



GNSS MARKET REPORT

ISSUE 2

May 2012

GSA GNSS Market Report – Issue 2





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Methodology and sources of information

The present market report has been produced applying the GSA's* market monitoring and forecasting process. The underlying forecasting model is based on advanced econometric techniques. An extensive set of variables is used to model scenarios based on key assumptions. These assumptions are cross-checked through an iterative process involving renowned experts in each market segment. Additionally, a check is performed for each segment by comparing the model's results with the most recent market research reports from independent sources.

The model makes use of publicly available information including the following sources: Eurostat, US National Transportation Statistics, International Road Assessment Programme (iRAP), United Nations public information, International Telecommunication Union (ITU), Nations Online, GSM Association, Boeing, Airbus, Federal Aviation Administration, General Aviation Manufacturers Association (GAMA), Eurocontrol, the Food and Agriculture Organisation (FAO), FP7 project websites. The surveying chapter has been prepared in cooperation with CLGE.

Disclaimer

The information provided in this report is based on the GSA's best estimates and forecasts at the time of publication**. Although the GSA has taken utmost care in checking the reasonableness of assumptions and results with the support of industry experts, the GSA does not take any responsibility in the further use made of the content of this report.

Feedback and further information

We are looking forward to receive any comments and feedback. If you have any questions regarding this report, please contact the GSA via market@gsa.europa.eu

* **About the GSA:** The European GNSS Agency (GSA) is an agency of the European Union. One of its missions is to support the European Commission in promoting the market exploitation of EGNOS, keeping Europe at the forefront of the satellite navigation sector.

** **Previous reports:** In the past GSA has communicated various market forecasts through different channels including GSA's own website and conference presentations. The current publication is based on the latest and most comprehensive analyses and takes into account the most recent trends and the most recent information with respect to the Galileo deployment.

Market definitions

GNSS market

- ▶ The GNSS market is the market of products and services using GNSS based positioning and navigation as a significant enabler.
- ▶ When assessing the size of the market for multi-purpose products like smartphones, a correction factor is taken into account to reflect only the (retail) value of the parts related directly to positioning and navigation, for example:
 - ▶ **PND:** 100% of retail value since GNSS is the key enabler.
 - ▶ **GNSS-enabled smartphone:** for the core market, only the value of GNSS chipsets is counted. For the enabled market, the entire retail value of the smartphone is included.
 - ▶ **Subscription to a GNSS-enabled location based service:** 100% of retail value.
 - ▶ **Precision agriculture system:** only the retail value of the GNSS receivers, the maps and the navigation software is counted.
 - ▶ **Aviation:** only the value of the GNSS receiver inside the FMS system is taken into account.

Market segments

The following six segments have been selected for this report*:

- ▶ **Road:** PNDs and in-vehicle systems, supporting navigation and other ITS applications
- ▶ **LBS:** GNSS-enabled mobile phones and services
- ▶ **Aviation:** GNSS devices for commercial, regional, general and business aviation
- ▶ **Agriculture:** tractor guidance, Variable Rate Technology (VRT) and Automatic Steering
- ▶ **Maritime:** merchant fleet only and their GNSS applications in the open sea
- ▶ **Surveying:** land and hydrographic surveying

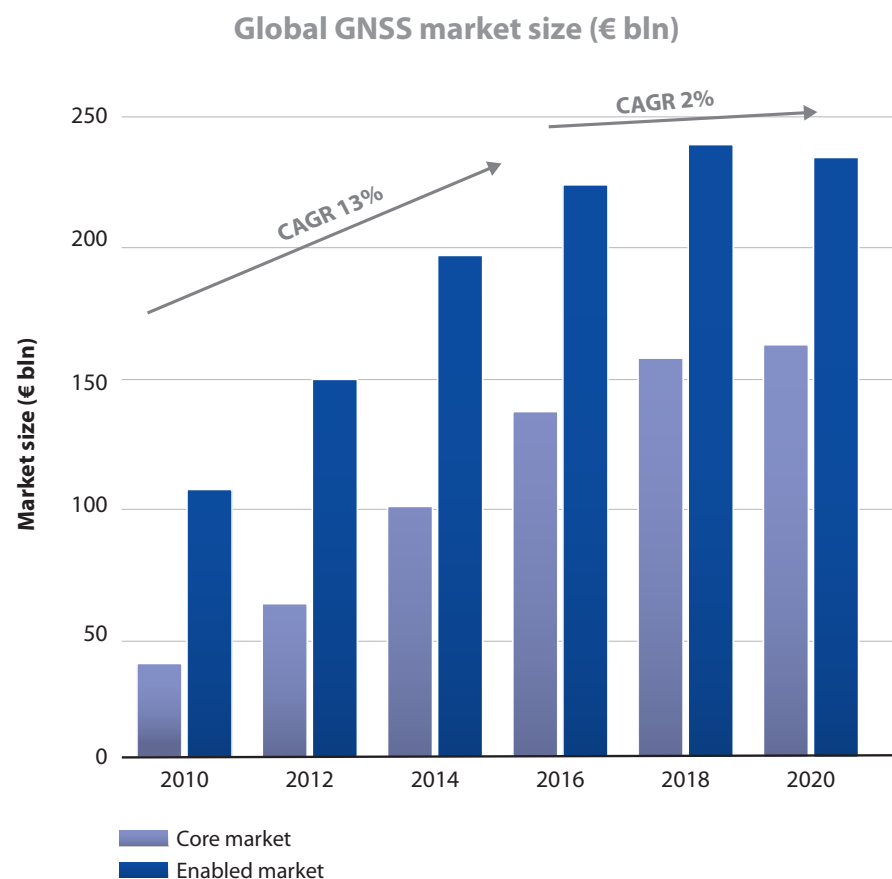
Global geographic coverage

- ▶ European Union (EU-27)
- ▶ North America (USA)
- ▶ Rest of the world (including non-EU European countries)



* rapidly growing interest in GNSS solution has been identified in rail segment. The segment is currently being analysed and will be added in the next issue of the GNSS market report.

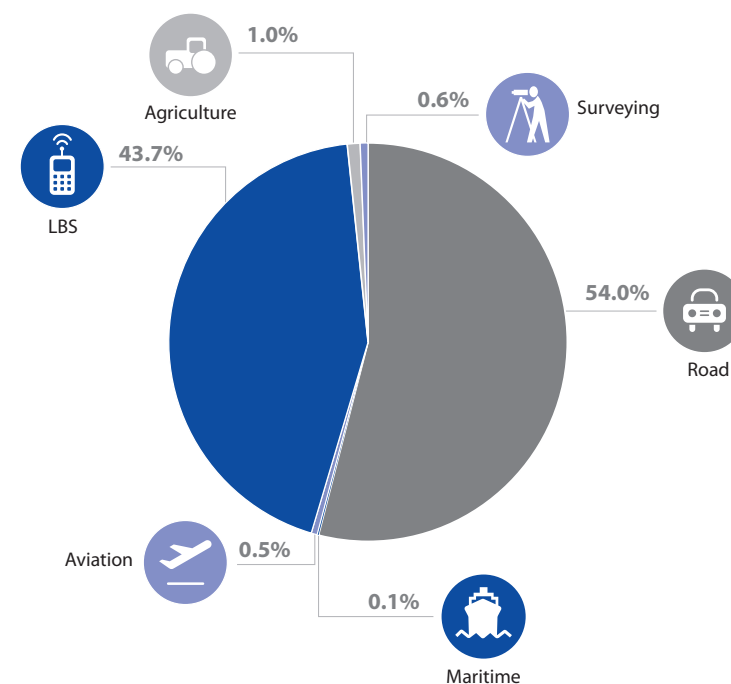
The enabled GNSS market will continue to grow rapidly for the next five years



Core GNSS market includes only the parts of products' retail value that are directly attributable to GNSS (1% in the case of GNSS enabled smartphones). It also includes service revenues directly attributable to GNSS.

The **enabled market** includes the Core GNSS market plus the full retail value of all GNSS-enabled platforms.

Global core GNSS market by segment
(cumulated revenues 2010-2020)



- ▶ The worldwide GNSS market is growing fast and total enabled revenues are expected to increase at 13% CAGR between 2010 and 2016.
- ▶ The total enabled GNSS market size is expected to stabilise in the latter half of this decade due to market saturation, price erosion and platform convergence.
- ▶ Road is the largest market by revenue, followed by LBS.

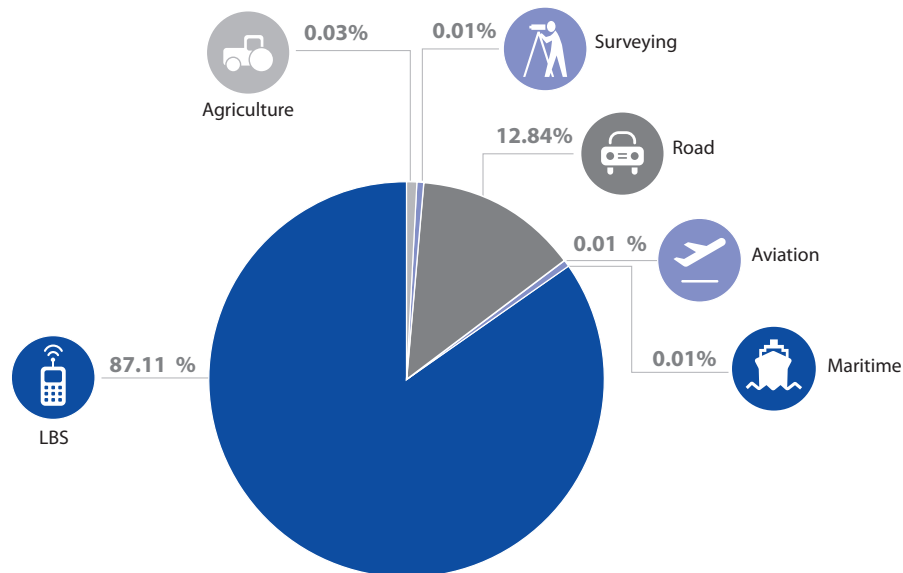
Global shipments will exceed 1 billion units before 2020, driven by growth in emerging economies

GNSS shipments worldwide will grow on average 10% per year over the next decade. Short term forecasts in some markets are depressed by global economic conditions.

For example, global car production grew slowly by 3.2% in 2011 following its recovery in 2010, returning to levels previously achieved in 2007*.

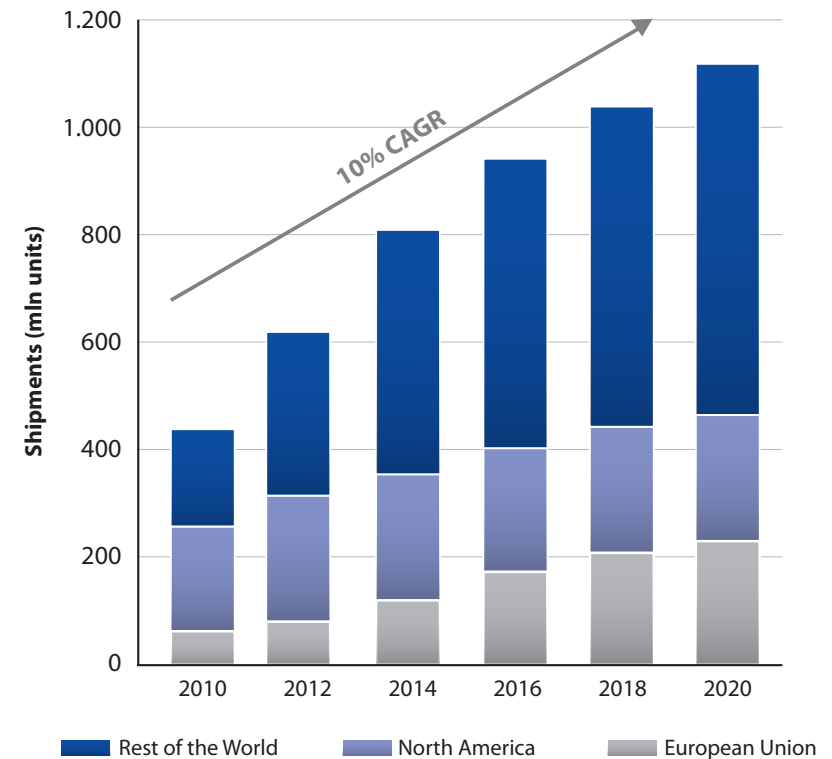
LBS and Road together account for over 99.9% of global shipments of GNSS enabled devices between 2010 and 2020.

Unit shipments of GNSS devices worldwide
(cumulative 2010-2020)



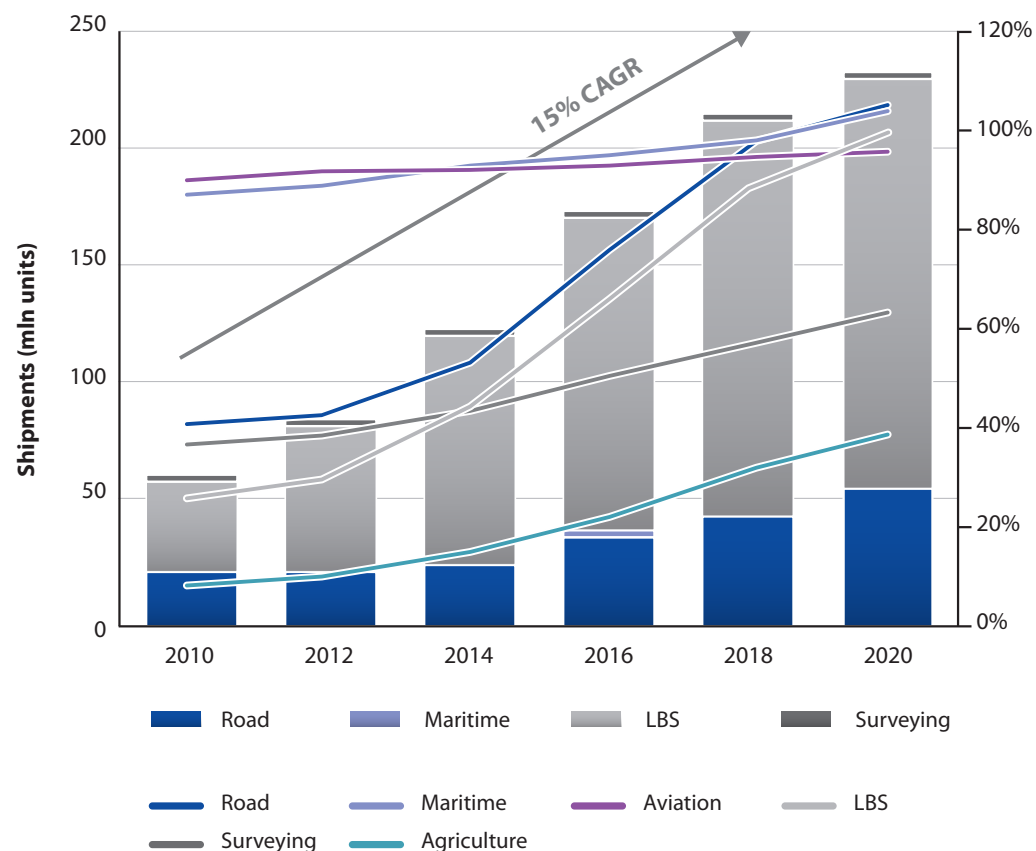
* Source - International Organization of Motor Vehicle Manufacturers.

