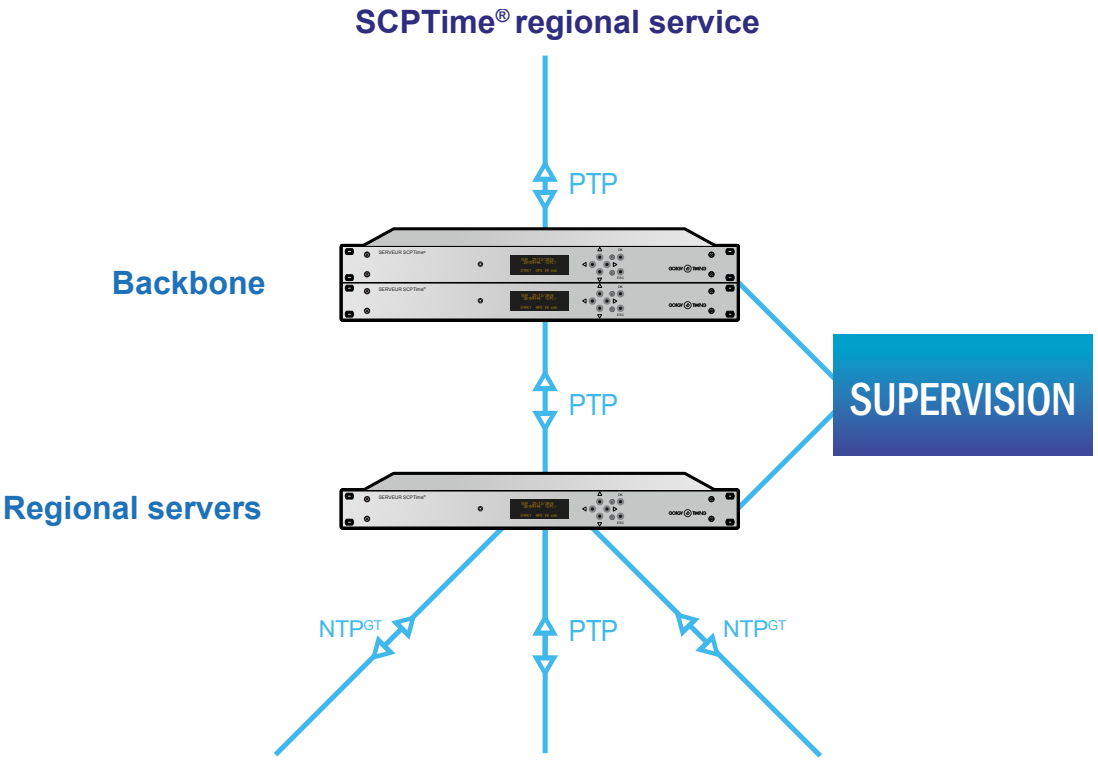
The time broadcasting service SCPTime® is provided by geographically-distributed time servers.

Each server receives the time information sent by the production server and has a highly-stable atomic micro-oscillator that ensures it can autonomously broadcast time in case of contact loss. PTP (or NTP in degraded mode) time protocols are used for this purpose.

The regional distribution server between the user and the **SCPTime®** network communicates via synchronization lists used for purposes of traceability of the time provided to the client.

The regional services are distributed according to the synchronization needs of various geographical areas. Each cell is scalable and its size can be adjusted according to changing needs.

Network links are private until this distribution level, which ensures exchanged data integrity. In case of a distribution output via public links, security is ensured by NTP^{GT} systems.



SCPTime® TIME BROADCASTING (Traced and Secured)

Bidirectional time broadcasting, BiaTime®

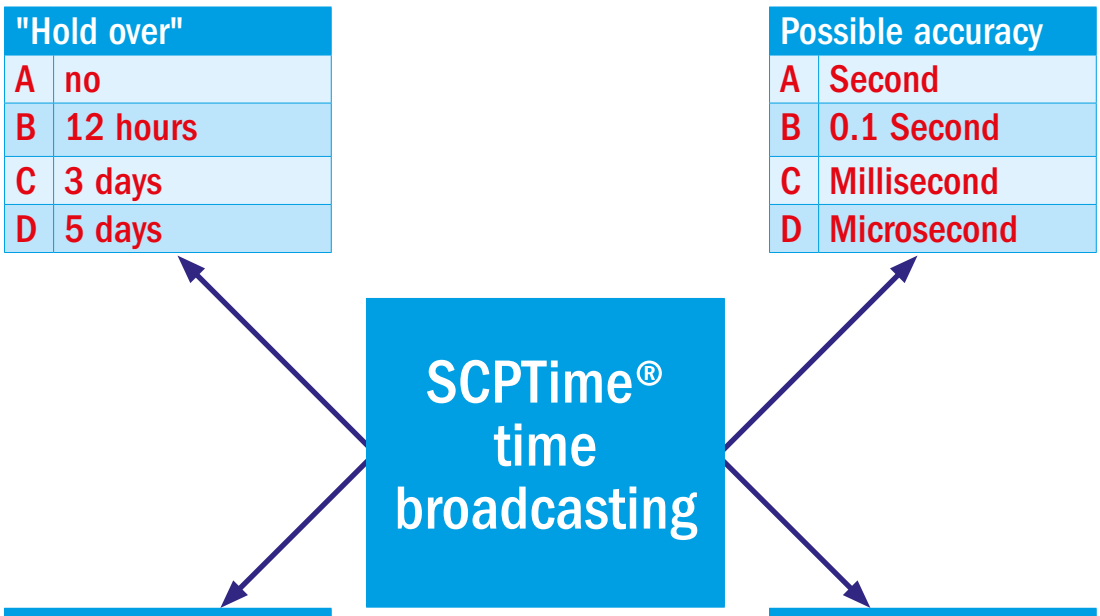
The **BiaTime®** technology can cover the whole time spectrum of the digital world, including associated laws and rules.

The coverage is ensured by 4 **BiaTime®** levels (A, B, C and D), in strict compliance with the **SCPTime®** standards, which enable the issuance of a synchronization certificate from the reference source (legal time, internal time, international time, etc.).

The added value of SCPTime® broadcasting is the monitoring and traceability certification of the used time, thanks to its systems of time protocol securing and data analysis based on Big Data techniques.

The links between the 4 bidirectional time broadcasting modes **BiaTime®** and the hardware needed to be synchronized are preassigned and consider imponderable events such as latency issues. An **SCPTime®** agent can be setup to calibrate the synchronization of the user's pieces of hardware.

