Timing & Synchronisation (T&S)

GNSS applications

- **Telecommunication applications**: Telco operators require accurate and consistent time and frequency at distant points of their networks to face increasingly demanding broadband requirements.
  - **Digital Cellular Network (DCN)**: GNSS is used to provide consistent frequency and time alignment between all base stations within the network.
  - **Public Switched Telephone Network (PSTN)**: GNSS is usually a back-up to atomic clocks to provide Time slot management.
  - **Professional Mobile Radio (PMR)**: GNSS is used for synchronisation of timeslots and handovers between base stations.
  - **Satellite Communication (SATCOM)**: GNSS is typically used in Satellite Control Stations and Telecommunications Gateways, mostly for frequency control.
  - **Small cells**: GNSS can be used to provide frequency and phase alignment.

- **Energy applications**: Energy operators require an accurate time source to monitor the energy flow of their networks.
  - **Phasor Measurement Units**: GNSS is used to provide a precise timing marker at nodal points of the networks to ensure its monitoring and protection against failure.

- **Finance applications**: Financial institutions are legally committed to trace operations with a consistent and accurate time scale.
  - **Banks**: GNSS is used for time stamping functions, to log events in a chronological manner and therefore be able to recreate causal links.
  - **Stock Exchanges**: Stock Exchange servers apply time stamps to the trades they execute and to the quotes they establish, GNSS having a key role in this.

What you can read in this chapter

- **Key trends**: GNSS Timing capability is at the core of most vital infrastructures.
- **User perspective**: GNSS helps to offer a wide variety of benefits to end users.
- **Industry**: List of main players by value chain segments.
- **Recent developments**: New legislation expected to boost GNSS device shipments.
- **Future market evolution**: Resilience and improved robustness will be pivotal for future networks.
- **Focus on European GNSS**: EGNSS bringing resilience to Critical Infrastructure.
- **Reference charts**: Annual evolution of GNSS devices' installed base and revenues by application and region.

*Small Cells synchronisation* quantified in this edition of the GNSS Market Report Analysis extended to non-EU regions.
GNSS Timing capability is at the core of most vital infrastructures

Key Market Trends
- The Timing capability offered by satellite navigation systems is at the core of most vital infrastructures: telecom networks operation, energy distribution, financial transactions, TV broadcast are some examples of areas where GNSS is used for timing or synchronisation purposes.
- GNSS provides a unique offering to the T&S user communities by delivering a free, stable and very accurate time and frequency source available worldwide.
- Expansion of telecom networks (e.g. Small Cells, 4G) makes GNSS more and more essential, driving future shipments.
- The T&S community is facing many challenges linked to an increased need for resilience, reliability and security, supported by an evolution of the regulation.

GNSS has a long heritage in Timing & Synchronisation

A wealth of critical operations requires access to Timing and Synchronisation. This encompasses the telecom, energy and finance domains that are detailed in this chapter but also other applications such as oil pipeline networks, water distribution networks, railway and maritime transportation networks and Air Traffic Control Systems.

GNSS is widely used by the T&S community as it provides accurate, “low cost” and widely available timing services allowing time, phase and frequency network synchronisation. However, despite a long experience in GNSS, the T&S community is currently facing many challenges linked to an increased need for reliability and security: as detailed in the following page, cyberattacks on Critical Infrastructure are an increasing issue and GNSS is obviously subjected to these cybersecurity threats – in particular through jamming and spoofing. To limit the threats operators can rely on local oscillators which play an important role for handover in case of GNSS failure.

Other complementary T&S solutions exist or are being developed: they can be local such as Chip Scale Atomic Clocks (CSAC) or regional such as wide scale network time distribution and eLoran. These technologies have distinct modes of failures that are different from GNSS and provide back up or redundant sources of timing. Besides, protocols such as Precision Time Protocol (PTP), Network Time Protocol (NTP) or Inter-range instrumentation group time codes B (IRIG B) are also widely used in all segments for synchronisation. These protocols may rely on GNSS as Time source. In the case of PTP, clocks synchronisation can achieve sub-microsecond accuracy on a local area network.