Shipments of GNSS devices worldwide (mln units)



EU sales will reach 200 million GNSS devices by 2018, 20% of global shipments

EU shipments per annum (mln units) and EU GNSS penetration (%)



- ▶ GNSS enabled device sales in the EU will continue to increase over the next decade at a CAGR of 15%. This growth will be accompanied by a drop in prices.
- ▶ LBS handset sales make up the majority of shipments – approximately 170m in 2020 up from 38m in 2010. Over the same period, penetration will increase to nearly 100%.
- ▶ Road GNSS shipments are expected to reach over 50m by 2020. Penetration will grow from 34% to almost 100%.
- ▶ Aviation and maritime markets are already highly penetrated and are expected to reach close to 100% by 2020.
- ▶ Survey and agriculture markets are expected to grow steadily, reaching approximately 60% and 40% respectively by 2020.

Using EGNOS today



EGNOS is Europe's first venture into satellite navigation. It increases the accuracy of the GPS position and provides information on its reliability, making it suitable for safety-critical applications.

Consisting of three geostationary satellites and a network of ground stations, EGNOS achieves its aim by transmitting a signal containing information on the reliability and accuracy of the positioning signals sent out by GPS. It allows users in Europe and beyond to determine their position to within about 1 metre.

EGNOS, the first European SatNav system

- ▶ EGNOS has been operational since 2009 and free of charge
- ▶ Interoperable with other SBAS (Satellite Based Augmentation Systems) such as WAAS (US) and MSAS (Japan)
- ▶ The majority of devices on sale in 2012 include SBAS capability

Widespread availability of SBAS capable devices

- ▶ High level of SBAS penetration in professional markets and over 60% of automotive GNSS devices sold in 2012
- ▶ GPS corrections delivered via geostationary satellite, providing 1m horizontal accuracy
- ▶ Integrity message, providing additional confidence of position
- ▶ Corrections also delivered via IP and terrestrial communications in areas of reduced visibility

Already providing significant performance advantage for specific applications and operating environments

- ▶ Commercial and General Aviation
- ▶ High Precision Agriculture
- ▶ Recreational Maritime Vessels and Inland waterways
- ▶ Automotive Navigation
- ▶ Personal Location Based Services (LBS)
- ▶ GIS and Mapping

Preparing for leveraging Galileo and multiple constellations added value



Galileo will be Europe's own Global Navigation Satellite System (GNSS), providing highly accurate, guaranteed global positioning services under civilian control. It will be interoperable with the US GPS and the Russian GLONASS, two other global satellite navigation systems in operation.

Galileo will open up new and exciting prospects for economic growth. It will benefit citizens, businesses and governments throughout the EU and beyond.

Galileo, Europe's GNSS contribution

- ▶ An independent constellation of 30 satellites, wholly interoperable with GPS
- ▶ Initial Operating Capability (IOC) in 2015 to include a total of eighteen operational satellites
- ▶ Full constellation due to be operational by 2020

Galileo-ready devices already available

- ▶ Many GNSS receivers and chipsets provide support for multiple constellations and are 'Galileo ready'
- ▶ Alongside GPS, GLONASS and Compass, Galileo will provide significantly enhanced positioning availability and accuracy in urban environments
- ▶ Galileo offers dual frequency open service (OS) capability
- ▶ Restricted access to more advanced features via the Public Regulated Service (PRS) and Commercial Service (CS)

Galileo and multiple constellation added value will enable new applications, new markets and public economic benefits

- ▶ Resilient navigation for regulated maritime vessels and commercial air transport
- ▶ Pedestrian and indoor navigation
- ▶ Affordable high precision services
- ▶ New services to increase drivers safety and comfort
- ▶ Train control and rail traffic management

Road: more than personal navigation

Car navigation

Car navigation remains the dominant application of GNSS within the vehicle. GNSS data combined with electronic maps allow positioning and guidance of the road user. Richer content combined with connectivity allows a wider set of applications and features to be offered.

Car navigation is delivered via 3 types of platform:

- ▶ Personal Navigation Devices (PND), very popular in the EU, have enjoyed fast growth over the last years. Many PNDs are now connected in order to provide live traffic information and other dynamic content.
- ▶ In-Vehicle Devices (IVD), favored by Japanese and US consumers, have also showed an upward trend in the last 5 years.
- ▶ Smartphone based applications are gaining momentum all over the world, mainly displacing sales of other platforms and enabling rapid growth outside of EU and US. (See section entitled LBS)



Emergency call

The European “eCall” initiative has recently seen an acceleration and it is now expected that all new type approved models of passenger cars and light vehicles in EU

will have an eCall system from 2015.

eCall will bring rapid assistance to motorists in a collision in the EU by dialling 112 automatically in the event of a road accident and providing location and vehicle identity.

Roads will be safer not only in Europe, but also in other countries as similar laws are introduced elsewhere (eg, in Russia and in Brazil).

Road Network Efficiency via User Charging

GNSS-based toll collection systems allow more efficient use of the road infrastructure, reducing both traffic and environmental effects.

In 2010, France joined Germany and Slovakia in pioneering GNSS-based tolling schemes for trucks on its road network and several EU countries are evaluating the adoption of satellite technology for their tolling schemes.



■ Category 1: existing or planned GNSS

■ Category 2: technology evaluation

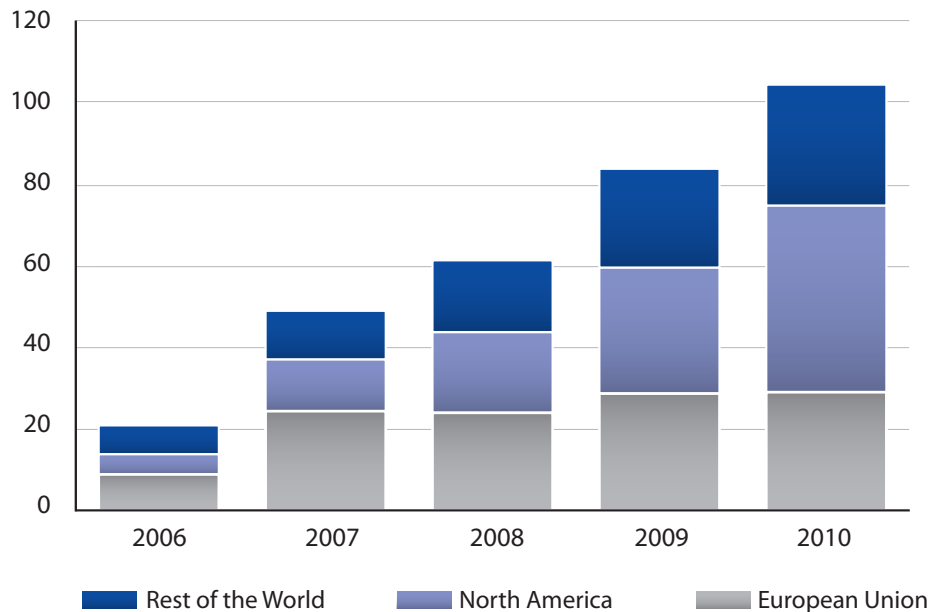


Road navigation value chain: increased platform connectivity

	 Chipset manufacturers	 Device vendors (PND manufacturers/ IVD system integrators)	 Map data providers	 Service providers
Example companies	<p>Total CSR-SIRF (US/EU) revenue in 2010 was \$800.6 million, up 17% when compared to equivalent 2009 revenue.</p> <p>Broadcom (US) develops chipsets for GNSS and telecommunication devices. 2010 revenues were €5.3 bln, up from €3.3 bln, two years earlier.</p> <p>STMicroelectronics (EU) is active in this industry for 20 years. 2010 revenues were €8 bln, declaring a 27% growth in their automotive business.</p>	<p>PND manufacturer market is dominated by Garmin and TomTom.</p> <p>Garmin (US), 47% share of the US market and 26% of the European market (2010);</p> <p>TomTom (NL), with 20% share of the US market and over 50% of the European market (2010).</p> <p>Other PND manufacturers include Mio, Magellan and Navman.</p>	<p>Navteq (US-FI) is a leader in digital map provision and has been a wholly owned subsidiary of Nokia since 2008. 2009 revenue was €579 mil, up slightly from €560 mln in 2008.</p> <p>Tele Atlas (NL) is 2nd main map provider and has been a wholly owned subsidiary of TomTom since 2008. Its turnover in 2009 was €252 mln, down slightly from €290 ml in 2008.</p> <p>Google Maps Navigation provides free road map data for Android users. The data has been available in the US since 2009 and large parts of mainland Europe since 2010. In March 2011, Google announced that they provide map services to 150 millions users.</p>	<p>Existing and emerging third party service providers are due to take advantage of new content, lower data tariffs and connected vehicle platforms. These include mobile operators (eg, Vodafone), telematics providers (eg ViaMichelin), LBS portals (eg Yell Group) and automotive manufacturers (eg Volkswagen, PSA).</p>
Market trends	<p>GNSS performance continues to improve through improved signal processing techniques and closer integration with various technologies (GSM, GPS, Wi-Fi). New products include multiple constellation capability – essential for many urban ITS applications. Consolidation amongst small number of manufacturers across all types of vehicular devices.</p>	<p>After a period of rapid growth, market saturation and competition from smartphones has resulted in a slowdown in PND sales globally. Smartphones, including free navigation and mapping capability will drive growth outside of EU and North America. Price erosion is high, driven by declining costs and strong competition. Signs of vehicular platform convergence, driven by common data standards and lower data tariffs.</p>	<p>Acquisition of global map data providers by device vendors has resulted in fundamental change in business models and free availability of navigation data. Innovation remains strong with new details, additional content and special features (e.g. 3D) driving product and service differentiation. Despite these improvements, the availability of map data for certified applications remains a challenge.</p>	<p>Apart from map data providers, this market is not yet consolidated and includes many providers and business models. The level of innovation is high and convergence with internet and mobile applications is taking place. Services are expected to become key differentiator and source of revenues.</p>

Strong market growth will continue and spread worldwide

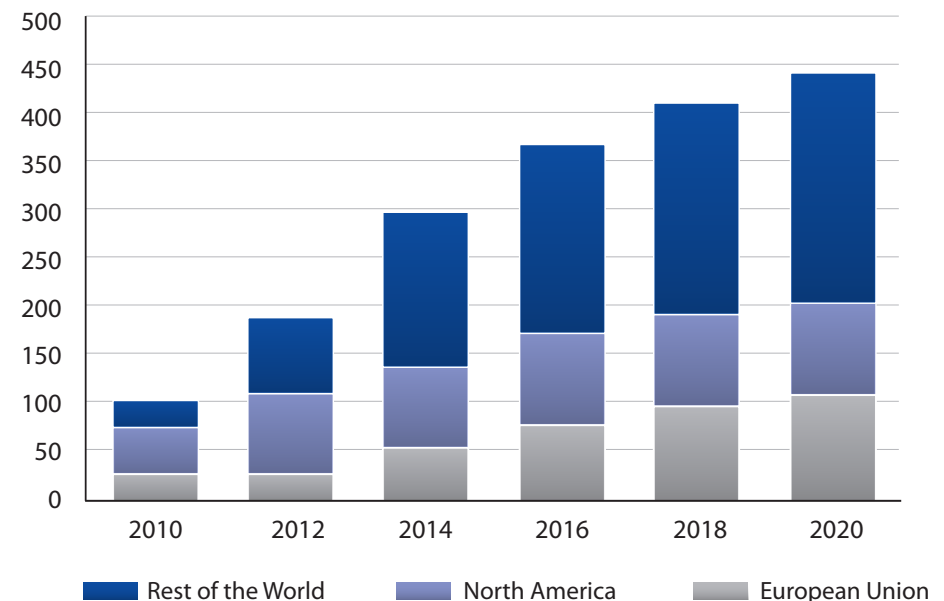
Historical worldwide shipments of GNSS devices in road sector (mln units)



- ▶ GNSS market for road applications has grown by approximately 50% per annum in terms of shipments
- ▶ As a result in 2010, 32% of road vehicles in the EU have a GNSS device on board
- ▶ Strong competition and high demand has driven down device prices. Over a five year period, the average price of a PND has fallen from 600€ to less than 160€
- ▶ In 2010, EU and North America constituted 73% of global shipments.

- ▶ Between 2010 and 2020, growth in shipments will slow down as markets such as North America and Europe saturate.
- ▶ Global growth, fuelled by the Rest of the World, will be equivalent to 15% per annum.
- ▶ By 2020, EU and North America will constitute approximately 40% of global shipments.
- ▶ By 2020, many vehicles will be served by multiple GNSS devices, as users and vehicle manufacturers look to different types of platform to deliver different applications (eg navigation, eCall, road tolling, fleet management)

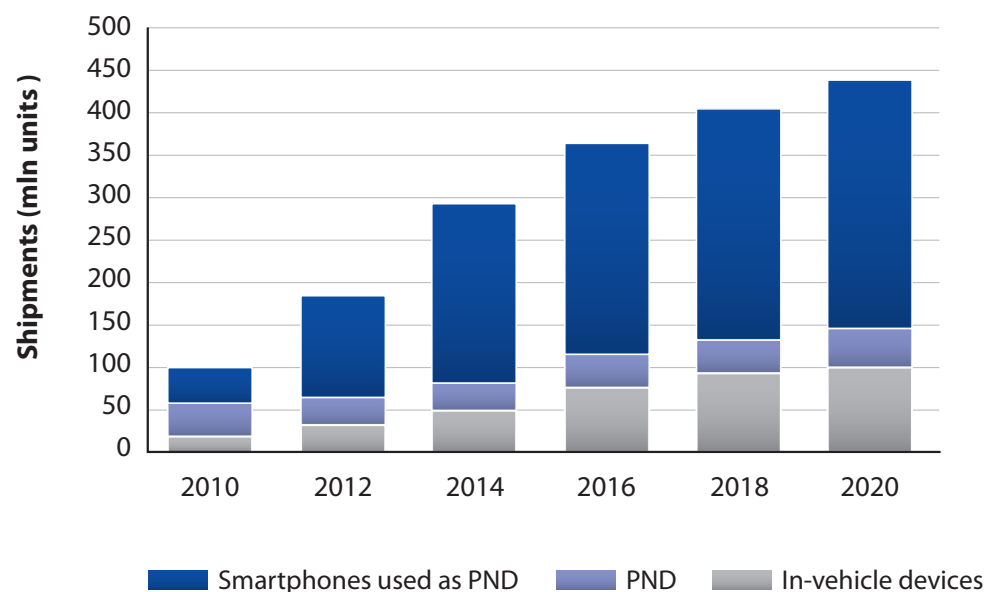
Forecasted worldwide shipments of GNSS devices in road sector (mln units)





By 2020, the majority of vehicles will be equipped with at least one GNSS device

Worldwide shipments (mln units) of GNSS devices in road sector



Future scenario: the connected vehicle

- Future vehicles, connected to a roadside distributed network will support a range of both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2X) applications. This is expected to include road side assistance, intelligent active driving, infotainment and traffic management.
- The connected vehicle concept requires on-board (and potentially embedded) network connectivity and GNSS positioning capability. The ideal future for the consumer is one in which the functionality of the vehicle is closely integrated with nomadic devices such as smartphones. Vehicle Manufacturers and other partners are currently therefore seeking to develop and commercialize appropriate solutions.