Overview of the 4 BiaTime® levels:



*GORGY TIMING patent

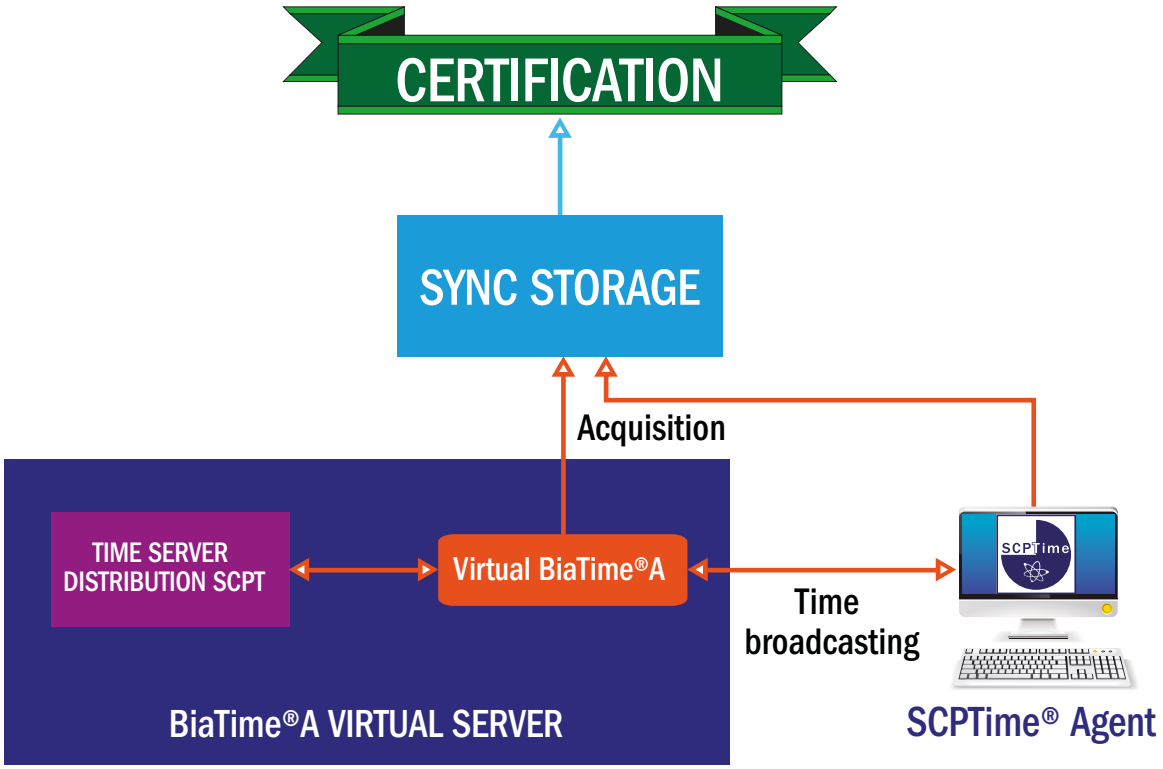
BiaTime® A

BiaTime® A is a time broadcasting device that uses virtualization technologies to broadcast the guaranteed UTC second. This source time broadcasting is accredited by the SCPT network regional time server.

It can be accessed via the Internet network: the SCPT agent can be downloaded on the target piece of hardware.

Traceability (T in SCPT) is ensured by the pair BiaTime® A - Agent. It ensures the issuing of the SCPT Class A certification.

The below diagram shows the BiaTime® A operational principle thanks to which a cybersecurity approach is possible through the NTP^{GT} protocol and reinforced by the SCPT Agent.



To be efficient, this synchronization mode needs a good connection quality and a high-stable Internet access to avoid too uneven situations. Temporary issues linked to the synchronization quality will be highlighted by time monitoring.

BiaTime® A helps in responding to these issues is case of repeated problems.

The SCPT agent must be installed on hardware devices run on usual OSs (Linux, Windows, MacOS...). If the OS does not support the SCPT agent, the synchronization must be made via a BiaTime® B or C.

BiaTime® B

Biatime® B is a time dissemination system combining hardware, digital electronics and embedded computing.

It is linked, via an Internet or private network, to the UTC source time broadcasting unit and provides a synchronization service up to 0.1 certified second.

Traceability is possible for any piece of hardware connected to the system, and 2 types of certificates are offered:

- **SCPT full class B certificate**
- **Full Extend class B certificate**

The full extend certificate authenticates that the clock is periodically updated on the hardware piece having acquired time thanks to Biatime® B. For this to be possible, an SCPT agent must have been installed on that piece of hardware.

BiaTime® B is a physical time server that can easily be installed at the heart of small IT systems, offices or networks.

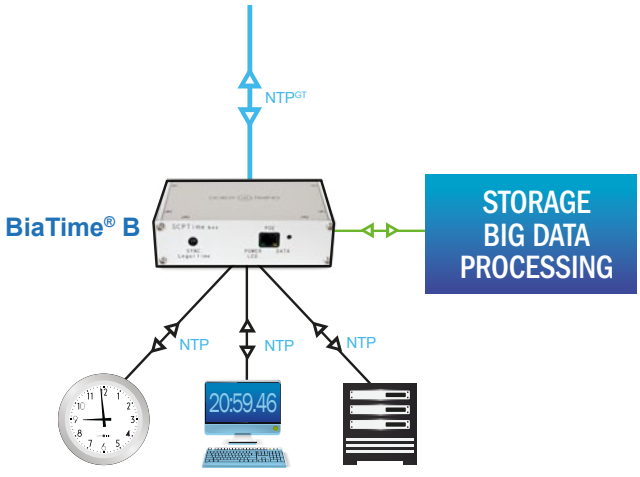
Its design and its very compact aluminum box offer a high protection against man-made noise.

BiaTime® B operate with a TCXO-type oscillator of an accuracy to a hundredth of a second, which helps ensuring a 0.1-second accuracy, even in Hold over mode, in case the connection with the regional server is impossible for 12 hours in Guarantee mode or 2 days in Degraded mode.

Its pared-down architecture hosts a vigilance system so that logical inputs and outputs passing through a single physical access can be monitored.

Dialogues with hardware is made through NTP protocol, that can be completed with a downloaded SCPTime® agent.

The certification process consists in analyzing synchronization logs periodically stored in the client database, and the analysis results can be accessed via the Time Synchro dashboard.



BiaTime® B is designed for small networks or parts of decentralized networks, where around twenty hardware devices are networked: solicitors, lawyers, insurance companies, businesses, administrations, schools, hospitals...

BiaTime® C

BiaTime® C is a time dissemination system combining hardware, digital electronics and embedded computing.

It is linked, via an Internet or private network, to the UTC source time broadcasting unit and provides a synchronization service up to 0.001 certified second.

Traceability is possible for any piece of hardware that is connected to the system, and 2 types of certificates are offered:

- **SCPT full class C certificate**
- **Full Extend class C certificate**

The full extend certificate authenticates that the clock is periodically updated on the hardware piece having acquired time thanks to Biatime® C. For this to be possible, an SCPT agent must have been installed on that piece of hardware.

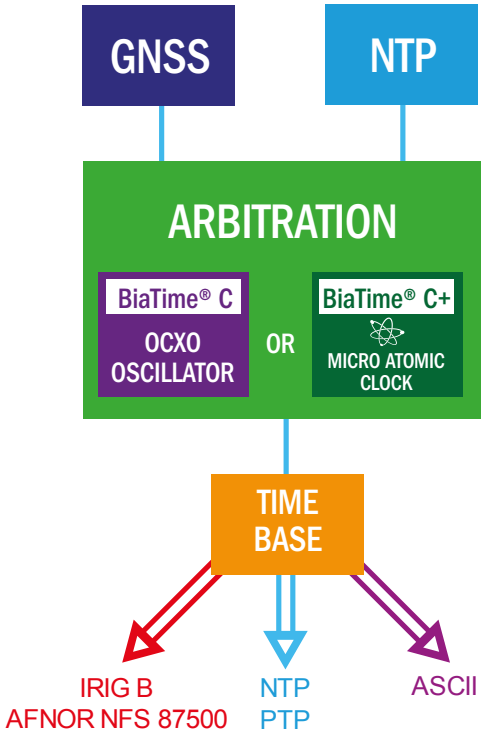
Thanks to **BiaTime® C**, it is possible to obtain a time that is secured, certified and traced from its UTC source, to periodically synchronize IT hardware using a bidirectional dialogue with acknowledgment of safe receipt.

BiaTime® C must be installed at the heart of IT systems. It is in the form of a 19”1U rack and offers a UTC accuracy to a thousandth of a second.