Increased GNSS interest for Small Cells synchronisation

Small cells are low-powered radio access nodes that operate in licensed and unlicensed spectrum that have a range of several meters to 1 or 2 kilometres. Small Cell base stations can be deployed at street-level or within buildings and are key elements of the LTE deployment. Total Cost of Ownership (TCO) for Small Cells is very low (<1/10) compared to a Macro Cell base station. The Small Cells market is therefore growing very rapidly to support the need for greater coverage and increasing mobile broadband traffic.

LTE Small Cells networks synchronisation can rely on GNSS. This is a potentially promising GNSS market as the outdoor Small Cells market is expected to grow by 43% CAGR from now until 2020. As of 2015, around 10 mln Small Cells were deployed worldwide.

Telecom

In the telecom segment Satcom, DCN, PMR and PSTN rely on GNSS for phase and time alignments. Moreover, LTE Small Cells can also benefit from GNSS for frequency and phase alignment. Several other synchronisation solutions exist (e.g. PTP or SyncE) depending on several factors such as the class of Small Cell (pico, femto, micro), or whether the Small Cell is located indoors or outdoors.

Energy

Smart grid development is under way all over the world. Phasor Measurement Units (PMU) are pivotal to the development of Network Automatic Protection systems. PMU are deployed across remote locations of the power network (nodes) requiring a microsecond level of accuracy. The internal time references are currently based on GNSS receivers.

Finance

Precise synchronisation between financial platforms with wide geographic distribution is required in particular for High Frequency Trading. GNSS is already widely used in the finance domain. This trend should continue with the upcoming new regulatory frameworks that will require financial operators to achieve UTC traceability with microsecond Timestamp Resolution (EU - MiFID II Directive, Article 4).
GNSS helps to offer a wide variety of benefits to end users

Overview of the main user requirements in Timing & Synchronisation
The table depicts, in alphabetical order, the key user requirements as assessed through the GSA’s continuous monitoring with the user community. Only high priority requirements are shown, i.e. other requirements might also be relevant for considered applications, and the table is subject to updates. Information on the parameters is provided in Annex 2.

Resilience of Critical Infrastructure is an increased concern
At DEFCON 23 a low cost GNSS Software Define Radio (SDR) spoofer was presented. With very limited resources, non-GNSS specialists have successfully spoofed navigation signals. Moreover, the recent GPS timing anomaly (January 26th 2016) reinforced the need for integrity and redundancy of GPS Timing (see box on the right).

With the advent of new threats on GNSS and the increased importance of protecting critical infrastructures, resilience has become mandatory. Possible impacts of GNSS spoofing attacks and GPS disruptions are therefore taken very seriously at all levels, from network operators to GNSS equipment manufacturers and Critical Infrastructure policy makers. Solutions to mitigate these threats exist (e.g. use of local oscillators, complementary technologies or network architecture design). Moreover, thanks to its unique Open Service Navigation Message Authentication (OS NMA) and Commercial Service Authentication services, Galileo will provide authentication capabilities able to detect and parry spoofing attacks.

Following its Directive on the “Identification and designation of European critical infrastructures and the assessment of the need to improve their protection”, the European Commission has considered a new approach to the European Programme for Critical Infrastructure Protection. This new approach aims to combine some key terrestrial and space-borne European assets, including Galileo.

The European Union Agency for Network and Information Security (ENISA) is also deeply involved in these activities. In particular ENISA Work Programme 2016 includes activities on “Network and information security threats”.

Impact of the January 26th 2016 GPS anomaly
On the 26th of January 2016, timing users of the GPS system experienced issues after a number of GPS satellites broadcasted incorrect information regarding the offset between UTC and the GPS time. Some timing receivers experienced a 13 microsecond offset. Impact and duration experienced by T&S network operators were different depending on the network typology, back up solutions in place or even the location of the network.

For instance, the anomaly impacted the BBC digital audio broadcast system as adjacent transmitters interfered with each other. During this anomaly the time provided by EGNOS remained stable and properly synchronised to UTC.