Shipments of all types of GNSS devices will exceed 400 million per annum by 2020. This includes smartphones that are used as the driver's preferred means of vehicle navigation.

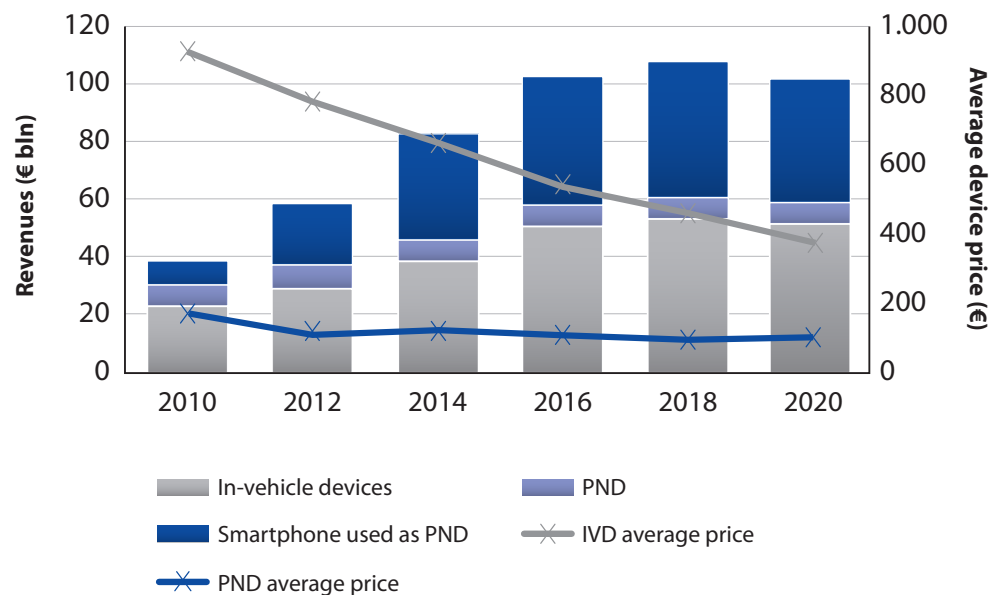
Assumptions

- In 2010, 10% of all GNSS enabled smartphones sold, are used for the purposes of vehicle navigation. By 2020, this figure is expected to rise to 30%.
- PND sales have peaked in North America and Europe in 2010. Further decreases in sales (due to substitution by smartphones) will eventually be offset by moderate growth in other regions of the world and assisted by reduced device prices.



GNSS revenues will consolidate due to price erosion and platform convergence

Global GNSS market size (€ bln) and device prices (€) in road sector



The graph includes the entire retail price of the smartphone in the device revenues in order to allow a fair comparison between each type of platform.

Global revenues consist of direct revenues from device sales as well as service revenues such as traffic information and map updates. New service revenues based on co-operative systems as well as new and innovative information and entertainment services will provide an important additional source of growth (not modelled in the scope of this report).

Global revenues are expected to peak around 2018 as both device prices and service revenues erode through increased competition and volume sales.

Device prices

Prices for PNDs are expected to decrease from 160€ in 2010 to 90€ in 2020 (-5% CAGR).

Prices of in-vehicle systems (in-car platform for navigation and advanced services) will decrease from 920€ to 360€ (-9% CAGR)

GNSS penetration

High penetration of GNSS limits growth in pure sales, although many vehicles will be served by multiple platforms. True convergence of platforms is not foreseen until after 2020.

Global revenues

Total road segment revenues will increase rapidly from around 40b€ in 2010 to over 100b€ in 2016, driven by the increase in device sales. PNDs are forecast to consist of only 5% of global revenues in 2020.



EGNOS – increased position performances, operational since 2009

Operators (toll chargers, service providers, public authorities, logistics operators) are required to provide a guarantee of positioning, ensuring a higher service quality. This is particularly important for road pricing schemes to prevent or manage claims and just-in-time logistics.

EGNOS improves the accuracy of position measurements by transmitting signals that correct GPS data and provide information on its reliability.

EGNOS contributes towards an assurance of position to operators, thus delivering essential business benefits.

EGNOS, the first European SatNav system



- ▶ EGNOS is in operation since 2009 and free of charge
- ▶ Nowadays, almost all new devices include EGNOS-enabled chipsets
- ▶ Several large-scale European projects are benefitting/ expecting to benefit from EGNOS:

EC initiative: EGNOS2ROAD



The EGNOS2road project has been funded by the European Commission and has provided a technical and economic evaluation of EGNOS for two road applications:

- ▶ Road charging
- ▶ Tracking & tracing of professional fleets

The study, that involved a major road operator and a capital city mobility agency, concludes that EGNOS delivers enhanced accuracy at zero cost for users and is recommended in all new systems. The trials have demonstrated significantly improved accuracy both within urban and extra-urban regions.

In addition, value added services based on EGNOS integrity and EDAS, enable service qualification and greater assurance of performance. EDAS delivers EGNOS correction messages directly over the Internet as an alternative channel to the geostationary satellites.

Example of R&D project: COVEL (www.CoVeL-project.eu)



COVEL delivers a road lane level vehicle positioning system based on low cost mass-market receivers by exchanging satellite raw data among vehicles using vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2X) communication technology.

GPS-only based solutions cannot fulfill the new requirements and therefore the absolute positioning is more accurate thanks to EGNOS corrections - that can also be delivered via V2X communication.

Advanced algorithms of relative positioning and cooperative map matching further increase the position, distinguishing the exact lane and enabling advanced traffic management functions (e.g. inform driver in real time to change lane because of either a stationary or approaching vehicle).

Mobile LBS accelerates as technology and application innovation continues

GNSS – an assumed feature of most smartphones



Partner technologies for GNSS

Leading smartphones display a host of technologies to improve position performance

- ▶ Assisted GPS to reduce Time to First Fix
- ▶ Highly sensitive GNSS chipset
- ▶ Wi-Fi, cellular and hybrid positioning as back-up
- ▶ Magnetic compass
- ▶ Motion sensors and gyroscopes for tilt

As an example of such innovation, a smartphone of one of the leading brands launched in 2011 includes a barometric pressure sensor and triple axis gyroscope.

A growing number of mobile phones to be sold during 2012 will also be 'Galileo or GLONASS ready' as manufacturers offer the benefits of multiple constellations beyond GPS alone.

▶ Google

- ▶ 30% of all internet searches are looking for places, rising to 40% when via mobile platform
- ▶ Google Maps for Mobile has grown from 50m to 150m users in just one year in 2010



▶ Android

- ▶ In February 2011, there were 88,000 apps available to US customers. This figure had more than doubled in just 6 months since August 2010.
- ▶ 28% of all Apps can access location. The number of Android applications classed as LBS grew tenfold during 2010

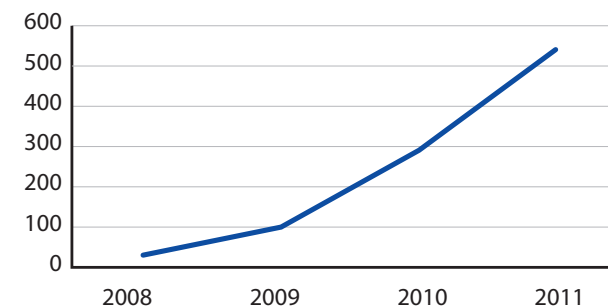


▶ iPhone

- ▶ The Apple App Store reached over 500,000 apps in 2011 and attracted nearly 23,000 additional developers between August 2010 and February 2011
- ▶ In 2010, 34% of all Apps could access location. The most popular categories of Apps are navigation and travel



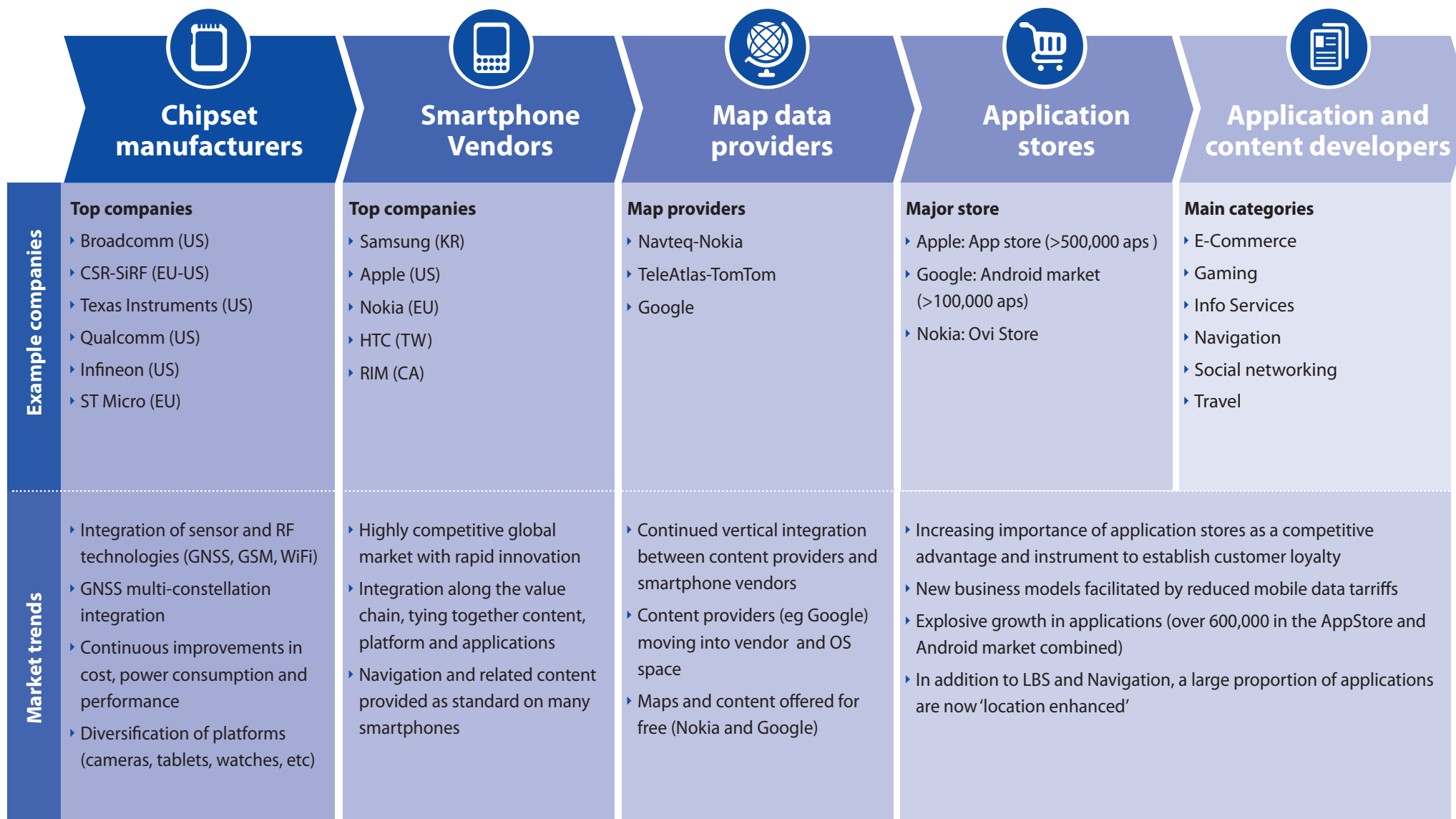
iPhone APPs available (thousands)



Source of data: <http://148apps.biz/app-store-metrics>



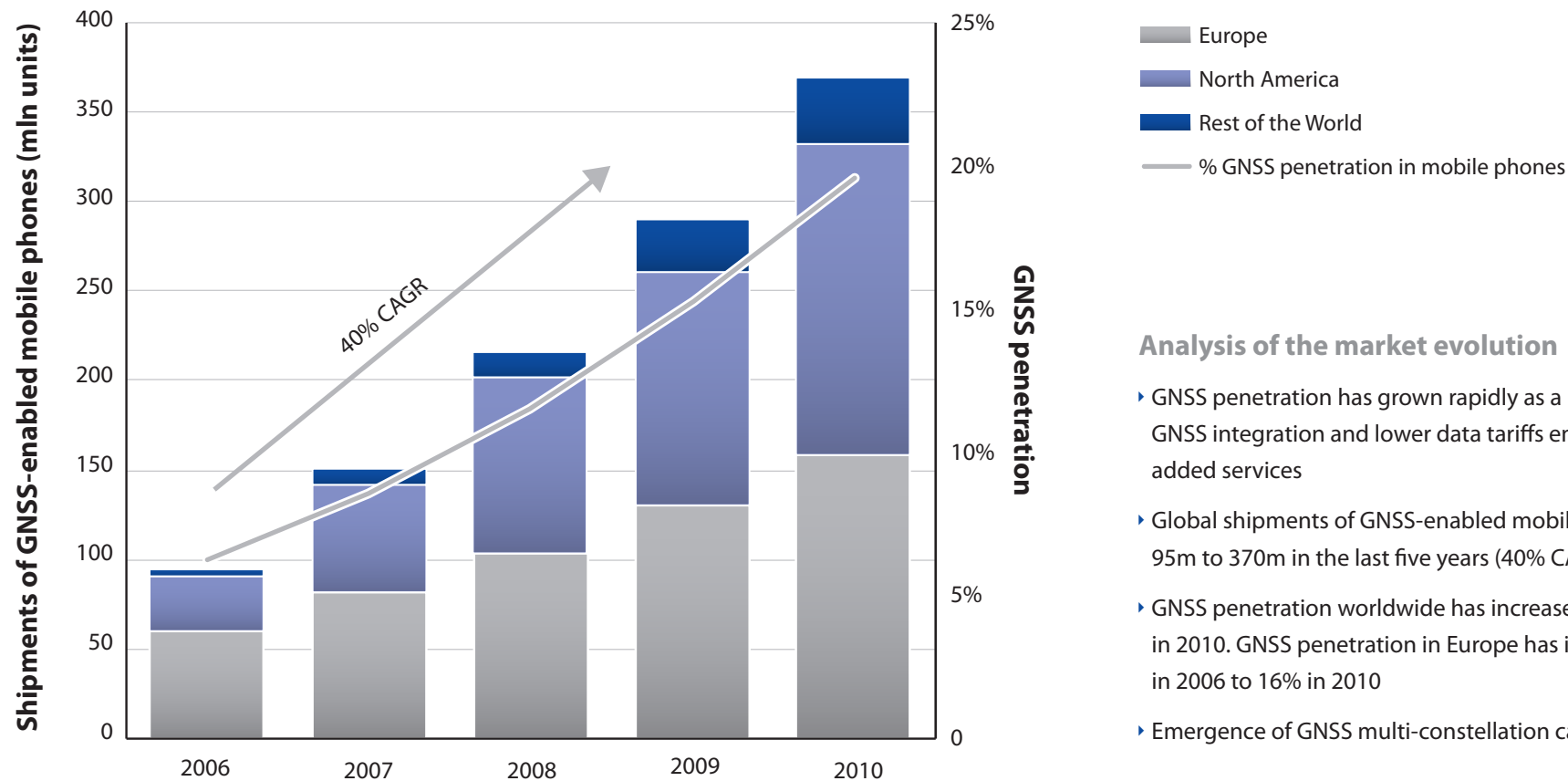
LBS value chain: vertical integration by leading smartphone vendors