It has 2 physical inputs and permanently compares both external sources with an internal reference. Monitoring is done through an arbitration software capable of validating time and switching the **BiaTime®** in Hold over mode if a contradiction is detected. In Hold over mode, its OCXO quartz-based internal clock ensures synchronization reference time provision and guarantees a UTC accuracy to a thousandth of a second during up to 3 days.

For a long-term stability in Hold over mode, a **BiaTime® C+** version is offered, with an atomic micro-clock the Hold over mode of which can maintain a UTC accuracy to a thousandth of a second for up to 30 days.

BiaTime® C and BiaTime® C+



La BiaTime® C is aimed at time systems: big businesses, administrations, banks, rescue centers, rail transport, Radio/TV...

BiaTime® D

BiaTime® D is time broadcasting system combining hardware, digital electronics and embedded computing that assures users that:

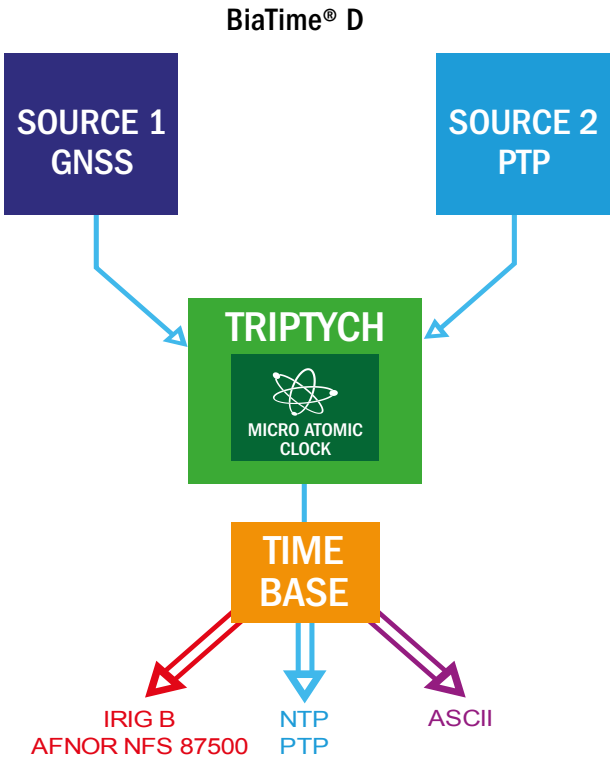
- **a UTC accuracy to a microsecond is guaranteed thanks to the Triptych technologies**
- **the synchronization autonomy complies with UTC thanks to reference atomic clocks**
- **the used time is monitored**
- **the time data of all the devices connected to the BiaTime D is traced**
- **a full class D certificate**

BiaTime® D is a cutting-edge time server that operates at a scale of a few nanoseconds. The delivered time's accuracy to the microsecond is guaranteed. It embeds a cesium atomic micro-clock that can operate under harsh temperature conditions ranging from -25°C to +70°C.

It has 2 physical inputs. The Triptych system continuously compares both external sources and the internal time source (atomic micro-clock). **This system has been patented by GORGY TIMING** and can deliver time data within less than 10 nanoseconds.

BiaTime® D has a Hold over autonomy thanks to which an accuracy to the microsecond can be guaranteed for 48 hours, as well as the possibility to work in Degraded mode (100 microseconds) for 10 days.

Le **BiaTime® D** is designed for infrastructures needing to operate with a microsecond granularity, such as High-frequency trading platforms regulated by the European directive MiFID II. Other examples of applications include hardware in need of a reference time of few microseconds: managing switches in energy, telecommunication networks (5G) and cybersecurity.



BiaTime® D is designed for time systems: trading rooms (high-frequency trading), area control centers, military markets, metrology labs...

ACQUISITION AND STORAGE

Time acquisition SCPTime®

SCPTime® delivers a complete traceability of time production (UTC source), distribution and broadcasting.

SCPTime® is fully compatible with the methods usually used to update hardware clocks. The SCPT agent can be downloaded to ease this updating process (called Acquisition).

This Agent is compatible with most of the OSs (Linux, Windows, MacOS...) and is available in native mode (deployment in progress) on proprietary OSs. For instance, Schneider Electric's Edge Box TM, GORGY TIMING's **SCPTime®** regional servers and SNCF's future technical equipment).

The Agent ensures the certification can be extended to the synchronization process run on hardware devices. The **SCPT Agent** indicates the time spectrum in its synchronization query, and its compliance level can thus be checked for each synchronization.

The SCPT Agent also provides synchronization frequencies and other features which vary according to the developer.

Operation storage

The system is based on an operation platform which can drive all the **SCPTime®** elements, and particularly supervision, storage and certification for companies having subscribed to **SCPTime®**.

The platform also issues authorizations to download **SCPTime®** and hosts Customer service.

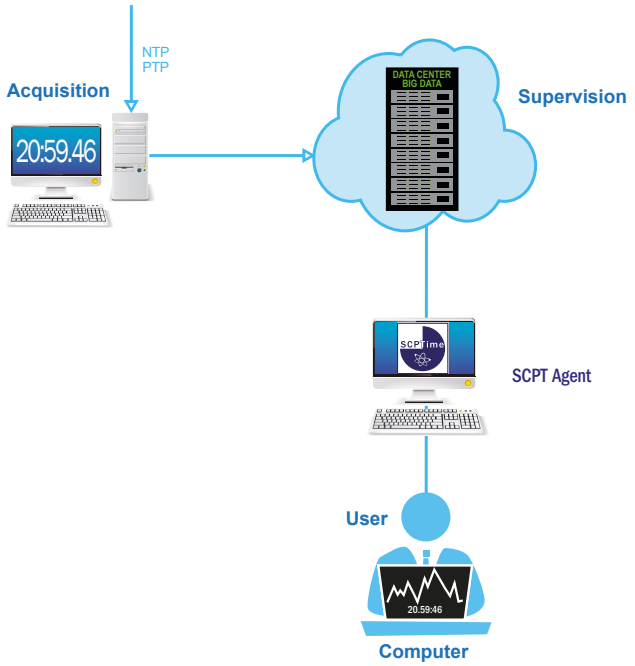
There are 2 levels of operation. One consists in ensuring time flow security and optimization and the other focuses on operational analysis. Action proposals are escalated to the first system and the analysis is used to validate the certification part.

Tailored supervision

To ease operations, all the synchronization transactions are stored in a BigData-type NOSQL system.

SCPT datanalysers highlight compliance with good synchronization practices according to professional rules, as well as laws and regulations (for instance MiFID II).

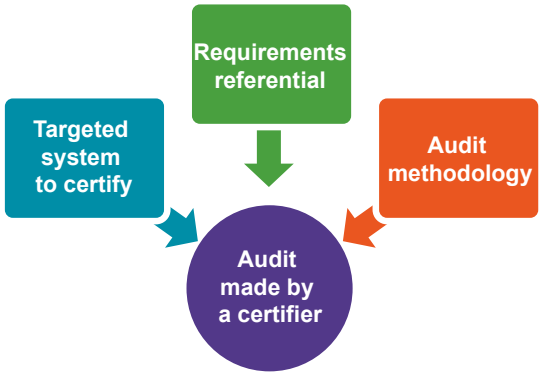
Each customer can view information in a dashboard according to 2 lines: the professional line, where compliance is highlighted, and the client line, which focuses on the operational state of the **SCPTime®** system.



