GNSS applications

According to the distinction provided by IMO Resolution A.915(22), GNSS applications can be split into navigation and positioning:

**Navigation**
- **Sea**
  - SOLAS vessels: All passenger ships and cargo ships larger than 500 gross tonnage (300 tons for international voyages) are regulated and rely heavily on GNSS for navigation. At least three devices are typically fitted on vessels for redundancy reasons.
  - Non-SOLAS vessels: GNSS systems for maritime navigation are widespread across commercial and recreational vessels, both overseas and in high traffic areas.
- **Inland Waterways (IWW):** GNSS is also used to ensure safe navigation in inland waterways (rivers, canals, lakes and estuaries).

**Positioning**
- **Traffic management and surveillance:** These activities are supported by GNSS-based systems including AIS and LRIT.
- **Search and Rescue** is the search for and provision of aid to people in distress or danger. Different types of devices can make use of GNSS positioning:
  - In the frame of the Cospas-Sarsat programme, ship and person-registered beacons (i.e. EPIRBs and PLBs) transmit, once activated, the necessary information for rescue to authorities via satellite communication.
  - When activated, AIS-SART devices continuously transmit an alert message that includes GNSS-based location, which triggers an alarm on all AIS equipped vessels within VHF range.
- **Fishing vessel control:** GNSS positioning enables Vessel Monitoring Systems to check the position of fishing vessels, as well as the time spent in international and foreign waters, protected marine areas, etc.
- **Port operations:** Transit progress, docking and loading-unloading operations are monitored through GNSS-based technologies.
- **Marine engineering:** GNSS is used to support marine construction activities (e.g. cable and pipeline laying).

**In this chapter**
- **Key trends:** GNSS is a key enabler of navigation and positioning marine applications.
- **Industry:** List of main players by value chain segment.
- **Recent developments:** Recreational vessels account for an increasingly large share of GNSS shipments.
- **Future market evolution:** Search and Rescue beacons and recreational navigation will further drive GNSS growth.
- **User technology:** The added value of multi-GNSS receivers led the IMO to invest in the development of new performance standards.
- **Focus on European GNSS:** Accelerated process of IMO recognition in WWRNS will speed up the uptake of Galileo.
- **Reference charts:** Yearly evolution of GNSS devices’ installed base and revenues by segment and geographic area.

NEW! This issue of the GNSS Market Report includes three new applications: Recreational navigation, Search and Rescue PLBs and Fishing Vessels.

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1. IMO: International Maritime Organization
2. SOLAS: International Convention for the Safety of Life at Sea
3. AIS: Automatic Identification System
4. LRIT: Long-Range Identification and Tracking
5. EPIRBs: Emergency Position Indicating Radio Beacons
6. PLBs: Personal Location Beacons
7. AIS-SART: AIS Search and Rescue Transmitter
8. VHF: Very High Frequency
9. WWRNS: World-Wide Radionavigation System
Almost 5 million tonnes of fish are caught yearly by the 87,500 EU fishing vessels. 70% of the EU vessels belong to Greece, Italy, Spain, France, Croatia and the UK.

Starting in the 1970s, the European Commission progressively legislated fisheries and aquaculture, aiming to balance resources and exploitation. This set of legislation evolved into the EU common fisheries Policy (CFP), whose most recent reform took effect on 1 January 2014.

The EU maritime surveillance system now relies on a series of GNSS-enabled technologies for vessels detection and monitoring:

- The **Vessel Monitoring System (VMS)**, a satellite-based system providing data to fishery authorities at regular intervals on the location, course and speed of EU fishing vessels above 12m. Notably, non-EU vessels of the same size must have an operational satellite tracking device whenever they are in Community waters.

- The **automatic Identification System (aIS)** is an identification and monitoring system used for maritime safety and security (but also for control purposes), allowing vessels to electronically exchange identification data, position, course and speed. Since May 2014, it has been mandatory on vessels above 15m.

As a result of the regulation, 9,000 fishing vessels are now equipped with VMS devices in the EU, whereas 8,000 are fitted with AIS transceivers.

