Timing & Synchronisation

WITH AN ANALYSIS OF GNSS USER TECHNOLOGY

GNSS MARKET REPORT

ISSUE 4

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European GNSS Agency

Timing & Synchronisation

GNSS applications

This chapter addresses the following areas of use:

- The **Telecommunications** sub-segment uses the GNSS timing function for handover between base stations in wireless communications, time slot management purposes and event logging.The applications analysed in this chapter are **SATCOM, Professional Mobile Radio (PMR)**, **Digital cellular network** and **Public Switched Telephone Network (PSTN)**.
- The **Energy** sub-segment, including power transmission, uses GNSS timing in systems providing frequent measurements relevant to the network status and to determine the location of faults along a transmission line. The application analysed in this chapter is the **Phasor Measurement Unit (PMU)**.
- The **Finance** sub-segment uses GNSS to timestamp financial transactions, allowing one to trace causal relationships and synchronize financial computer systems. The applications analysed in this chapter are **Banks** and **Stock Exchanges**.

Unlike the other segments, the following analysis covers **EU28+Norway only**.

In this chapter

- **Key trends:** GNSS is widely used for Timing & Synchronisation of critical networks.
- **Industry:** List of main players by value chain segment.
- **Future market evolution:** A market dominated by Telecom and benefiting from the roll out of networks.
- **User technology:** Manufacturers propose new capabilities to address the needs of 4G LTE network synchronisation.
- **Focus on European GNSS:** European GNSS can bring improved resilience to Timing & Sync operations.

GNSS is widely used for Timing & Synchronisation of critical networks

Key market trends

- Many Telecom and Energy networks rely on GNSS for synchronisation operations. GNSS is also used to timestamp financial transactions.
- Impact of Timing&Sync service disruption could potentially have serious consequences on the operation of Telecom, Energy and Finance networks.
- There is an emerging need for robust Timing & Synchronisation of these networks.

Key role of Timing and Synchronisation

Precise Time and Synchronisation (Timing&Sync) is crucial to a range of strategic activities. This is especially the case for **Critical Infrastructure** (CI), a system or asset essential for maintaining such vital societal functions as health, safety, security, economic and social well-being of people. GNSS is often used to provide this Timing & Sync service in CI.

GNSS for Timing & Synchronisation

GNSS can be used to provide both Timing & Synchronisation:

- **Timing:** GNSS provides direct and accurate access to Coordinated Universal Time (UTC).
- **Synchronisation:** Synchronisation between receivers at different locations can be established and maintained using GNSS reference time. In addition, a master clock synchronises itself using the time provided by GNSS, redistributing this time to the slave clocks disseminated within the systems.

NTP and PTP are protocols for clock synchronisation between computer systems. They can rely on GNSS as a time source.

User needs

Key stakeholders in Timing&Sync are telecommunication network operators, associations like ENTSO-E in Energy, and regulatory bodies (these are highly regulated markets).

The user needs related to Timing&Sync depend heavily on the application. The accuracy requirements start from low in finance transactions (order of milliseconds) to medium for Energy and most Telecom applications (order of microseconds), whereas Satcom services have high accuracy needs (order of nanoseconds).

There is an increasing interest in GNSS authentication and improved robustness to interference. In Energy, independence and continuity of service are also increasingly valuable. This is part of a global trend of a continuous security improvement.

GNSS role for Timing and Synchronisation applications

Telecom:

In Satellite Communication **(SATCOM)**, GNSS is used for TDMA (Time Division Multiple Access) timing on the satellite links and terrestrial links and NTP (Network Time Protocol) type services for IT/network/satellite monitoring/control.

In **Professional Mobile Radio (PMR)** and **Cellular Networks (Cellular)**, GNSS is used for the synchronisation of timeslots and for handovers between base stations.

In **Public Switched Telephone Networks (PSTN)**, GNSS is used as a backup in case timing information from atomic clocks is lost. GNSS reference time can be used for time of day, traffic timing and time slot management.

Many telecom networks employ local oscillators that enable service to be temporarily maintained in case of GNSS loss.

Energy:

Network automatic protection of systems (Wide Area Measurement Systems/ Wide Area Control Systems) are using **Phasor Measurements Units (PMUs)** as a source of Timing&Sync information for Network Monitoring (current use) and Automatic Protection (future use). Automatic Protection requires a high level of accuracy and redundancy at PMU level.