CERTIFICATION

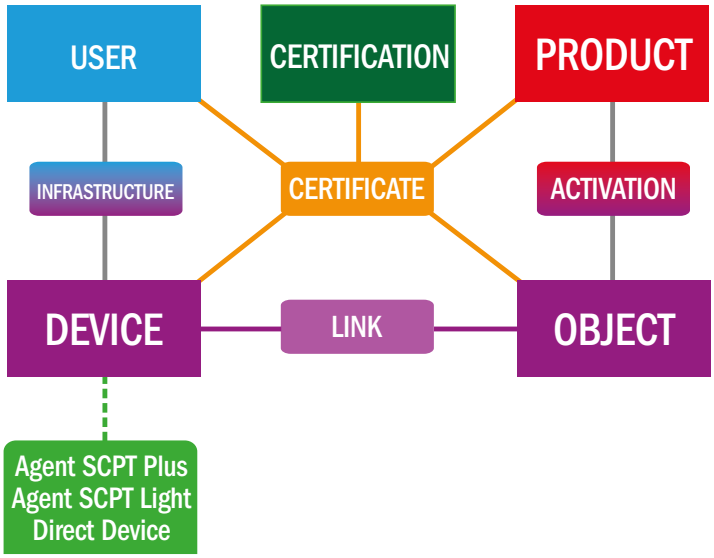
SCPTime® guarantees total cybersecurity and traceability of the time path, delivering certificates of compliance to the European time reference.

Compliance certificates for servers and software used, and for service provided are needed to obtain a certificate issued by an accredited body (LNE, for instance).



Source SealWeb

To deal with this complexity, the operation flows must be monitored through the following relational database:



For the final user, constraints are very much reduced as **SCPTime®** facilitates the certification process, supporting the complexity demanded by cybersecurity (see the recommendations of the French national agency for IT system security, ANSSI).

Users fulfilling the criteria of **SCPTime®** use can obtain various certificates according to the desired level of precision ("accuracy class"), to synchronization frequency ("level of compliance"), to the rate qualifying for a clock update ("success rate") and to the SCPT agent use ("extend").

This European certification is a proactive tool for legal protection such as "anticlaim management" or "Nachtragsmanagement".

INSDUSTRIES' REQUIREMENTS

SCPTime® complies with current standards:

- Law: connection to a UTC reference time.
- Security: bidirectional time, traceable up to the final user.
- Accuracy: certified precision that varies according to professional specificities, ranging from the subsecond to a few nanoseconds.
- Technology: cybersecurity element.

Prevailing feature, according to the target

	Law	Security	Accuracy	Technology
Industry	●●●	●●●	●●	●●●●
Transport	●●●	●●●●	●●	●●●
Banking	●●●●	●●●●	●●●●	●●●
Energy	●●	●●●●	●●●●	●●●
Army	●●	●●●●	●●●●	●●●●
Administration	●●●●	●●●●	●	●●
Emergency relief	●●●●	●●●	●●	●●
Insurance	●●●●	●●●	●●	●
Solicitor notary	●●●●	●●●	●●	●
Justice	●●●●	●●●	●	●
Monitoring	●●●●	●●●	●●	●●
School	●●	●●	●●	●
Hospital	●●●●	●●●	●●	●●●●
Private individual	●●●	●●●	●	●

SCPTime® SUBSCRIPTION

Features	Criteria	BiaTime®A Subscription	BiaTime®B Subscription	BiaTime®C Subscription	BiaTime®D Subscription
Synchronization	Internet NTP[GT]	✔	✔	✘	✘
	Direct link NTP[GT]	✘	✘	✔	✘
	PTP/SyncE/WR	✘	✘	✘	✔
Security	Warning	✔	✔	✔	✔
	Data authenticity	✔	✔	✔	✔
	Hold-over	✘	✔	✔	✔
	Arbitration	✘	✘	✔	✘
	Triptych	✘	✘	✔	✔
Certification	Legal time source	✔	✔	✔	✔
	Availability guarantee	✔	✔	✔	✔
	BiaTime®B Box	✘	✔	✘	✘
	BiaTime®C server	✘	✘	✔	✘
	BiaTime®D Grandmaster	✘	✘	✘	✔
Accuracy	Guaranteed second	✔	✘	✘	✘
	Guaranteed 0.1 second	✘	✔	✘	✘
	Guaranteed millisecond	✘	✘	✔	✘
	Guaranteed microsecond	✘	✘	✘	✔

Type	Synchronisation	Security	Certification	Accuracy
BiaTime®A Subscription	Internet NTP[GT]	Alert + Authenticity of data	Legal time source + Guaranteed service availability	Guaranteed second
BiaTime®B box Subscription	Internet NTP[GT]	Alert + Authenticity of data + Hold-over	Legal time source + BiaTime®B box + Guaranteed service availability	Guaranteed 0.1 second
BiaTime®C server Subscription	Direct link NTP[GT]	Alert + Authenticity of data + Hold-over + Arbitration	Legal time source + BiaTime®C server + Guaranteed service availability	Guaranteed millisecond
BiaTime®D Grandmaster Subscription	PTP/SyncE/WR	Alert + Authenticity of data + Hold-over + Triptych	Legal time source + BiaTime®D Grandmaster + Guaranteed service availability	Guaranteed microsecond

05

PARTNERS

SCPTime® is an ambitious collaborative project supported by bpifrance (PSPC) aiming at building a French Time/Frequency industrial chain.
This Minalogic-Grenoble labelled, innovative and international project was approved by the steering committee of Programme des Investissements d'Avenir (program for future investments) and was signed by the French Prime Minister on June 2nd, 2014.

SCPTime® is a project gathering French experts in Time/Frequency:

SCIENTIFIC LABORATORIES

femto-st SCIENCES & TECHNOLOGIES
LNE-LTFB
OSU THETA
UFC UNIVERSITÉ DE FRANCHE-COMTÉ
LNE Le progrès, une passion à partager
l'Observatoire de Paris – SYRTE Systèmes de Référence Temps-Espace
Institut UTINAM

PRIVILEDGED PARTNERS

Business & Decision
Schneider Electric
SNCF

INDUSTRIAL PARTNERS

GORGY TIMING LA MARQUE DU TEMPS
Syrlinks
tronics microsystems
eolas groupe Business & Decision
TYLEOS CONSULTANTS
µQUANS

SUPPORT PARTNERS

bpifrance SERVIR L'AVENIR
MINALOGIC
Liberté • Égalité • Fraternité RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE

TEAM LEADER

GORGY TIMING LA MARQUE DU TEMPS

The FEMTO-ST Institute (Electronic, thermic and optical mechanical Franche-Comté) is a mixed research unit in association with the CNRS (UMR6174 CNRS-ENSMM-UFC-UTBM). They federate all sciences of mechanic, optic, automatic, time/ frequency, energetic and microsystems and nanoscience in a multidisciplinary approach. It is necessary for significant progress in the micro-technics fields. Today the Institute employs around 750 people and is structured in 7 departments. FEMTO-ST has an important micro-technology platform (MIMENTO) with 865m² of clean rooms with high technological equipment for academic and industrial partners. These are part of the national network RENATCH of the big technological centers. The Laboratory manages the LabeX ACTION (http://www.labex-action.fr/) on intelligent systems and is a partner of the LabeX FIRST-TF (http://first-tf.fr/), federating the French Time/ Frequency community and working on the miniature and compact atomic clocks. FEMTO-ST also supports the EquipeX OCS-IMP which is a metrology platform for the characterization of the short term frequency stability and phase noise of sources from the RF range to optic. Finally, FEMTO-ST is a partner of the REFIMEVE project (http://www.refimeve.fr/) which aims to gather Time/ Frequency French and European laboratories and then, ensure the signals transfer from the best atomic standards by optical fiber. The Time/ Frequency department of FEMTO-ST is involved in the LNE-LTFB, renown as a secondary laboratory of the LNE. FEMTO-ST attaches importance to industrial transfer and valorization.