Possible evolutions of user requirements with Telecom 5G
Digital Cellular Networks rely on GNSS for synchronisation of timeslots and for handover between base stations. In particular LTE requires around 1 microsecond of accuracy. The standardisation of the next generation of Telecom Networks (5G) is underway.

By 2020, 5G is expected to be a new paradigm in the Telecom industry. 5G will provide higher data rates and lower latency with new use cases such as Broadband access everywhere, augmented reality and “massive” M2M / IoT.

Even if not completely defined 5G might require even further synchronisation accuracy depending on the technology adopted. EGNSS should be able to contribute to meet these more demanding accuracy performances.
The Value chain considers the key global and European companies involved in the GNSS downstream activities.

* European based companies. The world region is referred to the headquarter of the company, the actual area of activity might be wider.

The European\(^1\) GNSS industry in the global arena

Three of the world’s top five GNSS timing device manufacturers are European owned and based (Spectracom, OscilloQuartz, Meinberg). These three companies represent more than 50% of the overall market share.

The top three electricity network infrastructure vendors are European owned and based (ABB, Siemens and Alstom) and two of the top three mobile telecoms infrastructure vendors are European owned and based (Ericsson and Nokia Siemens Networks).

Overall, Europe is a global leader in smart grids, keeping pace with China and the US on smart grid roll out – including some high profile pilots.

Together with North America, Europe is leading the financial industry.

\(^1\) In the market share analysis, Europe is defined as EU28 plus Norway and Switzerland.
RECENT DEVELOPMENTS

Timings and Synchronisation

RECENT DEVELOPMENTS

Telecom: a mature market at the edge of new opportunities

The GNSS T&S segment is mainly driven by the telecommunication sector, which represents around 90% of the overall GNSS device shipments. This applies to all regions as a result of the Macrocell LTE infrastructure upgrades with nationwide rollouts expected to be finalised in 2015/2016. Consequently, following a peak observed in 2016, shipments are expected to slightly decrease in 2017. However, LTE Small Cells rollouts and 5G investments are expected to revitalise shipments between 2018 and 2022. This will be particularly the case in Asia and North America with Middle East and Africa expected to install new telecom infrastructures.

Currently Small Cells are deployed primarily in regions facing network congestions. Driven by a significant demand in mobile broadcast, Asia-Pacific is therefore the most important market for GNSS Small Cells with approximately 40% of the share, followed by North America and Europe.

Energy and Finance contribute marginally but are critical

In the Energy segment, Asia and North America are ahead of Europe as regards the deployment of PMUs. This is particularly the case in China which has become the largest market in power transmission and distribution and has therefore been at the cutting edge of smart grids technology. USA has also been very active in synchrophasor deployment as a response to Energy challenges in the country. It is the result of significant R&D efforts supported by the US Department of Energy (DOE) over a decade.

The Finance industry is clearly driven by North America which represents nearly half of the market. Europe is also very active with new regulation expected to modify the overall landscape (see box on the right).

Change in finance regulation creates new opportunities

On the 15th of May 2014, the Directive 2014/65/EU on markets in financial instruments (MiFID II Directive) was adopted. The MiFID II will take effect from the 3rd of January 2018. To prepare its adoption the European Securities and Markets Authority (ESMA) issued a Regulatory Technical Standards RTS25 on clock synchronisation. Article 4 of RTS25 states that “Operators of trading venues and their members or participants shall establish a system of traceability to UTC.” The traceability requirement implies to justify how UTC is generated, which means for a financial operator to be able to prove how the time stamp has been created.

A built in-capability such as Galileo OS NMA could therefore be seen as an added value. Moreover, for the most stringent applications, the regulation requires that clocks should provide 100 microsecond accuracy from UTC and a granularity of the timestamp of 1 microsecond.