Global GNSS penetration* in mobile phones reached 20%

Shipments of GNSS-enabled mobile phones (mln units)
and penetration of GNSS in mobile phones (%) worldwide



Analysis of the market evolution

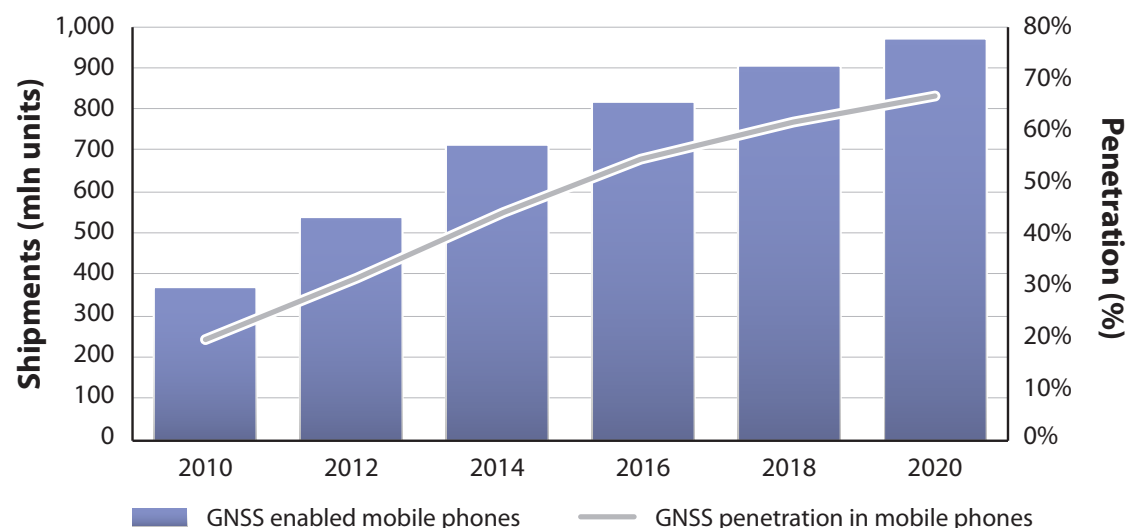
- ▶ GNSS penetration has grown rapidly as a result of reduced costs of GNSS integration and lower data tariffs enabling a wider set of value added services
- ▶ Global shipments of GNSS-enabled mobile phones increased from 95m to 370m in the last five years (40% CAGR)
- ▶ GNSS penetration worldwide has increased from 6% in 2006 to 20% in 2010. GNSS penetration in Europe has increased from less than 2% in 2006 to 16% in 2010
- ▶ Emergence of GNSS multi-constellation capability in 2011

* The penetration represents the percentage of mobile phones in use that are GNSS-enabled



Almost 1 billion GNSS-enabled mobile phones shipped in 2020

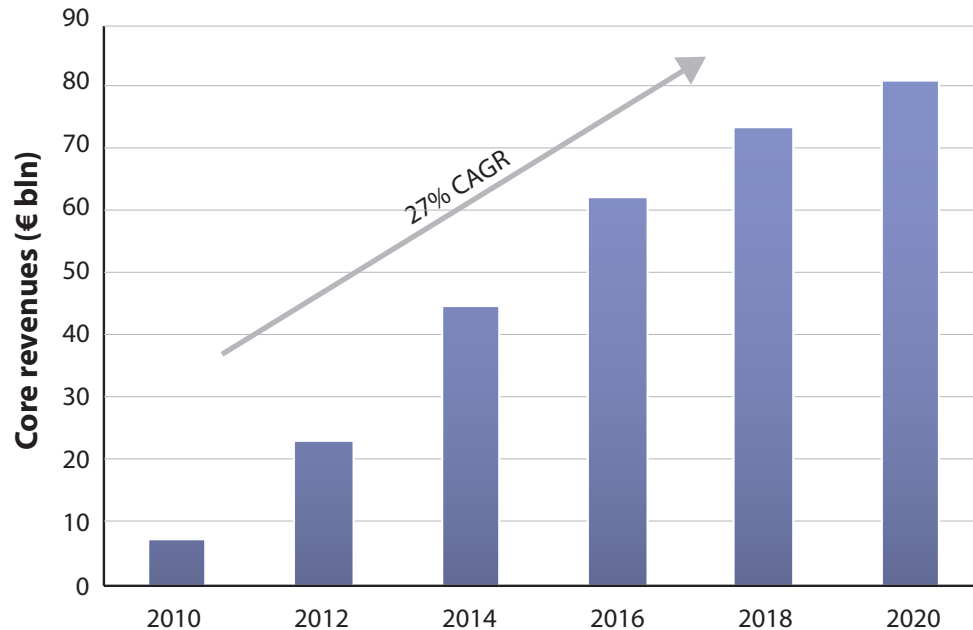
Shipments of GNSS-enabled mobile phones (mln units) and penetration of GNSS in mobile phones (%) worldwide



- Shipments of GNSS-enabled devices will continue to grow, accompanied by a reduction in device prices. These will include smartphones, PDAs and mobile handsets. This growth is equivalent to a CAGR of 11% over the next decade
- By 2020, the percentage of all mobile devices in use that include GNSS capability is forecast to reach 67%. This growth is expected to slow down after 2020 as the markets in most regions of the world reach saturation
- These developments are driven by the increasing affordability of LBS devices and applications
 - New applications such as mobile commerce, social networking and location based games are becoming widespread
 - Rich content such as navigation road data is now free of charge at the point of use thereby opening up its usage to a much wider population of users
 - Price erosion and reduced power consumption of GNSS chipsets thanks to closer integration and miniaturisation



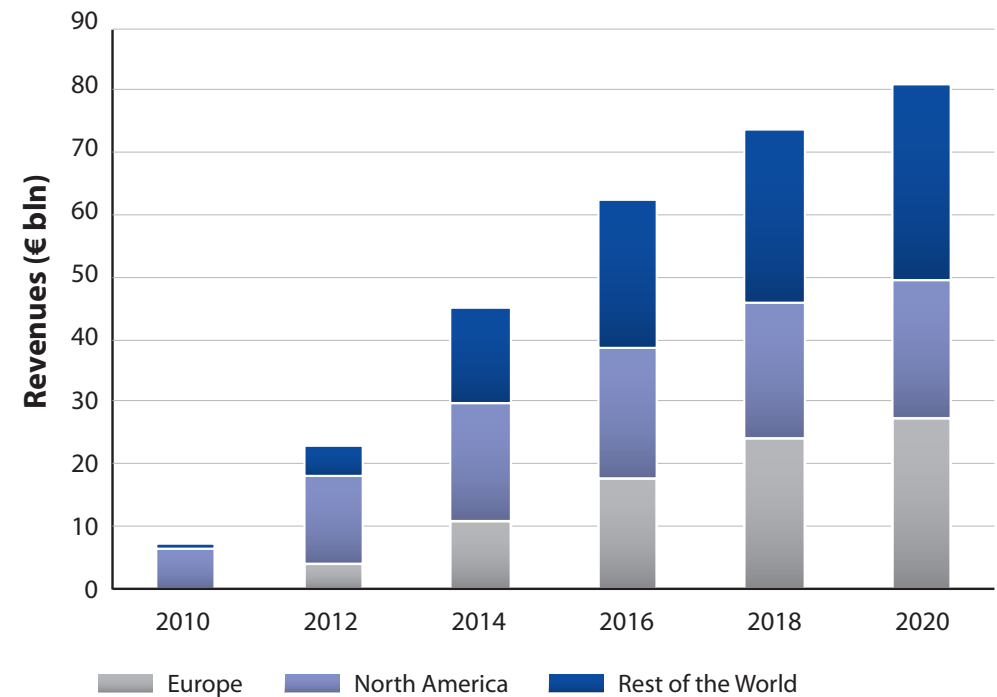
GNSS service revenues will take a share of increased mobile ARPU*



- Assumption – only 1% of the mobile device price (directly attributable to GNSS) has been included within the core revenues
- Service revenues will be driven through increasing data ARPU - CAGR 18% (2010-2020) based upon figures for Europe.
- By 2020, core revenues will be dominated by service revenues, outweighing device revenues 100 to 1.

* Average revenue per user

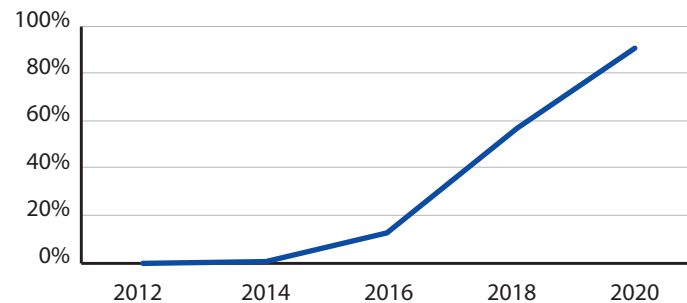
- Europe will capture a higher proportion of the market as the GNSS penetration will exceed 50% in Europe by 2015, and will continue to grow up to 97% by 2020.
- Over the same period, GNSS penetration will exceed 40% across the Rest of the World by 2015, reaching almost 60% by 2020.





Multiple GNSS constellation capability forecast to grow

Galileo penetration of GNSS-enabled mobile phone sales



GNSS chipset manufacturers are forecasted to sell multi-constellation devices from 2012 onwards that will be Galileo ready*.

Trials and demonstrations have shown that the addition of extra GNSS constellations will deliver substantial improvements in urban service availability. This will significantly improve pedestrian navigation applications.



Free software 'Toolkits' bring EGNOS accuracy and integrity to smart phones

EGNOS Toolkits include easily downloadable software packages, demo applications and other supporting materials, allowing application developers, researchers, university students and others to create, use and maintain EGNOS-capable positioning applications, retrieving corrections either from the Signal in Space or the Internet.

For receiver manufacturers and mobile phone developers, the EGNOS Toolkit contains free source code, allowing the easy integration of EGNOS capabilities into a smart phone.

The EGNOS SDK (core software, demo application, documentation) can be downloaded free at www.egnos-portal.com



Example of R&D project: Opti-trans

The EC has funded several projects that demonstrate the potential for Location Based Services (LBS) and GNSS technology.

The OPTI-TRANS project aims to create a Mobile GNSS platform that will enable commuters/travellers to plan their trip in an efficient manner. The concept supports both public and private transportation by combining information from various public transport authorities and other private vehicle owners.

The OPTI-TRANS platform will also create peer-to-peer ad-hoc groups of passengers based on pre-defined geographical areas and commuter profiling information to allow commuters of similar destinations/routing information to car-pool and share different modes of transport.



* Assumption: Galileo achieves Initial Operating Capability (IOC) by 2015 and delivers a stable operational performance to users

Integrity continues to drive GNSS demands in aviation

The aviation market



▶ The aviation market can be classified according to the use of the aircraft (both fixed wing and helicopter) as commercial, regional, business and general aviation*. The level of integration of the GNSS solution installed on the aircraft is directly related to these classifications and the growth in GNSS influenced by the availability to airspace or navigation procedures required by each operator.

- ▶ Commercial operators and high end business aviation tend to have GNSS receivers integrated into their avionics.
- ▶ Panel mounted displays provide a cheaper and simpler solution for most regional and general aviation users as they can be integrated to or used separately from other cockpit systems.

GNSS in aviation

- ▶ GNSS provides aviation users with complementary functions compared to traditional ground based radio navigation aids. As it requires no infrastructure on the ground, it provides (especially for SBAS) an opportunity for aircraft to operate with improved navigation into less well equipped aerodromes allowing more advanced use of GNSS supported operations to runways.
- ▶ GNSS already provides aviation with benefits in virtually all phases of flight. Its dependency upon GNSS looks set to continue as new capabilities are included on future avionics systems.
- ▶ User requirements driving the inclusion of new features are likely to be slow due to the regulatory environment that aircraft are expected to operate in combined with an average aircraft operational life of >30 years.

Growth in the use of GNSS

- ▶ Aviation demands the highest possible robustness and integrity of navigation systems. Developments in GNSS technologies are expected to focus on the inclusion of augmentation and multi-frequency solutions to realise increased use as sole means of navigation for aviation.
- ▶ The certification of EGNOS in March 2011 as a **Satellite Based Augmentation System (SBAS)** to support aviation has been demonstrated to deliver operational benefits of reduced minima to aerodromes without traditional instrument landing systems.
- ▶ The use of **Ground Based Augmentation Systems (GBAS)** is expected to increase these benefits and result in even lower minima. The benefit will be realised primarily by commercial aviation at suitably equipped aerodromes.
- ▶ Dual frequency receivers, including Galileo, will gradually become standard increasing GNSS performance en-route and in the terminal areas enabling rationalization of traditional navigation aids.



Opportunities for GNSS

- ▶ GNSS overcomes many of the deficiencies in today's air traffic infrastructure thanks to its accurate, continuous, all-weather positioning. This is particularly relevant for Regional, Business and General aviation which tend to frequent smaller less equipped airfields.
- ▶ The Single European Sky ATM Research (SESAR) programme defined in its 2020 navigation baseline that the primary means for aircraft positioning should be GNSS for all flight phases using a minimum of two dual frequency satellite constellations or augmentation systems (including SBAS). Today all new aircraft are equipped with GNSS devices.



* General aviation excludes kit planes, micro lights, ultra lights, gliders and hot-air balloons – platforms that would normally be associated with hand held receivers not certified by civil aviation regulatory authorities for use within aircraft. Unlike Issue 1 of this market report, this issue therefore only addresses those receivers certified for use within aircraft.