The 2 involved teams in SCPTime® are:

TEAM OSCILLATOR-CLOCK-METROLOGY AND SYSTEMS (OHMS), DPT. TF.

Recent striking facts of this team are the development of a sapphire cryogenic oscillator delivered to the ESA and placed on a ground-station in Argentina for the monitoring of spatial probes, the contribution to the micro atomic clock project, and the development of highly stable lasers close to the international state-of-the-art.

Group microsystems Opto-electro-mechanical (MOEMS), Dpt. MN2S.

The MOEMS group focuses its work on the miniaturization of complex optical systems like optical microscopes, physical modules for micro atomic clocks. They also work on Silicon production technologies and the development of innovative micro optical components and micro actuators.

(http://projects.femto-st.fr/MOEMS-Group/fr).

Competencies of FEMTO-ST concern essentially the microcell technology, optic, the Time/ Frequency metrology and the atomic physic.

Contribution of FEMTO-ST to SCPTime®

Today, FEMTO-ST has more than 10 years of common experience in the field of Cesium steam micro atomic clocks CPT and remains identified as the European leader. The combination of expertise and long collaboration of the two teams of FEMTO-ST is a strength for the **SCPTime®** consortium in the development of a cesium micro atomic clock.

Christophe GORECKI
Research director at CNRS, FEMTO-ST.
Local SCPTime® Coordinator

l'Observatoire de Paris | SYRTE

Systèmes de Référence Temps-Espace

Located in the Paris Observatory, **the SYRTE (Time-Space Reference System)** is a mixed research unit (UMR 8630) of the CNRS, the Paris Observatory, and the University Pierre & Marie Curie (Paris 6), with the LNE as an administrative supervising partner. The SYRTE also is a department of the Paris Observatory.

Combining fundamental/ applicative research and scientific services, the SYRTE is now first in international ranking of multidisciplinary fields: Time/ Frequency metrology, atomic interferometry and inertial sensors, celestial reference systems, Earth rotation, science history. The laboratory promotes its research activity towards the socio-economic world and society: patent submission, industrial partnerships, public services missions, training, and knowledge transmission.

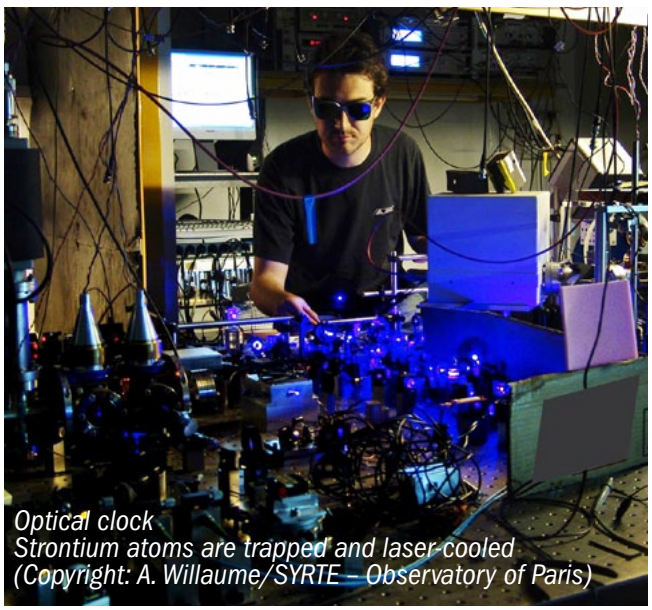
The SYRTE develops many metrological instruments take profits from the wavy characteristic of matter: highly stable clocks with cooled atoms among the best in the world, clocks for embedded systems (GALILEO, ISS…), inertial sensors (gyrometers, gravimeters, accelerometers) measuring rotation speeds or accelerations with an extreme precision. It also develops remote comparison methods through satellites of optical fiber in order to improve the construction, diffusion and atomic time scales connection.

Under the aegis of the LNE, the SYRTE is the National Metrology Laboratory in the Time/ Frequency field with the mission to improve and provide SI's units in this field. In this respect, it is in charge of the construction and the availability of the legal French time built from a UTC time scale made thanks to the cool atomic fountains of the laboratory (one of the best realization of the UTC International time scale reference. The SYRTE takes part in international collaborations in order to ensure the international equivalence to the French Metrology for the Mutual Recognition Arrangement (MRA). It also ensures the traceability of the first level in the standard chain towards users. The SYRTE is strongly involved in several operations of the "Investissements d'Avenir" program and manages the National Excellence Laboratory FIRST-TF on Time/Frequency metrology and its applications. It also copilots the laser physics laboratory of the metrology fiber network REFIMEVE+.

Contribution of SYRTE to SCPTime®

Contributions of the SYRTE to the **SCPTime®** project are made on different levels:

- **R&D activities:** characterization and improvement in the precision of techniques and time transfer protocols per optical fiber.
- **Know-how transfer to the industry:** cold atoms clock developed by Muquans from a SYRTE concept.
- **Service activity:** realization of the national time reference and providing of this reference to the SCPTime® system.



Optical clock
Strontium atoms are trapped and laser cooled
(Copyright: A. Willaume/SYRTE – Observatory of Paris)

LNE-LTFB

The Time/ Frequency laboratory of Besançon, the LTFB gathers means and competencies of two laboratories of the University of Franche-Comté, UTINAM and FEMTO-ST; created in 2008, it is also the heir of the Time/ Frequency laboratory of the old Besançon Observatory (currently the Theta Universe's Science Observatory). It currently employs 80 people including 20 researchers/ teacher researchers, 20 PhD students and 40 technicians, engineers and administrative employees.

Research

The LTFB ensures R&D activities through its two laboratories in different fields of Time/ Frequency:

- Cryogenic oscillators
- Optical clocks
- Micro atomic clock
- GNSS (GPS, GALILEO)
- Time and frequency transfer means
- Time and frequency transfer by optical fiber
- Theoretical studies, modelling/ characterization of oscillator stability

Time/ Frequency metrology

The LTFB fulfill several missions: elaboration, maintenance and diffusion of national and international time/ frequency references. It is done in a close collaboration with the SYRTE which ensures at a national level, the connection with the International Committee of Weights and Measures. In this case, the LTFB is associated by contract with the LNE as "designated institute" as given by the international metrology authorities (BIPM, EURAMET) to implement the national CMC (Calibration and Measurement Capabilities) for some of the metrology scales (frequency, time interval, phase noise).

These commitments require from the metrological mission to be accomplished with an ISO/ CEI 17025:2005 accreditation. The service also has to be ensured with the support of a self-financed quality engineer. This association with the LNE guarantees an international recognition for all metrological missions led by the LTFB. The metrological service works thanks to a team of ten people from both laboratories.

Infrastructure

The LTFB is based on two sites (the historical Observatory and the ENS2M site, an engineering school where the TF laboratory of FEMTO-ST is) a few hundred meters away.

Both sites are connected by optical fiber cables dedicated to it. They allow the sites to gather heavy equipment (hydrogen masers, Cesium standards, cryogenic oscillators).

2015-2020 perspectives

The LTFB has invested in 2011-2012 in three PIA (LabeX FIRST-TF, Equipex OscIMP, Equipex REFIMEVE) that have been successful. This exceptional success is a recognition of the excellence of work done by the time/ frequency community in Besançon within the LTFB.