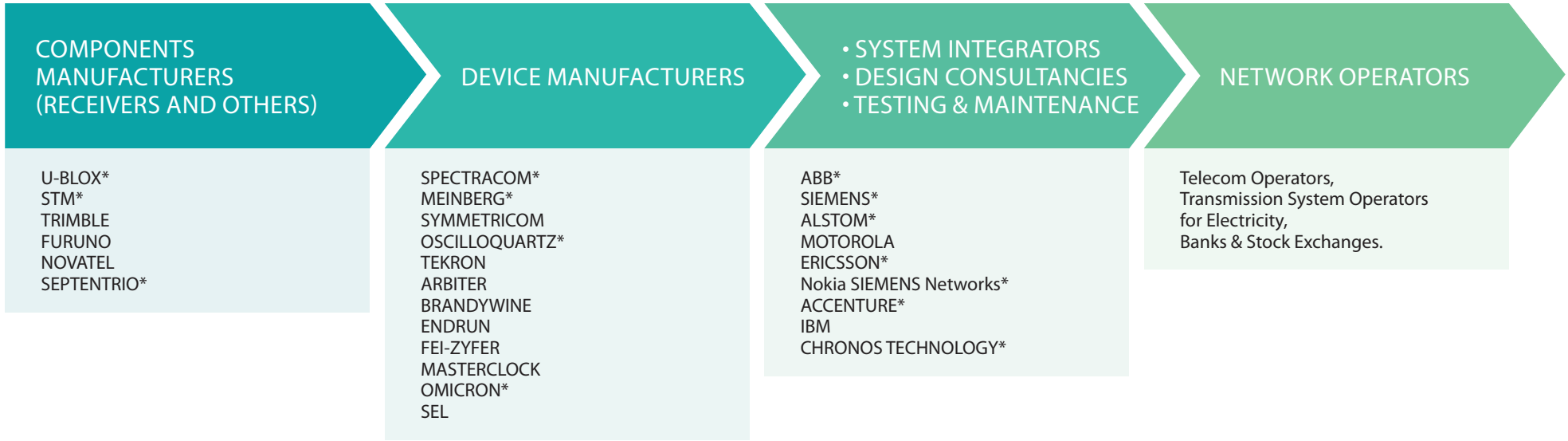
PMUs are deployed across remote locations of the power network (nodes), with internal time references currently based on GNSS receivers.

Finance:

Financial services rely on very powerful IT systems and networks requiring a high level of availability, security and reliability. GNSS is used for Synchronisation and Time Stamping functions to log events or quotes in a chronologic manner.

There is a widespread use of transfer protocols like NTP/PTP to distribute time (a NTP Primary Server can be connected to about 1500/2000 NTP clients).

Timing & Synchronisation Value Chain



The EU 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).

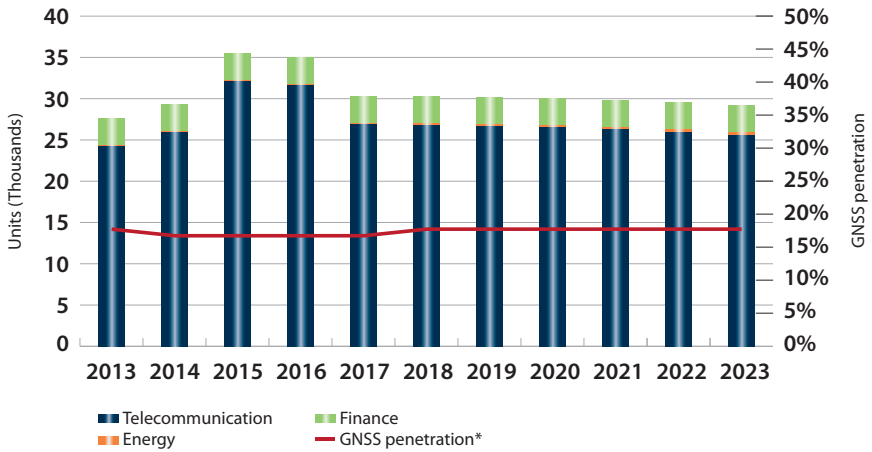
The top three electricity network infrastructure vendors are European owned and based (ABB, Siemens and Alstom) and two of the top three mobile telecoms infrastructure vendors are European owned and based (Ericsson and Nokia Siemens Networks).

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.