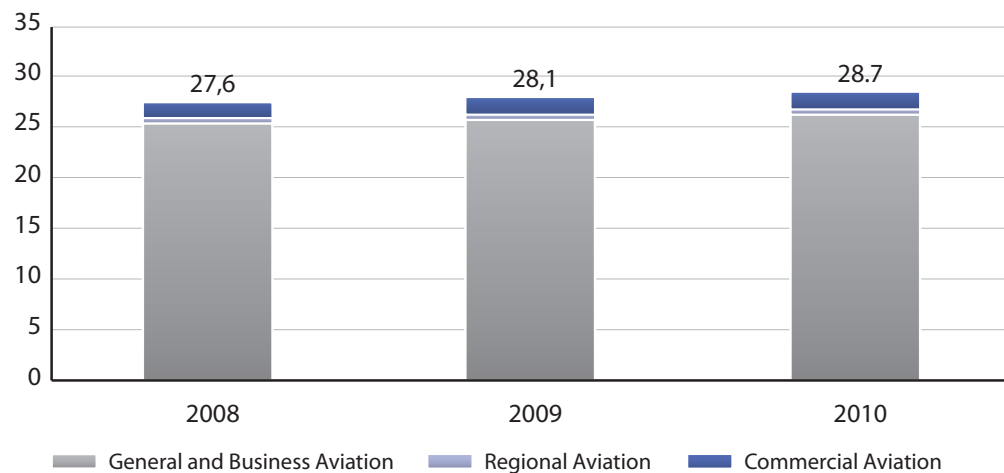
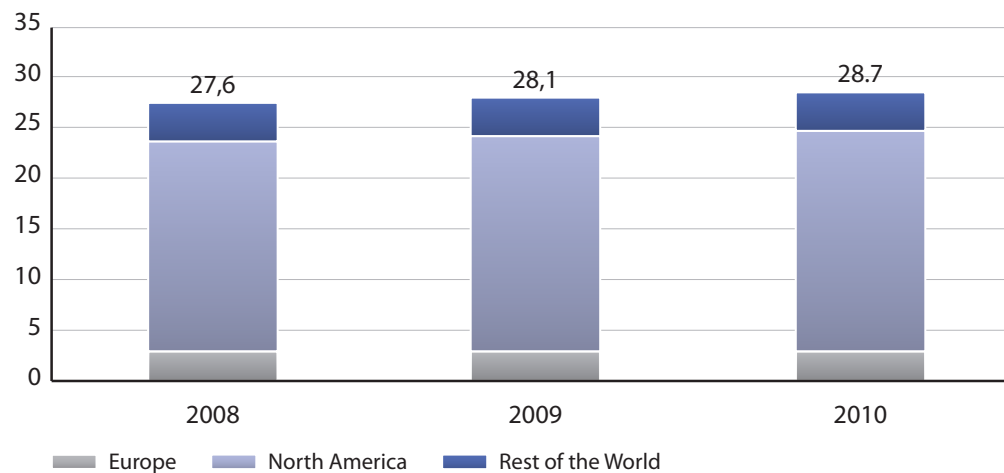


Aviation Value Chain - dominated by global brands with increasing sophistication of avionics and navigation systems



Shipments have been dominated in the past by US General & Business Aviation

Shipments of GNSS devices in the aviation sector (thousands)



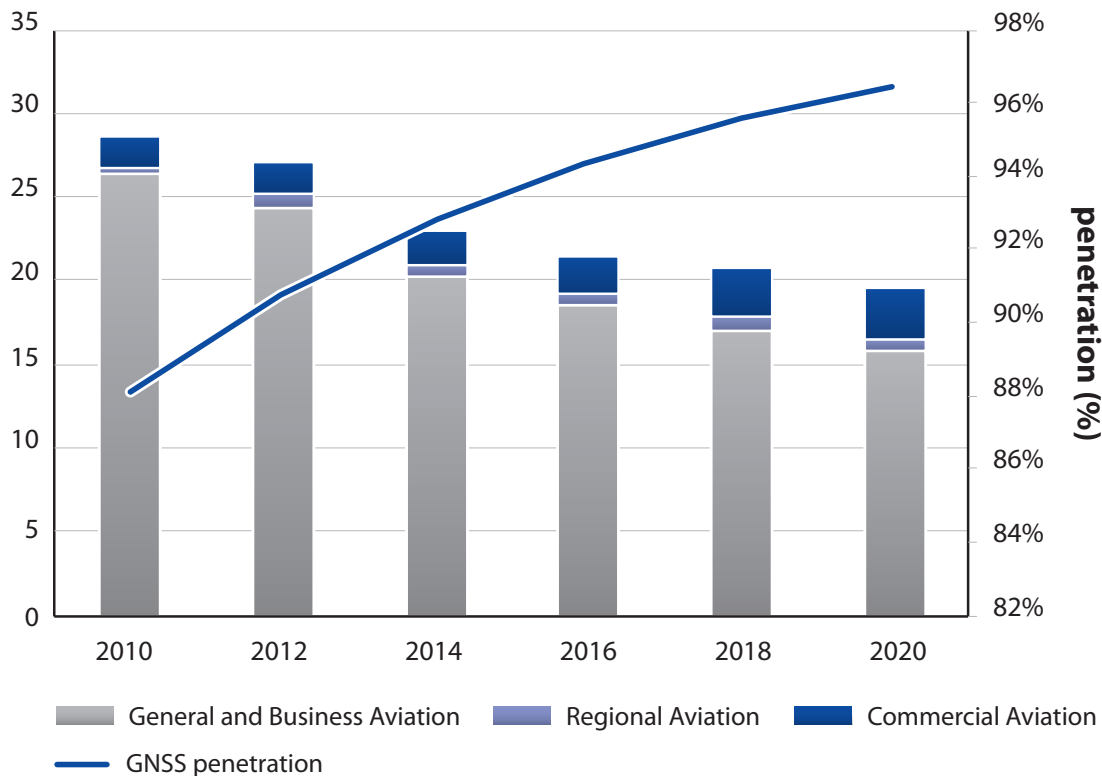
Analysis of the market evolution

- ▶ Growth of GNSS within the aviation market is dependent on shipments of new aircraft and retrofits of existing airframes.
- ▶ Penetration of GNSS in the aviation market is already high driven by large volume sales in General Aviation which have pushed overall penetration in the Aviation sector to approximately 90%.
- ▶ However, aviation benefits are realised through movements which are dominated by commercial aviation.
- ▶ Over the last few years the penetration of GNSS in commercial aviation has increased with sustained sales resulting in an increase in the public benefits that aviation can realise from deploying GNSS. Growth in penetration within commercial aviation is expected to increase from 70% to 90% by 2020.
- ▶ The growth in GNSS shipments has been dominated by growth outside of Europe and North America. This is expected to continue with growth in the BRIC markets driving demand for new aircraft equipped with GNSS.



The greatest GNSS penetration increase is expected in Commercial Aviation

Shipments of GNSS devices in the aviation sector (thousands)

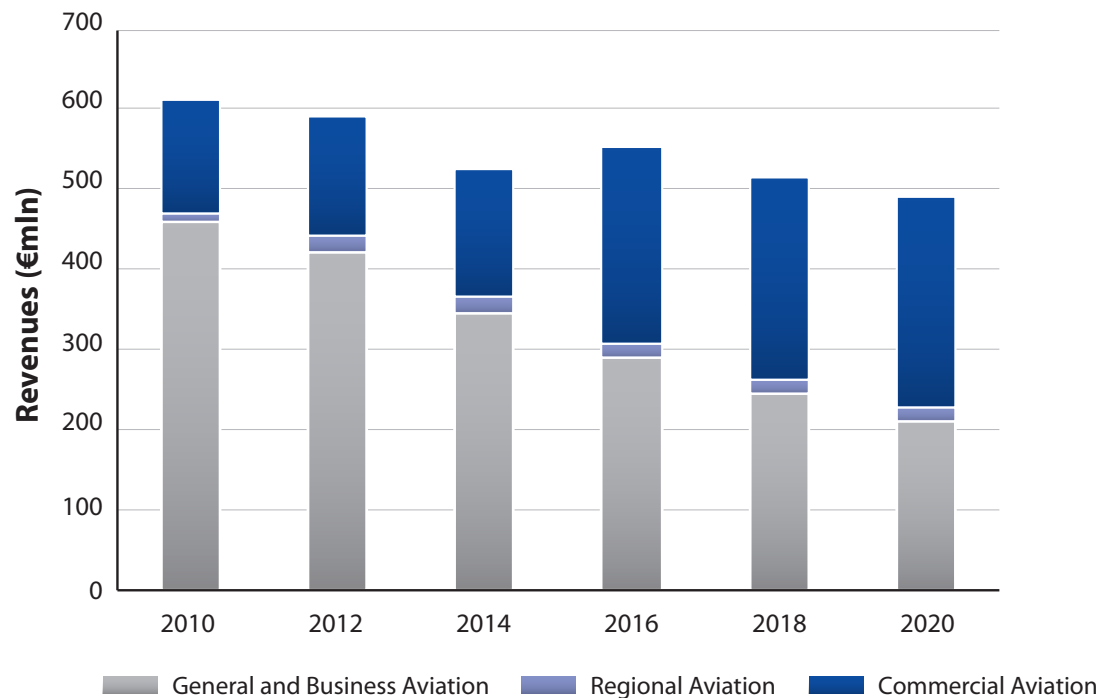


- ▶ The aviation GNSS market is a mature market. Overall shipments are expected to decrease as replacement equipage diminishes and demand is dominated by new build aircraft.
- ▶ General and Business aviation shipments will decrease the most as the retrofit market reaches its peak. However, General and Business aviation will continue to dominate sale volumes due to their much larger fleet size on the global market.
- ▶ Commercial aviation accounts for more than 80% of the instrument flight movements within Europe and its share in the total number of units shipped will increase from 6% in 2010 to 15% in 2020. As a result, the penetration into commercial aviation is seen as crucial to delivering the public benefits that are expected from GNSS.
- ▶ Only those receivers certified by civil aviation regulatory authorities for use within aircraft have been included in the total number of shipments.



A sustainable revenue from device sales of around €500M per year to 2020

Global GNSS market size in aviation sector (€mln)



- ▶ The revenues are dominated in the early years by General and Business aviation – users that tend to be early adopters of technology – seeking to take advantage of the new capabilities offered through SBAS systems
- ▶ It is expected that the average price for each type of aviation receiver will remain relatively stagnant. The revenues will fall less rapidly than volume due to the increased share of Commercial aviation, characterized by higher prices of receivers.
- ▶ The chart takes account of the increased cost of retrofit receivers, when compared to forward-fit receivers. This has an effect upon the profile of revenues in each segment.
- ▶ SBAS receivers are gradually becoming standard fit on new build aircraft. The availability of a commercial solution on large airliners is expected from 2016 with the advent of the Airbus A350. This is expected to drive accelerated demand for receivers in commercial aviation that will see an increased retrofit program for operators wishing to upgrade to the new capabilities.

Over the period 2010-2020, the following average prices apply. These include both retrofit and forward fit devices.

- ▶ CA: € 80,000
- ▶ RA: € 25,000
- ▶ GA: € 17,000

For each CA and RA aircraft, two GNSS receivers have been assumed*.

* In Issue 1 of the market report CA and RA had been assumed to have a single receiver costed as a percentage of an RNAV FMS upgrade. The updated costs in this report are based on validated costs experienced during European funded receiver installations on representative aircraft: installation and certification excluded.



Increased penetration of EGNOS benefits critical services

EGNOS: High precision, low investment

- ▶ EGNOS Safety of Life (SOL) signal has been certified for use in aviation in March 2011 and first procedures have been written in France and Germany.
- ▶ EGNOS embedded devices installed within Business and General aviation can now be operationally used to deliver benefits. Increased accuracy and integrity means the decision height can be decreased to as low as around 200ft, depending on local geography.
- ▶ With an EGNOS procedure, even small and medium-sized airports and heliports remain accessible in poor weather conditions. Plus, the lower decision height provided by

EGNOS may open up approach paths to runway ends previously inaccessible due to local obstacles.



- ▶ EGNOS provides a cost effective alternative to ILS CAT I, offering similar performance yet without the need for infrastructure installation. All that is needed is an on-board EGNOS certified receiver, an adapted approach procedure for the runway end, and corresponding flight management system functions.
- ▶ EGNOS enables also the implementation of safe approach procedures designed for helicopters.

Example of R&D project: HEDGE

The benefits of EGNOS to aviation have been demonstrated through numerous trials undertaken in the EU's Framework Programs.

Project HEDGE trialled the implementation of a new type of approach procedure that had not previously utilised EGNOS. The procedure supports

Helicopter Emergency Medical Service (HEMS) operations and provided a significantly lower operating limit.

As an emergency operation, this would deliver tangible benefits to both the HEMS operator and the patient including:

- ▶ Increased availability of the procedure in inclement weather conditions.
- ▶ Improved transport times for the patient to the hospital

HEDGE has also pioneered the first operational flight trial of a new offshore approach procedure providing guidance to remote oil rigs and platforms. By providing accurate guidance to helicopters on approach.





Harvesting the benefits of precision agriculture

Key technologies in precision agriculture

- ▶ The technological entry point for precision farming relies on standard GNSS receivers complemented by free satellite based augmentation services (e.g., **WAAS** in the US or **EGNOS** in Europe). The level of accuracy is below 1 meter and between 15-30 cm pass-to-pass accuracy.



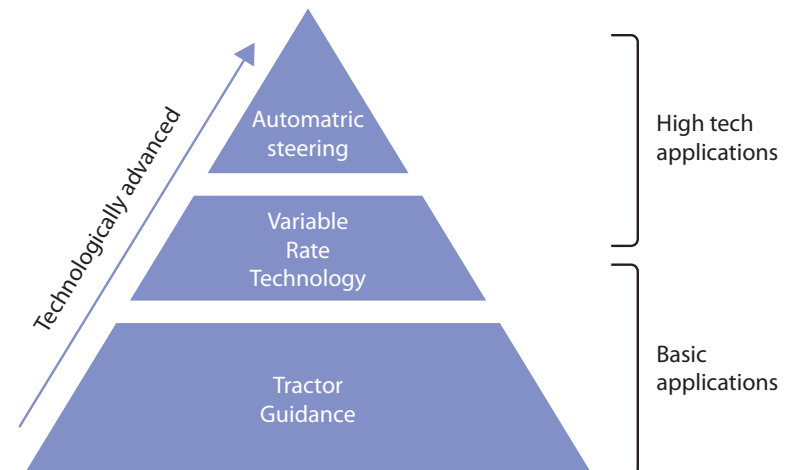
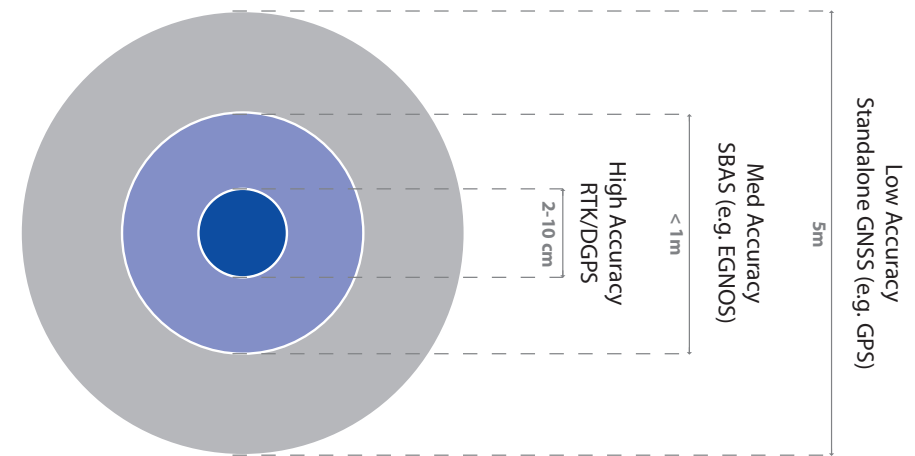
- ▶ EGNOS-only low cost devices are now provided by, for example, CLAAS tractor manufacturer (CO-PILOT TS), Trimble (EZ-guide 250), and by Leica Geosystem, (Mojo)."