Among all the proposed projects thanks to the success and increasing strength of the OscIMP platform, the SCPTime® project plans on building and making available a highly stable time reference that will be a replica of the national reference provided by the Paris Observatory UTC(OP).

The operational imperatives of such an achievement (its implications regarding the underlying technical infrastructure and the increase of the accreditation perimeter for the inclusion of these equipment and function) are the challenge to be taken for the department and the LTFB on the 2015-2020 period of time.

Contribution of the LTFB to SCPTime®

The LTFB also takes part in the definition and qualification of methods and time transfer protocols (common view GNSS, NTP, PTP, PTP White Rabbit)..

SCIENTIFIC LABORATORIES

From left to right :
Lommatzsch Thomas, Cayron Charles, Nouel Yannick.

The LNE, National Metrology Laboratory (Laboratoire National de métrologie et d'Essais), works on projects between science and industry. Created in 1901 as a test laboratory it has acquired expertise in fields related to security and quality of products (manufacturer, distributors, local authorities...) and in the research field especially in metrology.

The LNE is an EPIC (Public Organization with an industrial and commercial position) since 1978, under the control of the Ministry of the Industry. The LNE provides technical solutions to answer the needs of industrial manufacturers in order to ensure the compliance and quality of products on the market. As a major actor in metrology, it plays a key role in the measurement quality in fundamental, industrial or legal metrology. The LNE also an important activity in the fields of tests, training and standardization. To conclude, the LNE has more than hundred years of experience in tests and metrology with more than 800 employees (50% of engineers and Professors). Based in different locations in France, the LNE also has subsidiaries abroad (USA and Hong Kong).

In 2005, the French Government has given the LNE the head of the National Metrology Network (RNMF). It is a distributed system of 10 metrology laboratories including the Time and Frequency one: the LNE-SYRTE. The LNE represents France in the European (EURAMET) and international (Convention du mètre) institutions.

Contribution of the LNE to SCPTime®

The LNE intervenes within the **SCPTime®** consortium in order to create a referential of certification on solutions that will be offered. A certificate guarantees a high level of conformity regarding a referential to be trusted.

The certification of the **SCPTime®** project is crucial because it guarantees the good functioning of the developed system: meeting the requirements of the final customers is certified by a third and independent organization.

The referential will not be "exclusive", which means that any stakeholder meeting the requirements is entitled to aim for the **SCPTime®** certification.

The public certificate will include the general and technical requirements to ensure the user that the time delivered is:

- **Exact**: **SCPTime®** should give a precise time with a given uncertainty.
- **Traceable:** to be sure that the delivered time is linked to the UTC for timestamp applications.
- **Secured and monitored:** the referential will have to integrate requirements to prevent the system from being jammed or spoofed.

Several scenarios and certification levels are developed with, as a start, the delivering of a standard certificate: the device is tested and compared to the standard. Another certification level extends to the production process of the device to guarantee that each manufactured product meets the requirements of the referential.

PARTNERS IN USE
A public railway company, SNCF

Within the national railway transport system, the Public Railway Group (GPF) is composed, since January 1 2015, of 3 indivisible public organization: SNCF (control and strategic monitoring, economical coherence, industrial integration and social unity), SNCF Réseau (manager of the infrastructure of the national railway network) and SNCF Mobilité (exploiting of the railway transport service).

SNCF Reseau

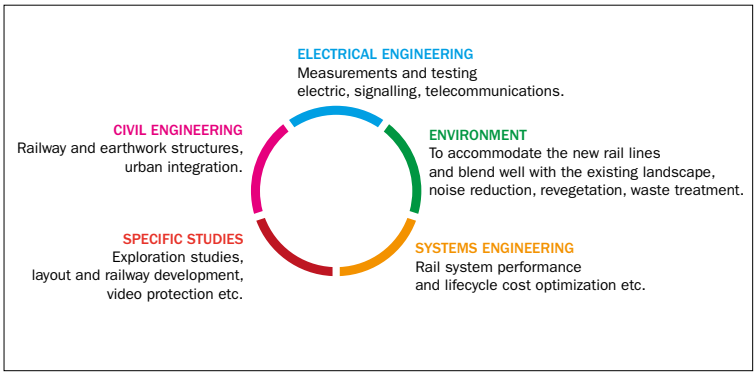
The ambition of SNCF Réseau is to reach a higher performance level and balance its finances before 2020. Its teams are spread throughout in France and work in concertation with the railway systems stakeholders. Common strategic objective: modernize the existing network in favor of daily train traffic.

SNCF réseau missions

- Maintain, modernize and commercialize the access to the railway network for all railway companies, travellers and goods.
- Guarantee the security and the performance of lines of the French network.
- Daily, contribute to the quality, regularity and comfort of the French railway service.

To this end, the SNCF réseau pilots 2 strategic plans:

- A wide plan of modernization demanded by the French Government (more than 2.5 billion € and 1.000 work sites per year).
- The innovation and maintenance security program, Vigirail (deployment of new technologies for the network monitoring).



The network in few figures

- 30.000km of lines, including 2.000 for high speed trains (800km more to be commissioned before 2017).
- 15.000 trains and 5 million travelers per day in 2015.
- More than 6 billion € turnover and 52.000 employees.
- More than 5 billion € invested for the modernization of the railway network in France.

The SNCF network is composed of 4 branches

- Maintenance & work: operational security, maintenance and renewal of the infrastructure.
- Engineering & projects: development, engineering, layout and improvement of the network.
- Access to the network: access to the national closed network infrastructure.
- Traffic: operational traffic management.

Engineering and projects (I&P) (main stakeholder of the SNCF for SCPTime®)

I&P takes part from the conception up to the providing of the railway infrastructure project.

It has a unique competence: its expertise in terms of system integration, makes it relevant to managing network development in maintenance and exploitation.

SCPTime® and SNCF Réseau

As a partner, the SNCF tests **SCPTime®** prototypes to ensure, confirm and certify time synchronization means in order to extend them on the whole French railway network. The challenge is to guarantee a synchronized time anywhere on the network for all connected devices such as points, encrypted telephony, and video-surveillance and events timestamping.

The SNCF uses a closed network and so, will have two quantum clocks as a source for all its applications. A regular calibration operation (every 2 years) will check its alignment on the UTC time. The memorization of all events in a Big Data system will allow for provision of an evidence report at any time.

This deployment for services such as electric traction, signing and SNCF network in general, is a real showcase of the contribution in cybersecurity for **SCPTime®**.

Schneider Electric is a worldwide European industrial group which produces and offers electricity management products, automatisms and suitable solutions to these fields.

The group was created in 1981 right after a change of field of Schneider and Co. created in 1836 (metalworking and steel industry).

Nowadays, SE has more than 160.000 employees and a 26.6 billion € turnover with 4.8% of it reinvested in R&D.

Schneider Electric representative in the SCPTime® project

Jorge ALVAREZ, innovation director of the industrial automative offers based in:
Site Horizon - 1ère avenue - 8 ème rue - Zone Industrielle
06516 Carros.

Role in the project: prototype of the different research results on selected fields linked to industrials infrastructures, especially automats.

Interest of the SCPTime® project for Schneider Electric

In tomorrow's uses of things, more and more spread geographically, we have to offer systems that can communicate over wide distances, for instance, to equip industries from a country or a continent with a production monitoring system.

In order to do so, our customers need to timestamp information from their source with a synchronized clock (certified in some cases for traceability in the production chain). Information feedback must be available and meet some special regulations to timestamp it from a certified and approved clock.