* European companies

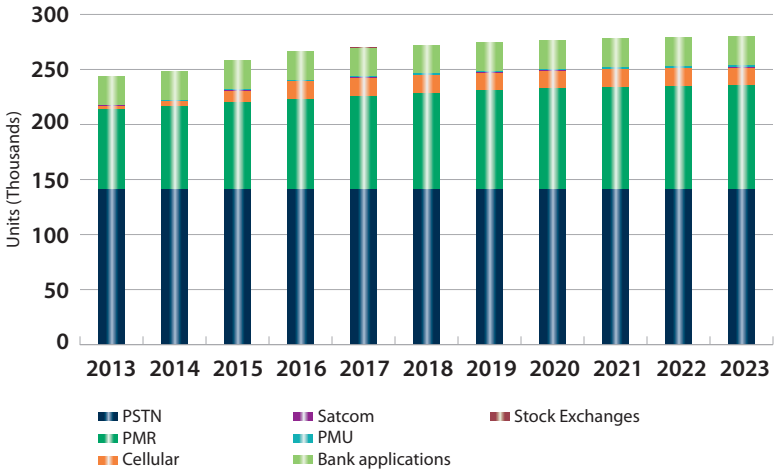
Value chain considers the key global and European companies involved in the GNSS dowstream activities. The presented value chain is global, unlike the rest of the analysis of this segment, which is for EU28+Norway only.

Shipments of GNSS devices by sub-segment



* GNSS penetration is the proportion of all potential users that are equipped with GNSS solutions

Installed base of GNSS devices by application



- Telecommunications expenditure currently accounts for ~3 % of GDP in the EU-28.
- Between 2002 and 2012, household electricity consumption rose in the EU-28 by 10%. Demand is expected to rise at around 1% p.a. until 2050.

The GNSS Timing&Synch segment is mainly driven by the **Telecommunication** sector, which represents around 90% of overall GNSS device shipments.
With the **upgrade of the Energy network**, GNSS penetration is expected to reach 10% in 2017 (compared to 18% of GNSS overall penetration). **GNSS Finance Timing&Sync** is a mature market, where PTP is increasingly considered with an on-going research aimed at optimising its robustness.

The GNSS installed base in the three segments (Telecom, Energy and Finance) in the EU28+Norway should reach 276,000 units in 2020, at which time it is expected to plateau.

Rapid growth is expected in **Mobile Cellular Networks** with investment in 4G, reaching a peak in 2015/2016. The digital Cellular Segment is the most dynamic for Timing&Sync due to the number of LTE base stations expected to be deployed in Europe and its increased dependency on accurate synchronisation (it evolves into LTE- Advanced). For **PMR**, the network infrastructure continues to grow and and along with it, so does GNSS stock. PSTN, PMR and SATCOM are all considered to be mature.

Even if a smaller market size is expected for the Energy sub-segment, an important network upgrade is foreseen in the coming years as use of **improved measurement and control systems (WAMS and WACS) is becoming widespread (smart grids)** with a CAGR(2017-2023) of the GNSS installed base around 15%.

Price of a GNSS timing device can range from €250 (standalone) to €10,000 (high end receivers). For Energy and Telecom, typical device prices are in the order of €3,000-€6,000

Manufacturers propose new capabilities to address the needs of 4G LTE network synchronisation

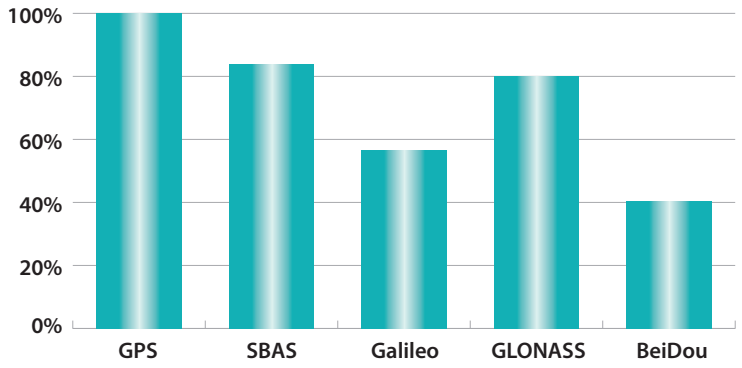
Telecom operators make up the majority of timing solution customers and, as such, are leading the way in the technological advancement. Although all available mobile networks (2G, 3G, 4G LTE) require reliable synchronisation tools, the advanced features of LTE challenge receiver manufacturers with ever greater precision requirements.