In the Maritime segment, GNSS is employed to satisfy the demand for **navigation** (in open sea or in specific situations, such as harbour entrances and approaches) and **positioning** (including, among others, vessel monitoring, traffic management, locator beacons for distress situations, etc.) of vessels and crews by different stakeholders.

The **e-Navigation** initiative of the IMO aims to enhance the safety and ease of navigation by integrating all navigational tools in an all-encompassing bridge system. As e-Navigation systems should be resilient, they can drive the uptake of multi-constellation GNSS.

The use of positioning in Maritime is widespread, with different categories of **vessels**, **beacons** and **ports** using GNSS for different purposes.

In the Maritime segment, GNSS is a key enabler of navigation and positioning marine applications

### Key market trends

- The market demand for positioning and navigation supports a wide range of GNSS applications, improving safety and productivity of maritime operations.
- GNSS-enabled solutions are increasingly used to monitor the operations of fishing vessels.
- GNSS is the preferred positioning technology for maritime Search and Rescue solutions.

### Key trends

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### Global number of vessels, beacons and ports

<table>
<thead>
<tr>
<th>Vessels</th>
<th>Merchant vessels</th>
<th>Fishing vessels</th>
<th>Recreational vessels</th>
<th>IWW vessels</th>
</tr>
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<tbody>
<tr>
<td>81,500 vessels</td>
<td>2.7 million</td>
<td>29.2 million</td>
<td>529,000 vessels</td>
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<table>
<thead>
<tr>
<th>Beacons</th>
<th>EPIRBs</th>
<th>PLBs</th>
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<tbody>
<tr>
<td>648 k beacons</td>
<td>580 k beacons</td>
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<table>
<thead>
<tr>
<th>Ports</th>
<th>Sea ports</th>
<th>Recreational marinas</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,289 sea ports</td>
<td></td>
<td>23,380 marinas (in 20 countries)</td>
</tr>
</tbody>
</table>

The end users in Maritime are ship masters, pilots and port authorities. The beneficiaries are a much wider category, including passengers, companies served by the maritime supply chain and through logistic applications, and consumers of sea products.

The user needs and performance requirements of GNSS solutions depend heavily on the applications, designed to satisfy needs of improved safety and productivity. In this sense, accuracy and integrity are key for navigating in restricted waters (e.g. port approach, inland waterways) as well as for positioning applications (e.g. manoeuvring, traffic management, Search and Rescue operations, marine engineering), as per IMO resolution A.915.

### GNSS and the control of fishing vessels in the EU

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Maritime Value Chain

**MARITIME ORGANISATIONS**

- **IMO** sets the standards for safety, security of shipping and pollution prevention.
- **IALA** is an international technical association harmonising aids to navigation.

**COMPONENTS MANUFACTURERS (RECEIVERS AND OTHERS)**

- FURUNO
- OROLIA*
- JAPAN RADIO CO HEXAGON (NOVATEL)*
- TRIMBLE
- RAKON
- SAMYUNG ENC LAIRD*

**SYSTEM INTEGRATORS**

- GARMIN LTD.
- KONGSBERG*
- NAVICO*
- JOHNSON OUTDOORS
- MITSUBISHI
- SAFRAN*
- FURUNO
- RAYMARINE

**SHIP OWNERS/ OPERATORS**

- MAERSK LINE*
- MSC*
- CMA CGM GROUP*
- EVERGREEN
- APL

**PORTS**

- Container Ports, Cruise/Ferry Terminals, Marinas.

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**The EU GNSS industry in the global arena**

European companies have a market share of 28% among components and receivers manufacturers, with the market being dominated by Asian players. The top three European companies are Orolia (including McMurdo), Hexagon and Laird.

Among system integrators, European companies have a strong presence with a 45% share of the market, compared to North America's 35% share. The top three European companies are Kongsberg, Navico and Safran.