INDUSTRIAL STAKEHOLDERS AND SERVICES

GORGY TIMING

LA MARQUE DU TEMPS

GORGY TIMING is a French family SME created in 1974 by Maurice GORGY. It designs, manufactures and sells time distribution and synchronization solutions. With more than 40 years of experience we provide our customers with the best of our know-how and competences. Our company is located in La Mure, near Grenoble. In a 3 500m² industrial building, GORGY TIMING covers all activities including R&D, Design, sales for France and export, production, finance and customer service. Its dedicated to SCPTime® R&D department is located in Europole near the train station in Grenoble and its technological ecosystem.

The values of our eponym brand are passed down from generation to generation. We implement all we can to build lasting and close relationships with our customers and partners to perpetuate their investments.

GORGY TIMING **leader of SCPTime®**

GORGY TIMING was nominated as team leader of the innovative project SCPTime® in 2014, assigned by the French Prime Minister with the General commission of the "Investissement d'Avenir" (Investment in the future) and supported by BPIFrance (the French public investment fund). The ambition of this project is to distribute a highly secured and traceable UTC international legal time in the digital economy where precision is essential.

Since the company's creation, innovation has been written in its DNA. For GORGY TIMING, what matters is not knowing what is going on, but rather looking further ahead and anticipating what could happen in its environment.

Its strong involvement in the French Time/Frequency industry network and technological ecosystem in Grenoble, brings an innovative dynamic within GORGY TIMING. It allows experience exchanges with University laboratories, engineering schools and big companies.

Thanks to its strong international presence since its creation, GORGY TIMING makes more than half its turnover abroad. Commercial and technical teams in the company speak 7 languages and our documentations are edited in French, English, German, Spanish, Chinese, Russian and Polish.

The company is certified ISO 9001 and ISO 14001. GORGY TIMING products lean on several international patents and meet the requirements of international standards including the MIL STD (military standard) and the NATO code Fa2xo.

GORGY TIMING is a partner of the Time/Frequency LABEX FIRST.

from the left to the right: Nicolas, Monique, Amandine and Maurice GORGY.

Muquans is a high technology French SME created in 2011. Established in Talence, in Aquitaine, Muquans is specialized in very high performance instrumentation, and is the first company in the world to exploit on an industrial scale, the quantum physics related to laser atoms cooling. Muquans, designs, produces and sells several scientific instruments based on disruptive technologies:

- **An absolute quantum gravimeter,** capable of measuring gravity with a stability and relative exactitude close to 10^{-9} for the geophysics markets.
- **A very high performance atomic clock**, offering a long term stability and a relative exactitude in the range of 10^{-15} that will be for different applications in time/ frequency metrology and high performance synchronization.

The company also proposes an entire range of very high performance laser systems:

- Scientific lasers offering unique performances and functionalities in terms of spectral attributes control dedicated to different scientific applications.
- Different technological components for high performances frequency transfer network through optical fiber.

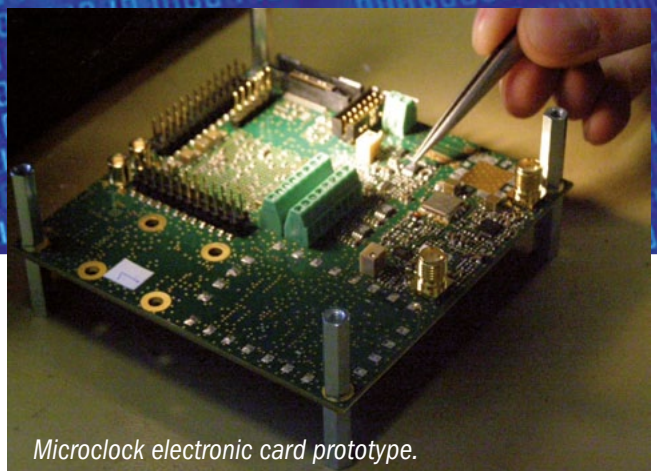
Muquans uses research led over 15 years by two laboratories of the CNRS (SYRTE and LP2N in the optical institute). This company was created by three people: Arnaud Landragin and Philippe Bouyer, research directors at the CNRS acting as scientific counsellors, and Bruno Desruelles, CEO of Muquans, who has extensive experience in the high technology industry. Muquans is active in more than 20 countries in the world and has several patents.

Contribution of Muquans to SCPTime®

Within the SCPTime® consortium, Muquans is an industrial producer.

Our atomic clock (Muclock) is a very high performance frequency reference which allows to create a time unit locally (a second) while guaranteeing a long term exactitude and stability to unique high performances on the market. The Muclock clock represents a time reference dedicated to meet the most critical timestamping requirements. The Muclock provides a local time scale ensuring a secured, certified and traceable time.

This solution has been chosen by the consortium SCPTime® for the creation of the time transfer network primary clock.


Microclock electronic card prototype.

Syrlinks has been created in June 2011 by 4 managers of TES Electronic Solutions. Syrlinks is an independent SME with a capital of 1.000.000€ whose headquarter is located in Cesson-Sévigné (near Rennes). The activity of the company comes from the SOREP Company, created in 1978 and that became Thales Microelectronics in 2000 and then TES in December 2004. Its historical core activity already was to design, develop and produce components and radiofrequency and hyper frequency modules for spatial, defense and security applications.

Nowdays to reply to the growth of new markets, Syrlinks had developed new product ranges. Its multidisciplinary R&D department and its laboratory facilities help it to take on complex projects and to reduce production times.

Syrlinks, designs the architecture and develops the equipment that meets the specific requirements of its customers in terms of studies and production. In parallel, it also sells a range of its own products for the fields of application below:

Time/ Frequency

- OCXO (Oven Controlled Wtal Oscillators) and VCO (Voltage Controlled Oscillator)
- Hardened frequency synthesizer
- Micro atomic clocks.

Radiofrequency communication

- Satellite embedded communication products in low orbit: X band transmitter, transceiver telemetry/telecommand in S band, L band transmitter.
- Development of RF/hyper frequency under-function and high efficiency amplifiers

Geolocation/ navigation

- GNSS receiver software for spatial applications.
- Cospas-Sarsat & Argos beacon.

Syrlinks solutions associate technology and reliability to aim at optimizing performance and the equipment integration level to be deployed in severe environments. 55 people work in this new structure. They cover all the necessary techniques needed for the development of spatial and defense products: quality, electronics, microelectronics, radio and hyper frequency, embedded software, numerical treatment of signal, mechanical. A laboratory of 350m² dedicated to the development of the equipment, their integration and then their production (in small series). Otherwise, Syrlinks has developed an ASIC for ultra-miniature distress beacons, and an ASIC for a temperature controlled quartz oscillator.

Contribution of Syrlinks to SCPTime®

Armed with an expertise in the Time/Frequency industry, Syrlinks has committed to the SCPTime® consortium in order to imagine and produce a micro atomic clock.

A true time keeper into the security facet of the architecture of SCPTime®, this clock will guarantee the good functioning of the system in case of GNSS signal failure. To develop this clock, Syrlinks will associate its software and hardware embedded electronic engineers and its quality and mechanical engineers. Syrlinks will integrate in its design, the subassembly of Tronics which is also an SCPTime® partner.


Guy Richard, CEO of Syrlinks.

tronics microsystems

Tronics Microsystems is a recognized technology leader in the field of added-value MEMS (microelectromechanical systems acting as sensors and/or actuators).

The company targets markets that grow rapidly thanks to the increasing miniaturization of electronic systems and provides tailored or serial products for various industries, such as aeronautics, security, medical and industry (network synchronization, for instance).