The use of **multiple constellations combined with holdover capabilities** helps to more efficiently synchronise networks by improving resilience and stability. A combination of GPS+GLONASS is proposed in around 30% of GNSS chipsets and modules that can be used in a timing environment or application (see the right chart below). Some higher end solutions include other constellations as well, up to four of them, working together with SBAS and other regional augmentations.*

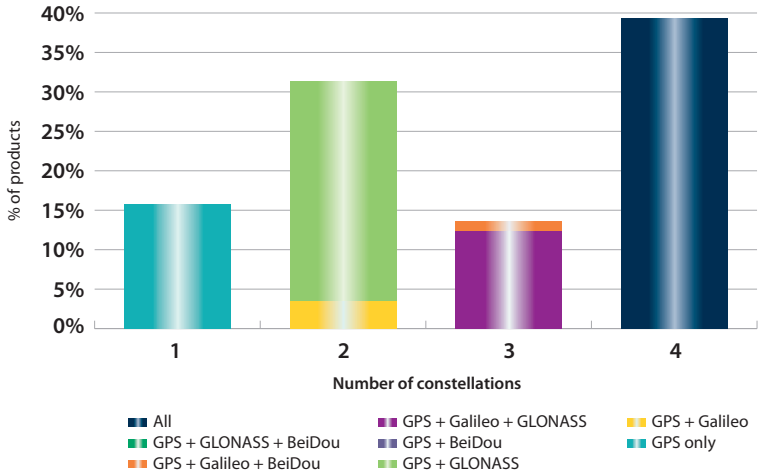
This trend is supported by the fact that manufacturers supplying the high precision segments, Surveying and Agriculture, expand also the multi-constellation capabilities of their timing product lines.

The core of each solution and the main price drivers are the oscillator and interfaces, with high end devices aiming to achieve **near atomic clock precision timing**. Such solutions are suitable for small cells, increasingly used by telecom operators to enhance network capacity and coverage. Infonetics forecasts the global small cell market to grow from a very small base now to $2.7 billion by 2017. Geographically, the same source expects Asia-Pacific to lead the small cell market, with 50% of all units shipped in 2013, followed by EMEA with 34% and North America with 14%.

Capability of GNSS receivers – Timing & Synchronisation segment

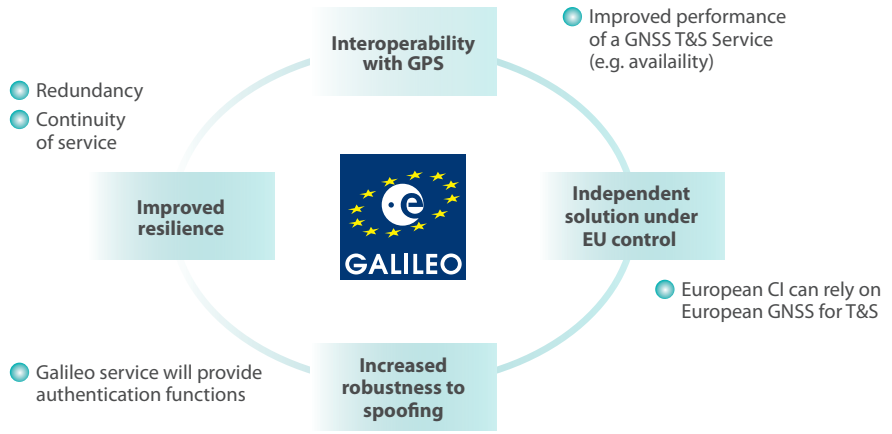


Supported constellations by receivers – Timing & Synchronisation segment



European GNSS can bring improved resilience to Timing & Sync operations

EGNSS differentiators



European EGNSS R&D Programmes support the competitiveness of the EU industry

DEMETRA is a H2020 funded project which aims to demonstrate the feasibility of delivering early EGNSS timing services to end users by utilising an operational demonstrator and conducting tests with pilot applications. An array of important service features that are necessary for a wide variety of users will be added, including high accuracy calibrated time transfer and a monitored and certified remote time stamping. Envisaged end users are telecoms, power transmission, banks, and TV broadcasting networks.

The proposed application will contribute to the independence for the timing of European critical infrastructure and fostering the dissemination of common standardised time services through Europe based on EGNSS.

The European Commission and Critical Infrastructure protection

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.

Interdependencies between critical infrastructures and industry/sectors are clearly recognized. As a result, the Commission will continue to develop the protection and resilience measures already in place while also looking to improve their utility.

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