▶ More advanced positioning technologies, usually rely on ground based infrastructures and guarantee higher accuracy. These technologies are local / regional Real Time Kinematics (**RTK**) systems or Differential GPS (**DGPS**). The levels of accuracy achieved by means of RTK-technologies are in the range of 2 to 10 cm.

Key applications in precision agriculture

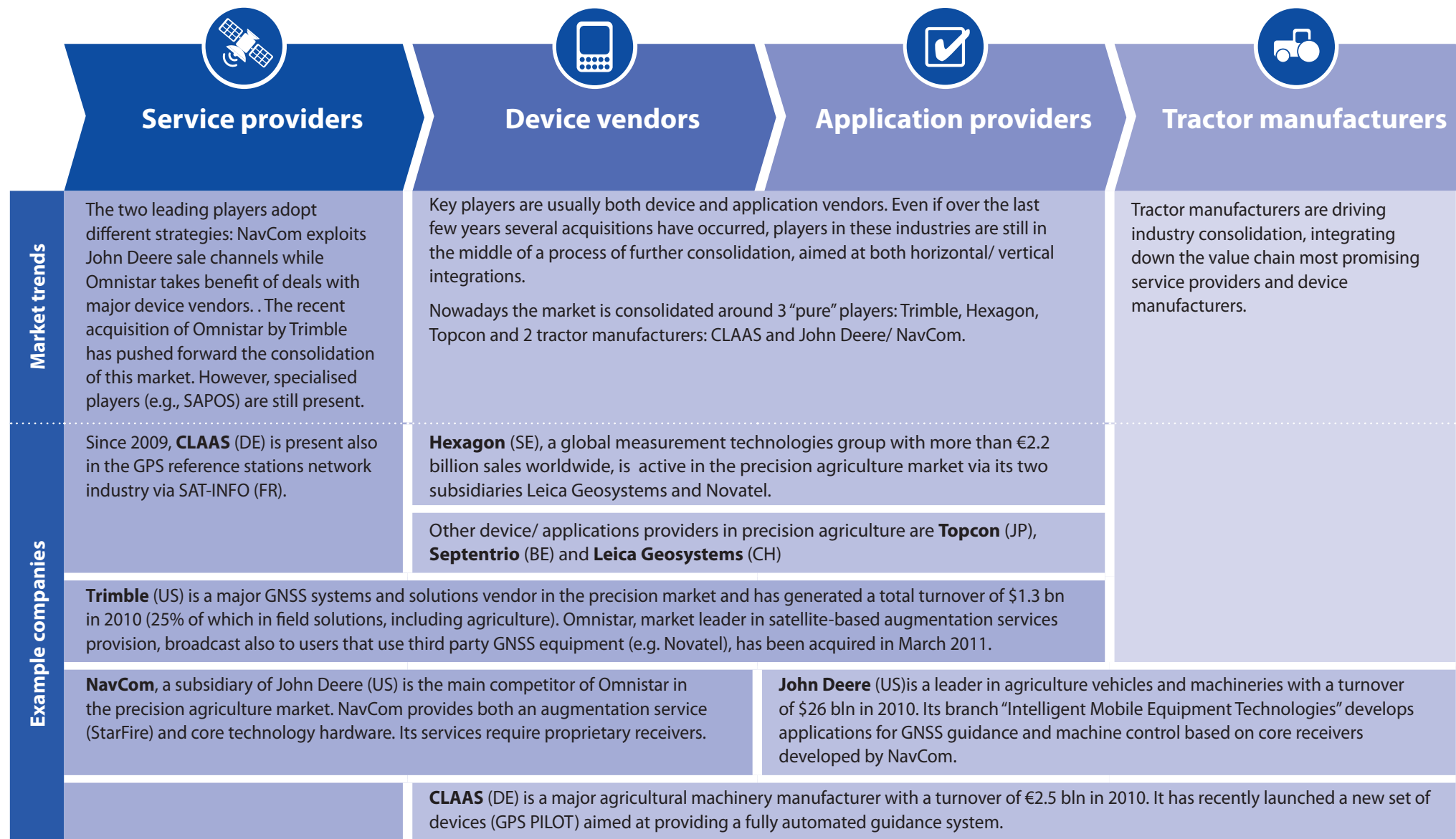
- ▶ Different applications can benefit from the added value of GNSS technology:
- ▶ **Tractor guidance** makes use of a digital display to help an operator on board of the vehicle to follow a predetermined path, thus minimizing risks of overlap/gaps. This application is often the first GNSS application a farmer adopts.
- ▶ With **VRT** (Variable Rate Technology), precise location information is used to guarantee a precise control over farming inputs (e.g., fertilizers), thus further enhancing the added value of tractor guidance/ automatic steering applications.
- ▶ **Automatic steering** is the most advanced of these applications and allows a vehicle to be automatically driven along a predetermined path. This application is used mainly in large farms.

The different levels of accuracy by GNSS technology





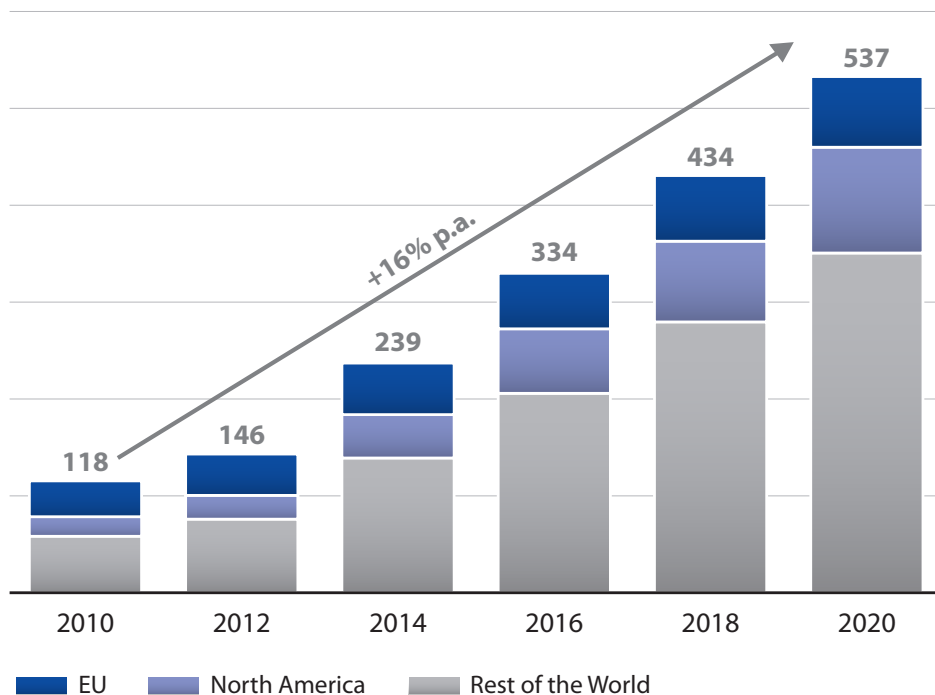
Agriculture value chain: further consolidation





Global shipments continue to grow, with major position of emerging economies

Shipments of GNSS devices in agriculture sector (thousands)

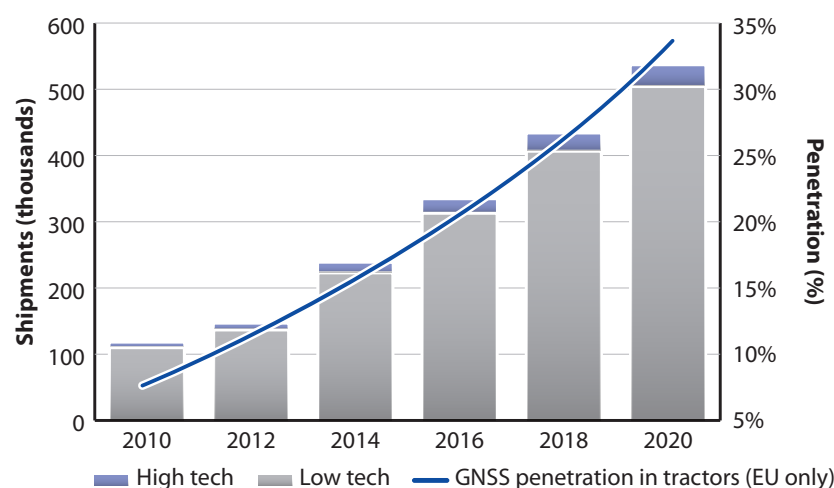


- ▶ GNSS device sales are expected to grow steadily worldwide, posting a growth of c. 16% p.a. in 2010-2020. Dynamic growth will be observed in all the geographies considered.
- ▶ With farm sizes increasing in Europe and GNSS equipment becoming more affordable, more and more farmers are investing in farm management solutions. The use of satellite navigation for precision farming can result in considerable cost savings, even on an average farm.
- ▶ Due to relatively large average farm size and wealth, high technology penetration and small farming population, in Western Europe, there are favourable conditions for a strong GNSS ramp-up in the coming years.
- ▶ In Central and Eastern Europe, Poland and Ukraine are following Czech Republic in adopting GNSS technology on the farms.



Global market penetration will accelerate - even beyond 2020

Shipments (000' units) and penetration (%) of installed base of GNSS devices worldwide in agriculture sector



Volume trends

GNSS-based solutions usage in agriculture is expected to grow steadily worldwide, to reach a penetration of 35% globally by 2020.

Yearly sales are expected to increase from c. 100.000 units p.a. in 2010 to reach more than 500.000 units in 2020.

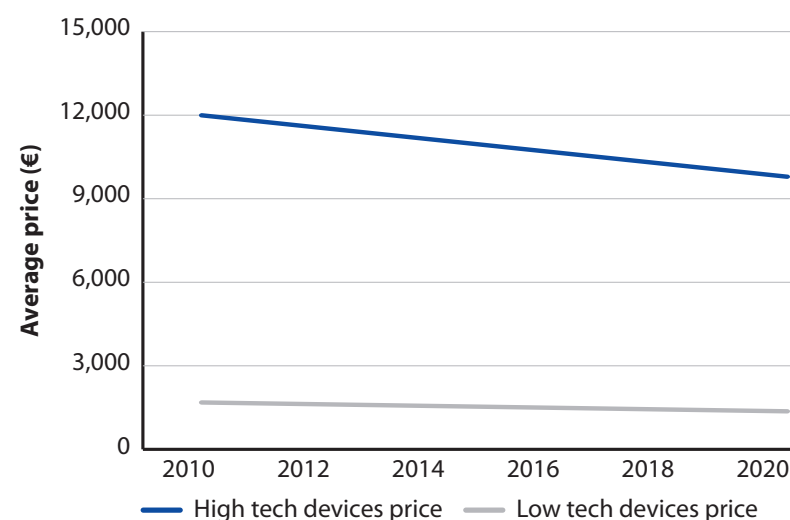
Modernization of agriculture (and consequent sales of vehicles pre-equipped with GNSS devices) is the key underlying trend in volume ramp up. Key applications that will drive this trend are tractor guidance and VRT applications.

Price trends

The price of high tech devices (i.e., Automatic steering) is expected to decrease steadily along the time period considered, falling from c. 12.000 € in 2010 to c. 10.000 € in 2020. In the same period, the price of low tech devices (i.e., Tractor guidance and VRT applications) is expected to remain rather stable in a price range of c. 1.500 € per device.

Affordable prices are one of the incentives to use high precision solution in agriculture. The investment in GNSS equipment has measurable returns since significant savings in fuel and agricultural inputs (i.e., seeds, pesticides, fertilizers and water) coupled with yield increase can be achieved.

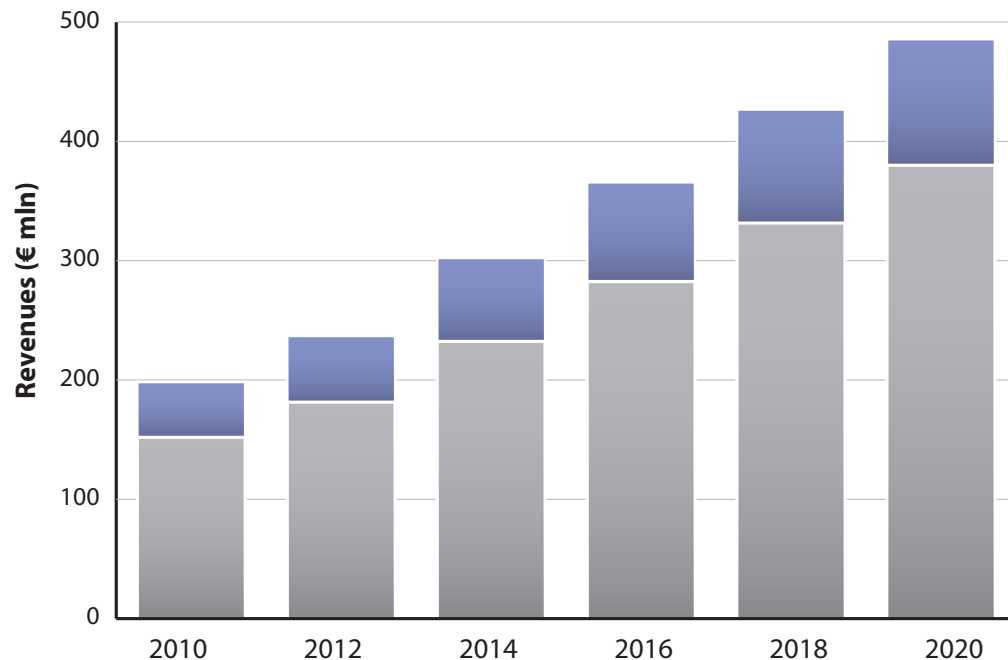
Global GNSS market size (€ mln) and device prices (€) in agriculture sector





Global revenues will continue to grow strongly throughout this decade

Global GNSS market size (€ mln) in agriculture sector



Revenues trend

The global GNSS market size is expected to grow steadily in the coming years, mainly driven by strong growth in automatic steering solutions (representing the majority of revenues) all over the time period considered, to reach a maximum in 2020 (ca. 500 €m revenues).

Several underlying trends are the basis of this growth. To cite a few, increasing average farm size and wealth, decreasing farming population, efficiency needs due to increasing world population, increasing technology awareness, higher access to agricultural machinery dealerships.

The emergence of new constellations and multiple frequencies are expected to have a significant impact on precision agriculture.

Together they will deliver an improved level of performance that is only possible today with additional infrastructure or commercial services.

These trends, combined with the arrival of additional satellite constellations GLONASS and Galileo, and enhancements guaranteed by SBAS corrections will result in reliable and virtually instantaneous provided resolution of one's position on earth to centimeters.