MiFID2 does not only impact European financial operators. It also applies to those who do not have a European presence but e.g. who trade on European venues and/or with European counterparties. All these operators will have to comply with MiFID II. Moreover, similar regulations from other countries (USA and Asian countries) are expected soon.
Resilience and improved robustness is pivotal for future networks

Overall **GNSS T&S shipments** are expected to **grow at a CAGR of 5.3% over 2017 – 2025**, driven by the **Telecom** market which will grow at 5.7% over this period. EU28 and North America should represent around 40% of the shipments in 2017 but Asia Pacific and Middle East should gain market share in the next decade. In terms of revenues, the T&S market could reach €1.2 bln in 2020 and then plateau up to 2025, benefiting from dynamic sales in telecom which will be limiting the effect of price erosion.

**5G could open new market opportunities in Telecoms**

Vertical market opportunities are expected for LTE, in particular in the transport and public safety/security markets which should boost shipments from 2020. The advent of **5G networks should reinforce this trend from 2020**, in particular in the Asia-Pacific region. The peak of 5G network rollouts is expected to occur between 2025 and 2030.

Moreover, **deployment of Small Cells** should have a clear impact on shipments. Small Cells shipments are expected to grow significantly between 2015 and 2025. The overall GNSS penetration should be adversely impacted by the Small Cells deployment: indeed GNSS penetration in Small Cells are expected to remain low compared to other synchronisation techniques such as PTP which are better fitted to indoor use cases.

In addition, from 2020, a slight decrease should be expected for PMR as a result of the convergence between LTE and PMR.

Finally no growth of the number of PSTN stations that would integrate GNSS should be expected over 2015 – 2025.

Energy and Finance are expected to witness continued growth

The finance segment is mature but a positive impact on sales is expected from forthcoming regulation (in particular MiFID II). America, Europe, Middle East & Asia Pacific are ready to get higher protection and could even accept to pay for more robust devices if they increase the security and hence provide a benefit for their operation.

The smart grids deployment is expected to contribute to development of the GNSS market worldwide. The deployment of PMUs in China and USA is already underway and should be growing faster than in EU. Similarly to the finance market, robustness will be key for the future market uptake.

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EGNSS bringing resilience to Critical Infrastructure

Galileo provides several key differentiators to the Timing and Synchronisation community, already with the declaration of Initial Services. In particular, Galileo will provide clear benefits to Critical Infrastructure operators thanks to its increased robustness against spoofing and an increased number of satellites facilitating integrity monitoring and ensuring improved availability.

Galileo’s authentication feature, available in the Open Service and in the Commercial Service, will provide resilience against spoofing. Used as a primary source of timing information or as a redundancy solution, Galileo will also improve the timing service availability, bringing another independent constellation and frequency agility to T&S operators.

**EGNOS**

The EGNOS system has been providing its own time service since March 2011. **EGNOS generates** its own time scale known as **ENT** (EGNOS Network Time). The ENT is obtained using information from atomic clocks that are deployed across Ranging Integrity Monitoring Stations (RIMS).

The EGNOS time is continuously cross-checked with UTC through the UTC time realisation of l’Observatoire de Paris, and the offset is transmitted to the user through the EGNOS navigation message (MT12). **EGNOS time information** can be obtained from GEO satellite or via the **EDAS service**, which allows users to access EGNOS data online in real time. EGNOS therefore offers a stable time service that is properly synchronised to UTC across all application domains, even during the recent GPS timing anomaly on January 26th 2016.

**Demetra Project: Demonstration of EGNSS services based on Time Reference Architecture**

**DEMETRA** aimed to demonstrate the feasibility of delivering early EGNSS timing services to end users by utilising an operational demonstrator and conducting tests with pilot applications. DEMETRA developed a prototype of a European time disseminator, based on EGNSS, validating the concept of “time as a service” and adding new or improved features like time certification, redundancy, resilience, integrity, and improved accuracy.

The nine developed services could become the basis for European timing standards, facilitating the independence from GPS for the timing of critical European infrastructure and fostering the dissemination of common standardised time services across Europe, based on EGNSS. The project has confirmed that the Finance, Energy and Telecom market sectors provide the greatest near-term commercial opportunity for the delivery of the timing services.

More information on: [https://www.demetratime.eu/](https://www.demetratime.eu/)