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* European companies

Value chain considers the key global and European companies involved in the GNSS downstream activities.
The device market is dominated by market players in different applications

Maritime applications are very diverse and rely on various systems integrating different technologies for specific purposes. The large system integrators are specialised accordingly. Garmin focuses mainly on recreational navigation, Kongsberg provides high-tech professional solutions for merchant fleets and oil and gas applications, whereas Orolia favours Search & Rescue and vessel monitoring solutions. By contrast, Furuno, the largest receiver manufacturer, is active in most maritime applications, including recreational and merchant navigation and vessel monitoring.

Recreational vessels account for an increasingly large share of GNSS shipments

According to ICOMIA*, there are around 29 mln recreational vessels in use (defined as rigid hull boats longer than 2.5m and not man-powered), whereas other crafts, including fishing vessels, are estimated to be around 3.3 mln. This explains the relevance of GNSS shipments for recreational navigation, despite the fact that GNSS penetration is higher in merchant vessels than in recreational and fishing vessels (87% in merchant against 22% in recreational vessels and 8% in fishing vessels across all applications and globally). Average GNSS penetration is provided in the Maritime reference charts on page 55. North America accounts for the majority of shipments, which in 2013 was recorded at 715,000.

Aside from recreational navigation, Search & Rescue represents the most relevant market for GNSS. Since 2009, the shipments of Cospas-Sarsat GNSS-enabled emergency beacons (EPIRbs and PLBs) stabilised at around 80,000 units per year (c.a. 40,000 each). The main regional markets are Asia-Pacific and the EU28 for EPIRBs, and North America and Asia-Pacific for PLBs.

On fishing vessels, both Vessel Monitoring Systems (VMS) and Automatic Identification Systems (AIS) are used by national authorities to track and monitor the activities of their national fishing fleets. The largest regional market is China, where some 50,000 BeiDou enabled devices are used both for basic communication across the fleet and for monitoring the use of authorised fishing areas, and in particular in contested waters (e.g. Taiwan).

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Search and Rescue beacons and recreational navigation will drive further GNSS growth

In the coming years, recreational vessels will be responsible for the further growth of GNSS yearly shipments, which will almost double from 1.15 mln units in 2013 to 2.0 mln in 2023.

In recreational navigation, GNSS solutions are spreading quickly, as end users have a strong inclination towards technological aids to navigation tools and tend to exhibit robust spending power. Since skippers do not have to rely on mandated equipment, they also use non-professional handheld or portable navigation devices.

GNSS shipments for merchant navigation are expected to almost double in the next ten years, reaching some 50,000 units.

Considering the geographical distribution of GNSS devices and revenues, North America is expected to remain the most important region in installed GNSS devices for maritime applications, although Asia-Pacific is growing at a faster pace. The installed base of GNSS devices in Europe is expected to increase slowly but steadily (see Maritime reference charts on page 55). Overall, the GNSS penetration is expected to double over the next decade, from 20% to 40%.

GNSS is increasingly at the core of Search and Rescue solutions

Search & Rescue beacons used within the Cospas-Sarsat programme significantly contribute to saving human lives, thanks to their capability of transmitting distress messages with global coverage. It is estimated that Cospas-Sarsat provides assistance in saving six lives every day. In the coming years, both the EPIRBs and PLBs markets are foreseen to grow thanks to technology upgrades, improved operational efficiency, portability and durability. The role of GNSS in providing precise positioning information will be even more central as the penetration of GNSS in EPIRBs is foreseen to grow from 70% to 100% in 2020, whereas in PLBs it is already close to 100%.

In 2014 AIS SART devices gained popularity following the Clipper Round the World Yacht Race, where Andrew Taylor was successfully recovered by his crew thanks to his AIS SART beacon. As a result, shipment of devices have skyrocketed during the year (not yet included in the estimates of the market shipments). The market is evolving rapidly, with end users starting to ask for solutions that combine Cospas-Sarsat and AIS capabilities.
The added value of multi-GNSS receivers led the IMO to invest in developing new performance standards

GNSS has become the primary means of navigation in many Maritime applications. The International Maritime Organization (IMO) has set operational performance requirements for GNSS to be recognized as World-Wide Radio Navigation Systems (WWRNS). These requirements are used as a benchmark to assess the performance of the potential core systems and their augmentations. They are expressed in the maritime context in terms of accuracy, coverage, availability, continuity and integrity warnings.