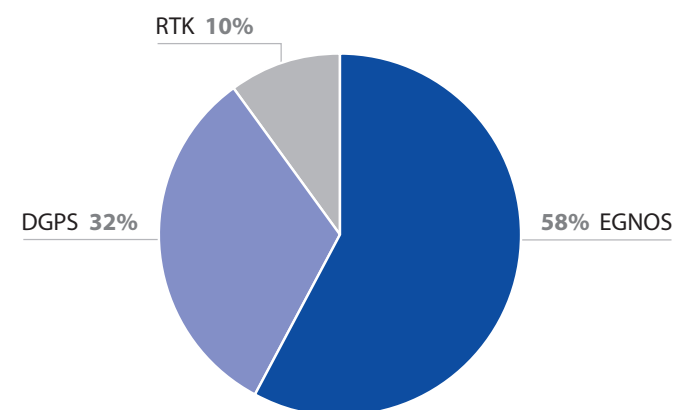
EGNOS at work along all phases of agricultural activity



EGNOS can increase productivity in all agricultural activities

- ▶ EGNOS is not anymore a technological opportunity, but rather a necessary infrastructure for successful agriculture, which being free allows new markets and opportunities to open.
- ▶ As farmers prepare the soil, EGNOS helps them to choose consistent driving strategies and to avoid row overlaps. European farmers can save up to 7% on operating costs with EGNOS thanks to time reduction and abatement of fuel, oil and machine expenses. EGNOS is the leading technology for tractor guidance applications.
- ▶ During seeding activities, modern agricultural engineering rely on EGNOS to distribute the right seed volume in the right spot. As fertilizers and plant protection products are applied to the crop, it is now possible to adjust accurately nitrogen and crop-spraying activities combining GNSS positioning, onboard sensors and application maps. EGNOS is also widely used in VRT applications.

EGNOS market share (estimated)
% of GNSS equipped tractors using EGNOS (2010)



Two projects, recently financed under FP7 programs, will foster EGNOS added value in agriculture even further.

UNIFARM



UNIFARM sets up a user forum to support the needs of farmers in the development of GNSS applications and services, thus enhancing the scientific and technological excellence in GNSS in agriculture. The project:

- ▶ collects users requirements and user cases, harmonizes them and to provide them to policy makers
- ▶ disseminates key information to improve awareness
- ▶ provides a design facility based on the users cases to allow firms the to benchmark their application or service.

GeoPAL

The GeoPAL project will significantly contribute to frame and steer the development of "smarter" and "greener" in-field and inter-field transport systems.

Taking advantage of the EGNOS features, the overall aim of GeoPAL is to provide an advanced logistics system for the harvesting and distribution functions of the bio-production related supply chains contemplating issues such as improvement of resource efficiency, reduction of GHG emissions, concerns of sustainable production, industrialisation/ automation of production and further development of the competitiveness.





Surveying sector is the early GNSS adopter

Land and Maritime surveys

- Surveying activities are sub-divided in Land Surveying and Maritime Surveying which operations and needs are very different.
- Land surveying covers many applications from forest management to building deformation control.



- Corresponding accuracy requirements are variable from sub meter to sub centimeter.
- Maritime surveying refers to:
 - hydrographic surveying (national mapping and coastal surveying operations)
 - off-shore surveying (survey operations for commercial applications such as oil and gas exploration).

- GNSS benefits mainly to centimeter applications such as property cadastre, topographic survey, maps, engineering survey (staking out), perpetuation of evidence.

Surveying has been one of the very first civil domains to use GPS: In the early '80s, manufacturers of both GPS systems and surveying instruments started to understand each other's markets and products.

At that time costs of surveyors systems based on GPS were very high, costing about ten

times the price of a traditional system.

Nevertheless, the use of GPS solves the issue of line-of-sight and allows to survey 20-40 miles per day.

General trends

- In a context where GNSS devices are more and more accessible at lower cost and with increased performance, the surveying domain experiences significant changes.
- In land segment, the need for professionals will be increasingly related to regulation and legal aspects while part of traditional surveyors tasks can be done by non-professional persons. The increasing needs for more accurate information will also support the activity in land surveying.
- In maritime, requests for improved accuracy in the vertical dimension increase significantly to measure seabed depth. But these measurements accuracy level are much more limited by sonar equipment than by GNSS ones.

GNSS infrastructure will grow with the implementation of new GNSS (Galileo...) and will offer a better quality of services with more visible satellites and additional functions. The expected benefits in the Survey domain are an improvement of the productivity, equipment's costs reductions, improved accuracies, a better and faster calculation of fix position and a better reception in difficult environment (e.g. masking, foliage...).

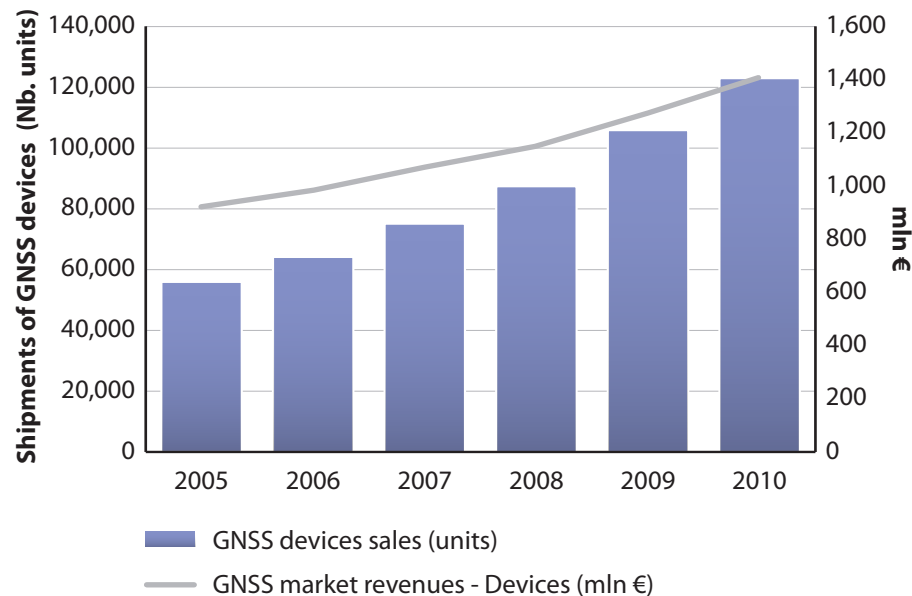


	Complementary Infrastructure (Commercial augmentations)	Receivers and Firmware	Applications	Professional Users	Customers
Land surveying Example companies	<ul style="list-style-type: none"> GPS Leica TERIA SAPOS Orpheon OMNISTAR (Fugro) 	<ul style="list-style-type: none"> Trimble Topcon / Sokkia Hemisphere GPS Javad 	<ul style="list-style-type: none"> Leica Geosystems Sokkia Stonex 	<ul style="list-style-type: none"> Surveyors Engineers Professional Organisations Constructors Educators Scientists 	<ul style="list-style-type: none"> Public organisations Private companies Individuals Insurance companies
Maritime surveying Example companies	<ul style="list-style-type: none"> Fugro Veripos Navcom 	<ul style="list-style-type: none"> Trimble Leica Kongsberg Hypack Novatel Septentrio Navcom 	<ul style="list-style-type: none"> GPS Leica infrastructure TERIA SAPOS Orpheon OMNISTAR (Trimble) 	<ul style="list-style-type: none"> Surveyors Engineers Professional Organisations 	<ul style="list-style-type: none"> Hydrographic offices, chart publishers Ports and harbors Offshore wind firms Underwater cable & pipeline installers Natural resources mgmt firms Aquaculture organizations
Market trends	<p>Augmentation services provided by complementary Infrastructures are essential for precise positioning. These infrastructures are notably useful for the fast collection of coordinates. Their use is expected to grow. Service providers are mainly specialised in land or maritime domain.</p>	<p>The number of receiver manufacturers is quite limited. New manufacturers are expected to enter the maritime segment in the future. GNSS based devices will evolve and will offer increased performances to support surveying productivity. In the offshore survey segment, systems used are either based on radio signals or systems using SBAS</p>	<p>In the land survey ecosystem the trend is the stakeholders' consolidation and concentration. The market is already dominated by a limited number of players having access to, or owning, core precision GNSS technology via acquisition or through the ownership structure (TopCon has acquired Sokkia; Leica Geosystems is linked to NovAtel and Trimble has developed core technology end-user applications). Trimble has also acquired Ashtech.</p>	<p>In land, the activity slows down due to economical context (less constructions and less parcels to manage / measure). GNSS performances have led many countries to adopt the digitalisation of geo referencing data for their land administration systems. This approach enables an almost automatic process to update maps information in the database.</p>	<p>In land, the demands for absolute positioning are mainly driven by public sector and requests for certified positioning will grow in the near future. Parallel non professional use will gain importance.</p> <p>In the maritime domain, the demands are balanced between public and private sectors. As the exploitation of maritime areas increases, the number of commercial customers and their demands for geo data should grow.</p>



More than 120,000 GNSS devices sold in 2010 for land and maritime surveying applications

GNSS market in surveying domain

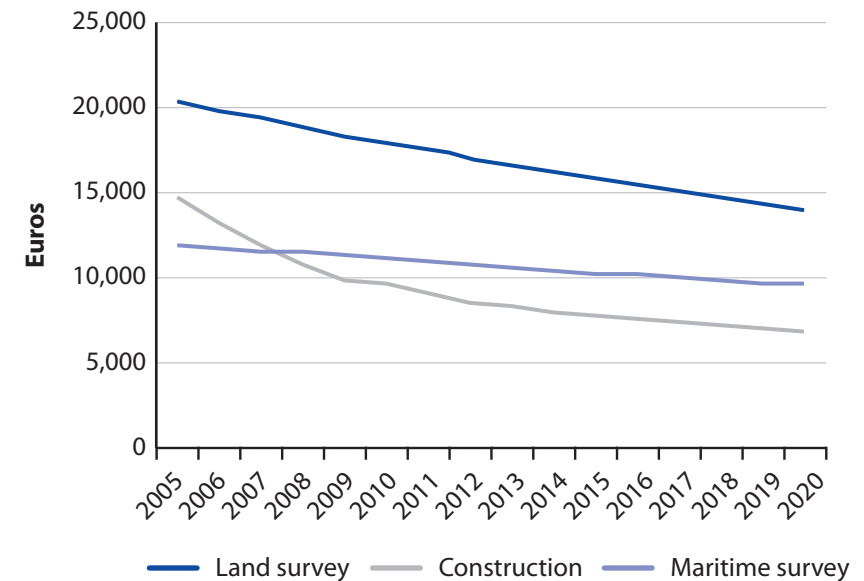


In 2010, the GNSS market in surveying represented about €1,4 bln for 120 000 units sold worldwide.

The average growth since 2005 is around 10%. This is notably due to penetration increase of traditional devices sales in Asia and South America and the growth of construction market in North America.

Prices are expected to decrease slowly and constantly in traditional markets. By 2020, average prices for land and maritime survey are expected to reach 15K€ and 10K€ respectively.

Surveying devices' prices evolution in North America and Europe



The price of Construction applications devices should decrease more quickly as the market penetration and volume raises.

Devices prices vary significantly, mainly depending on the related performances of the device.

In land surveying prices can be 15 K€ for surveying and 1-5K€ for mapping and GIS.



Surveying market is forecasted to boom over the next decade, reaching more than 0.5 million units shipped in 2020

The average growth is around 10% per year and is expected to increase significantly in the coming years with the booming of sales for constructions.

By 2020, this market will represent around €4 bln for 500 000 units sold worldwide.

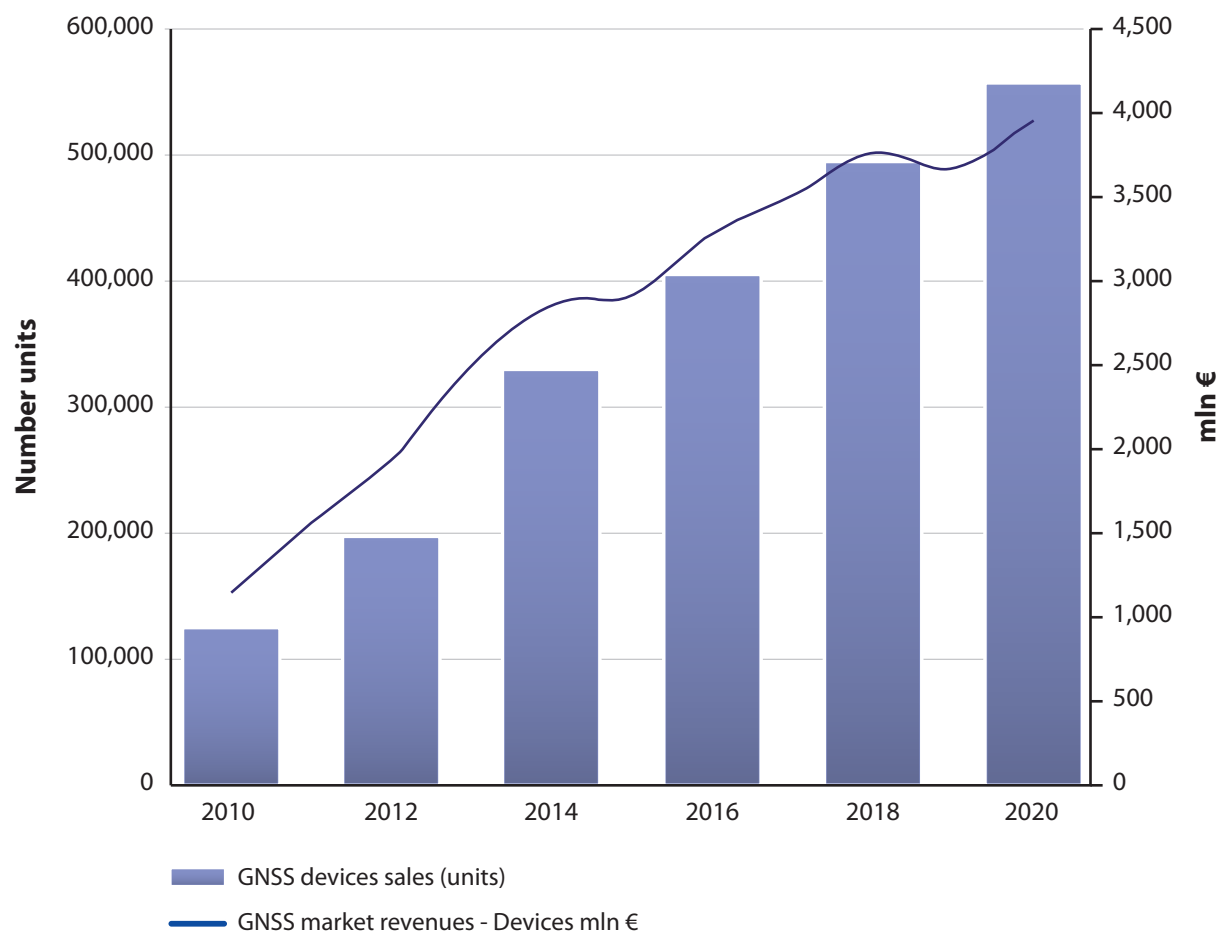
Analysis of market evolution

Construction market (machinery guidance...) will drive the future market: booming in North America and emerging in Europe and RoW.

In the maritime sector, the market will only slightly increase supported by off-shore activities.

Traditional surveying market is progressing slowly supported by needs for digital legal data (reference data for the constitution of Spatial Data Infrastructures).