Tronics was founded in 1997 and is located in Crolles, near Grenoble (France) and in Dallas, Texas (USA). It employs around 100 people, mostly engineers and scientists.

Following a tender offer in January 2017, EPCOS AG, a TDK Group company, now holds a 74% interest in Tronics. Tronics is a division of TDK's "Temperature & Pressure Sensors" Group.

On the Crolles site, Tronics has been developing technological bricks that are at the heart of the miniature atomic clock. Tronics has also implemented a technology enabling the production of atomic cesium vapor cells in its cleanroom.

Tronics' contribution to SCPTime®

Within the SCPTime® project, Tronics designs and assembles on its back-end line complete physical modules that integrate the cell, as well as other elements required for the clocks' operation (see Figure 1).

To respond to network synchronization applications or to other applications in GPS-denied environments, Tronics plans to provide, in the medium term, a complete, tested physical module which guarantees for an entire day a stability to a microsecond, within a space of less than 0.06 in3 (1 m3) and a consumption below 50 mW.

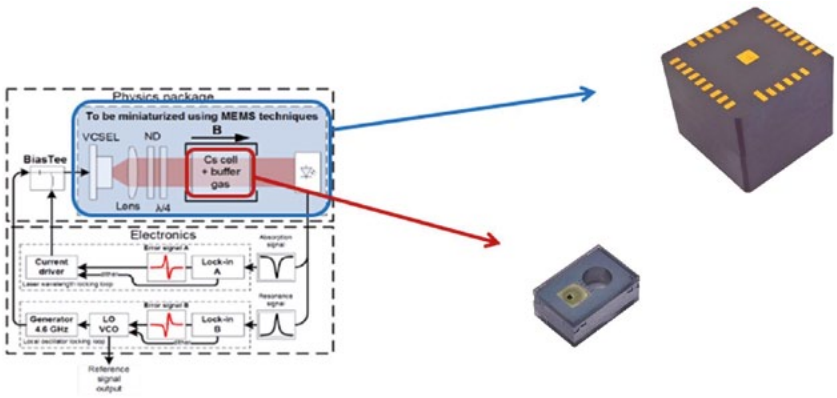


Figure 1: thanks to the MEMS technology, a high level of miniaturization is possible so that all the elements required for their operation can be embedded in clocks: the picture shows the clock's schematic structure, the box containing the physical module (0.59x0.59x0.51 in), and the microfabricated cesium cell (0.15x0.23x0.1 in).

EOLAS, the digital requirement, eolas.fr

Eolas guides its customers in today's digital world. Eolas replies to this digital requirement thanks to its web competencies. Web provider, designer and application developer, webmarketers, these different crafts have developed and grown, building strong expertise in the provision of online operating services. With its unique methodologies (BUILD and RUN), Eolas brings a strong value support.

Eolas was created in 1991 in Grenoble by Gérald Dulac and has offered its first web services in 1995. In 2015, Eolas had more than 4.500 clients, 144 employees and a turnover of 12 million €. Eolas has been part of the international Business & Decision group since 2001 in areas of consulting and system integration, leader of the business intelligence and of CRM, a major stakeholder of the E-business. (businessdecision.fr).

Eolas is also part of the Grenoble ecosystem and has a strong experience in shared R&D projects: research projects (8% of the turnover) led in association with universities and industries have brought the development of new innovative functionalities about open data, real time web, IoT, intuitive researches, automatic recommendations...

Eolas' expertise is used in the public and private sectors especially in distribution.

A responsible company, Eolas has created one of the first green data centers in Europe. Its conception and exploitation are are the result of the work of world experts in cloud computing, energy management, automatism and cooling management. It has been chosen to host the exchange node of the internet traffic (GIX) GrenobIIX, which guarantees extremely low waiting times with connected operators. Moreover, it benefits from interconnections with other datacenters, helping Eolas to offer its customers a lasting and efficient PRA/ PCA multi datacenter architecture that is coupled with an existing SLA.

Contribution of Eolas to SCPTime®

Eolas takes part in the SCPTime® consortium in three main areas:

- **Design and operate the SCPTime® online web service**. It aims at ensuring managed quality services to the future users of SCPTime®. Eolas developed the Subscription-Support-Reporting channel of the Service Level Agreement (SLA) and the time flow reporting. The system will be available for public and private uses.

- **Bring a digital experience.** Eolas shares its expertise in internet network infrastructures in e-business and in online user services. Eolas uses its most recent digital knowledge in developed programs in shared research (Energetic, CtrlGreen, Datalyse) oriented towards IoT, automatization of autonomous systems, real time big data, data visualization, open data and temporal joint data base.

- **Test and develop the use of a sure time within datacenters.** Eolas tests SCPTime® in its datacenters. There are several objectives : use and distribute a sure time and ensure high availability while creating a dating process for any use. The importance of this is key : to use a reference time in an information system and to have a dating service which allows the use of temporal joint tools.

"Embrace innovation"

Our core activity is ordered around the link between development strategy and innovation that are two faces of the same medal for Tyleos: the medal of competitiveness in the current world.

Our implication lays on our know-how, from ideas detection and qualification until effective market launch, through an approach that aims at transforming an idea into a product strategy, to develop it in project mode (to reach quickly and efficiently the objectives while restricting the weight of change management).

Tyleos mainly operates within the following areas:

- Development strategy with an unconventional approach, focused on three priorities 1 - the product, 2 - the product – yes, the product twice-, and 3 - the organization
  - 1 - The product as seen from inside the company (production, R&D, sales, marketing, communication, ...)
  - 2 - The product as seen from outside the company (customers, providers, journalists, e-reputation...).
  - 3 - The organization seen as the main lever to optimize different flows.
- Information systems, using "Tyleos concept" of information production, distribution and consumption, that is particularly fitting to the digital transformation.
- Great collaborative projects, thanks to Tyleos' dynamic and anticipative project management approach, along with it collaborative effort.

Tyleos and SCPTime®

The collaborative project **SCPTime®** represents the emergence, the development and the innovation in terms of "techno-market". The initial idea of Maurice Gorgy in 2012: "we must monitor GPS" has first, been perceived almost like a April fool's day, and created more misunderstandings than support except in the experts small world.

A plausibility analysis has been conducted, to define a **product strategy** aimed at including efficiently time in the digital economy. Tyleos, which of course already was included in the discussions, has been in charge of managing **the project** from a technical and financial point of view. It also included the search of ad-hoc and high level partners (industries and universities).

Then Tyleos has been commissioned by the consortium to accompany the project stakeholders and so, has established its own **project management** and **collaborative animation** methods that help to reach the collective objectives in the best possible conditions, and also one partner regarding its own objectives.

At this time, **SCPTime®** sharpens its product/market approach in the aim of a mature **market**. Already, it has been proved that the market demand is real and important. It is even growing stronger due to the European regulations on the digital economy practices. The Consortium is now ready on the market (the ultimate judge) and will now confirm and valorize the innovation given by the very relevant idea of Maurice GORGY.

So now... it's Market Time... and Tyleos is ready for primetime and the "Big Day"...

GORGY TIMING

LA MARQUE DU TEMPS

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afaq ISO 14001 Environnement AFNOR CERTIFICATION

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GORGY TIMING® SAS au capital de 1 109 067 €
SIRET 351 239 363 00028 - NAF 2652 Z - VAT Nr FR 20 351 239 363 - GORGY TIMING® RC 74 B 38

05/2017 - WHITE PAPER SECURED TIME SYNCHRONIZATION-V1.1