The ability to concurrently receive GNSS and augmentation signals from multiple satellites belonging to different constellations allows receivers to have a higher probability of acquiring a greater number of satellites at any single point in time. Consequently, navigation performances will be greatly improved, enhancing the users' experience and increasing the possibility for GNSS receivers to meet IMO performance standards.

In order to ease the introduction of multi-GNSS receivers into the Maritime segment, the IMO “Maritime Safety Committee 90” introduced the need to develop new performance standards for navigation receivers. These new standards will enable full use of the availability, continuity and integrity, as well as increased accuracy, thanks to a combination of multi-constellation GNSS and terrestrial and augmentation systems. To this extent, the IMO “Sub-Committee on Safety of Navigation, Radio Communications and Search & Rescue” is charged with developing “Performance Standards For Multi-System Shipborne Navigation Receivers”. The status of the initiative is advanced and such standards are expected to be provided in the course of 2015.

Anticipating the provision of standards, the adoption of multi-constellation in user equipment has already started. The charts below show the penetration of SBAS and the four global GNSS systems in the current maritime GNSS devices’ offering. Around 75% of all devices have implemented at least two constellations (see chart on the right). The most popular system, after GPS, is GLONASS, supported by regulatory measures taken by the Russian Federation. Galileo and BeiDou are increasingly present, and more than 30% of receivers are capable of processing all constellations simultaneously.

* For the methodology applied to the charts please go to page 15 of the Report.
EGNOS is already supporting navigation and positioning applications, both in sea and inland waterways, complementing DGNSS infrastructure. Trials conducted by the European Commission demonstrated EGNOS compatibility with IMO requirements (i.e. accuracy requirements for coastal navigation and horizontal alert limit requirements for navigation areas outside ports) thanks to several tests at different sites.

The benefits of EGNOS are also leveraged in AIS SART beacons, where increased positioning accuracy and reliability can have a real impact on Search and Rescue operations. Finally, EGNOS corrections can be transmitted via AIS in harsh environments, thus contributing to increased safety and social benefits.

The inclusion of the unplanned item ‘Recognition of Galileo as a component of the WWRNS’ in the 2014-2015 biennial agenda of the MSC Committee of IMO is a major step for the adoption of Galileo in SOLAS regulated vessels. Galileo will guarantee the improved signal accuracy and availability required, in particular by positioning applications.

Furthermore, along with the Forward Link to transmit distress calls from beacons to Mission Controls Centers, Galileo will provide the unique Return Link Service within COSPAS-SARSAT, enabling it to inform the casualty of the reception of the distress message. It will thus be the only system providing a two-ways, end-to-end loop.

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

The COSMEmos project offers benefits for ship routing through cooperative satellite navigation
Marine weather forecasts are constrained by limited sea coverage: insufficient meteorological information raises safety concerns and entail additional economic and environmental costs, as weather conditions (waves and wind) can increase the fuel consumption of commercial ships by up to 12-13%.

The COSMEmos (COoperative Satellite navigation for MEteo-marine MOdelling and Services) project proved that this gap can be addressed by collecting and processing a large amount of weather data provided by ships while navigating. Outcomes of this R&D project include improved local weather simulations and forecasts and contribute to advanced weather routing and navigation assistance for both commercial and leisure vessels.

More information on http://www.cosmemos.eu

SpyGLASS integrates innovative technologies into Vessel Traffic Management Systems
The recurrence of illegal activities at sea - especially in the Mediterranean Sea – such as clandestine immigration, smuggling and trafficking, have made maritime surveillance a priority.

The SpyGLASS project aims to address this issue by developing a comprehensive solution based on passive bistatic radars (PBRs), installed on the coastline to detect signals transmitted by Galileo and reflected from targets (boats). By making use of the Galileo constellation, this compact and cost-effective system will provide enhanced open-sea monitoring with global coverage.