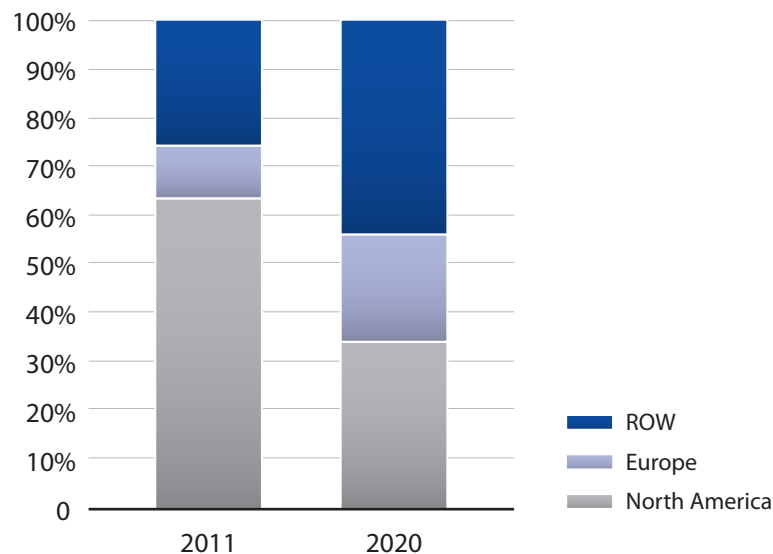
GNSS market forecast in surveying domain





US construction sector dominates the global shipments of GNSS devices

Regional split of shipments of GNSS devices
in land sector



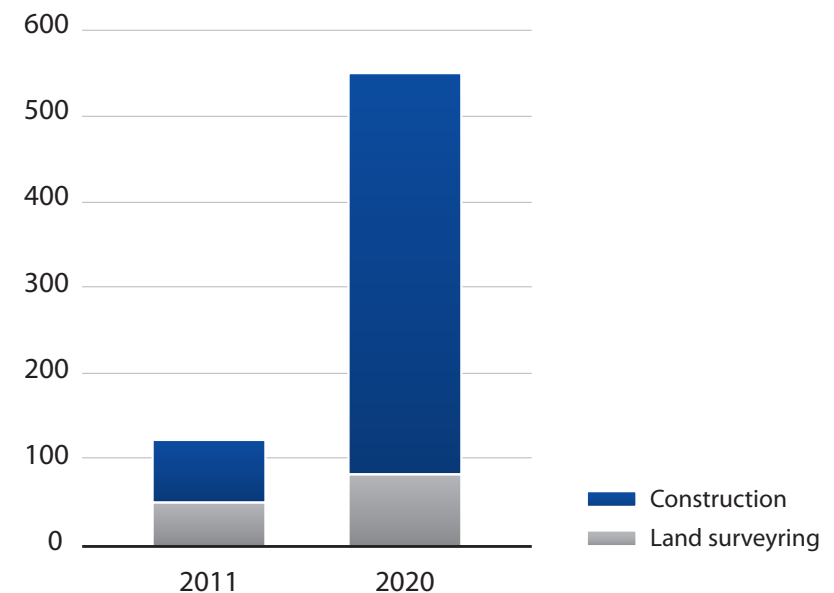
The GNSS market in surveying is largely dominated by the land sector as the number of required devices is much higher than in the maritime domain (120 000 units in land compared to 2200 units in maritime in 2010).

This fact will be more accentuated with the rise of construction applications. The construction sector alone represents about 60% of the total sales in 2011 and is expected to represent near 85% of the survey market in 2020. Shipments in maritime remains low compared to the land market with around 4000 devices in annual sales worldwide in 2020.

In the land sector, the market is largely dominated by North America. This is mainly due to the advent of the market of GNSS devices for construction in the US. This market will also grow in other regions but with a few years delay.

In the maritime sector, the market is more geographically balanced. This balance is expected to be kept as market is quite well established.

Change in structure of shipments of GNSS devices
in 2010 and 2020 (in thousands).





EGNOS gaining grounds in mapping while Galileo offers new possibilities for surveying

EGNOS for Mapping – free accuracy, widely available

The use of GNSS in surveying often means services with centimetre level accuracy and substantial costs. However for many mapping applications meter level accuracy provided by EGNOS is sufficient (e.g., thematic mapping for small and medium sized municipalities, forestry and park management, surveying of utility infrastructure, agricultural infrastructure mapping).

Thus, besides the professional users, EGNOS also allows more and more non-

professionals to access GNSS mapping technologies, thanks to the affordable and simple solution. This contributes to the growth in the overall survey market.



EGNOS is therefore able to deliver significant benefit:

- EGNOS is an effective option for a wide range of mapping applications where meter accuracy is adequate.
- EGNOS is free; it does not require installation of hardware nor on-going subscriptions.
- EGNOS corrections, thanks to EDAS, can also be received by terrestrial communication means, such as internet or cellular networks.
- EGNOS covers the majority of Europe, with no white spots.
- EGNOS permits real time positioning.
- EGNOS corrections, thanks to EDAS, can also be received by terrestrial communication means, such as internet or cellular networks.
- EGNOS provides system integrity, supplying information on the reliability of GPS signals.

Case study: ENCORE project

ENCORE (Enhanced Code Galileo Receiver for Land Management in Brazil) project is addressing the Brazilian need for geo-referencing rural real estates in a context of new regulatory demands.



The project covers the different phases of an application development, including requirement definition, design phase, implementation, testing, demonstration to potential users and dissemination activities. It has developed a high-precision and low-cost receiver which takes advantage of the novel characteristics of Galileo E1/E5 signals for surveying and mapping, in open areas under optimal reception conditions (open sky scenarios) and suboptimal ones (multipath created by moderate to thick tree coverage).

The project aims to introduce Galileo terminals in the Brazilian market for land management applications (geo-referencing and cadastre), with possible future expansion to other South American countries. It also aims to stimulate the participation of international entities from Brazil.

EU market penetration

- 40% of all GNSS mapping devices in 2010 are EGNOS capable, by 2015 almost 100% expected.

EGNOS usage

- By 2015, it is estimated that approximately 50% of mapping users will use EGNOS capability, compared to 10% in 2010.

Equivalent market size

- By 2015, mapping device revenues for which EGNOS is an essential feature are expected to exceed €100mln



GNSS is already central to the merchant maritime market

Merchant fleet

The maritime market includes merchant vessels, leisure vessels and vessels operating on inland waterways. Leisure vessels are by far the largest category with millions of device sales each year. The focus of this report however is only the merchant fleet classed as all sea-going vessels of 100 gross tons or more. Included within this category are vessels that are required to comply with the International Maritime Organization's Safety of Life at Sea (SOLAS) directives. The merchant fleet is largely engaged in trade, passenger transport and in specialist marine engineering services.

Use of GNSS in the merchant fleet

GPS and GLONASS have long been accepted elements of the IMO World Wide Radio Navigation System (WWRNS) and are widely used for navigation either through a standalone receiver on the bridge or integrated with an electronic chart system.

D-GNSS networks, operated by national lighthouse authorities provide additional accuracy and integrity in some coastal waters and is widely used in the merchant fleet.

GNSS is increasingly finding its way into other maritime systems and can now be found on vessels as part of their Automatic Identification System, as part of their search and rescue equipment, to enable them to be tracked for homeland security purposes and to allow them to be accurately positioned for marine engineering purposes.

Search and Rescue (SAR)

Search and rescue (SAR) is about searching and aiding people who are in distress or imminent danger and have activated an Emergency Position-Indicating Radio Beacons (EPIRB). The current international SAR service is provided free of charge by Cospas-Sarsat to national Rescue Coordination Centres and is used by about one million beacon owners for maritime, aviation and leisure applications and over the last 30 years has on average contributed to saving 1300 lives per year.

Opportunities for GNSS

The IMO has recently proposed a new concept for safe and efficient maritime navigation known as e-Navigation. It has been recognised that robust PNT is fundamental to the entire e-Navigation concept. As such it is likely to be a recommendation that dual GNSS constellation receivers are used as a means of meeting e-Navigation requirements. e-Navigation implementation could be a driver for Galileo uptake within the maritime community.





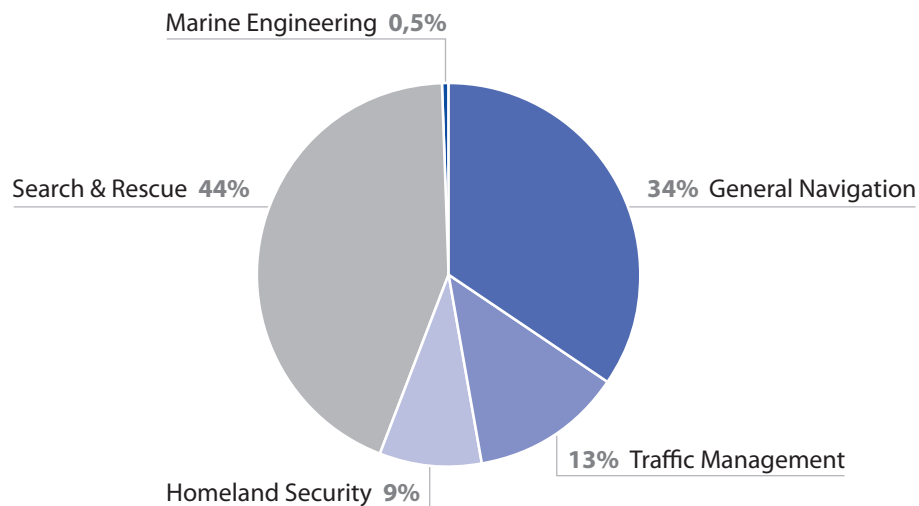
Maritime value chain: wide range of suppliers with varying levels of GNSS integration with bridge systems

	Device and Service providers	Bridge integrators	Ship owners/operators	Maritime administrations	Ports
Example companies	Main players <ul style="list-style-type: none"> Japan Radio Company Garmin Furuno Leica Geosystems Raytheon Trimble SAAB 	Main players <ul style="list-style-type: none"> Kelvin Hughes Raytheon Anschütz Northrup Grumman Sperry Marine Kongsberg Maritime Japan Radio Company 	Main operators <ul style="list-style-type: none"> Maersk Line MSC CMA CGM Group Evergreen APL 	Main organisations <ul style="list-style-type: none"> International Maritime Organization (IMO) sets international standards for merchant shipping International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) is an industry body harmonising aids to navigation 	Main categories <ul style="list-style-type: none"> Large container ports Specialist coastwise ports Cruise & ferry terminals
Market trends	<ul style="list-style-type: none"> Increased reliance on GNSS for navigation and as an input to other bridge systems Increasing use of vessel position for safety, commercial and homeland security applications Integrity remains an important priority Regulatory developments indicating that a multi-constellation and multi-frequency solution may be required in the near future Increasing levels of automation on the bridge in an attempt to reduce the workload of the mariner Larger modern vessels being constructed with high performance Integrated Bridge Systems 				

The merchant marine GNSS market is driven predominantly by vessel reporting applications

Many of the regulated applications of GNSS in the maritime sector already have high, if not total, GNSS penetration. For these applications, equipment replacement and new vessel construction is the driver for equipment sales.

**GNSS unit shipments by application
(2006-2010)**

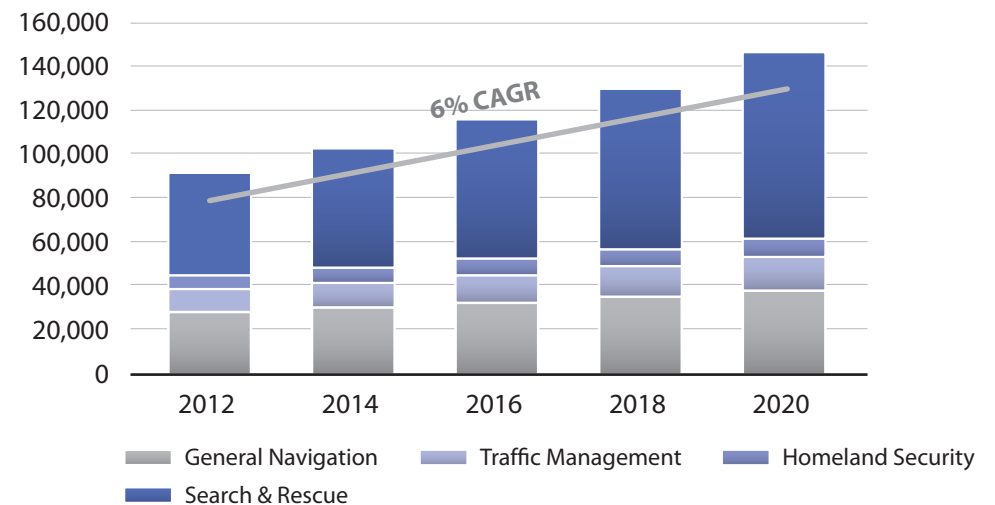


Sales of devices overall are now dominated by GNSS equipped search and rescue devices for which a number may be installed on each vessel, e.g. on lifeboats. In addition the lifecycle of a search and rescue beacon tends to be shorter than for a standard navigation receiver. Other applications tend to only be installed in smaller numbers.

Over the next decade shipments of GNSS devices will be driven by increased penetration of GNSS into search and rescue beacons. This will lead to a CAGR of 6% until 2020.

Future shipments of GNSS navigation equipment are expected to continue to be driven by replacement of old equipment and new vessel construction. Regulation could also impact the market, particularly if the IMO require or recommend dual constellation receivers to be carried as part of the e-Navigation initiative.

GNSS unit shipments (2010-2020) by application





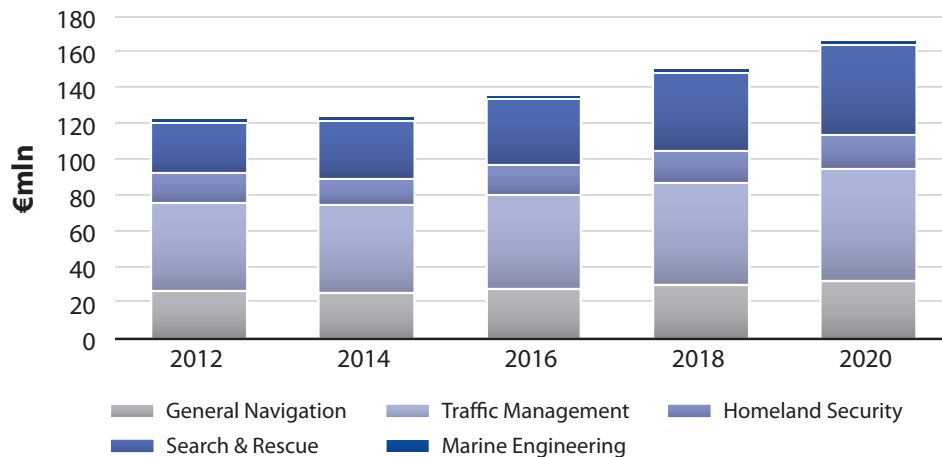
Revenues from GNSS in the merchant maritime domain will reach €169 mln by 2022

In the next ten years the total cumulative revenues from device sales in the merchant marine domain will reach €1.4Bn. More than half of this revenue will be driven by increasing penetration of GNSS within emergency position-indicating radio beacons (EPIRB) as well as a growing market overall. The more traditional use of GNSS for vessel navigation will account for over a quarter of total revenues.

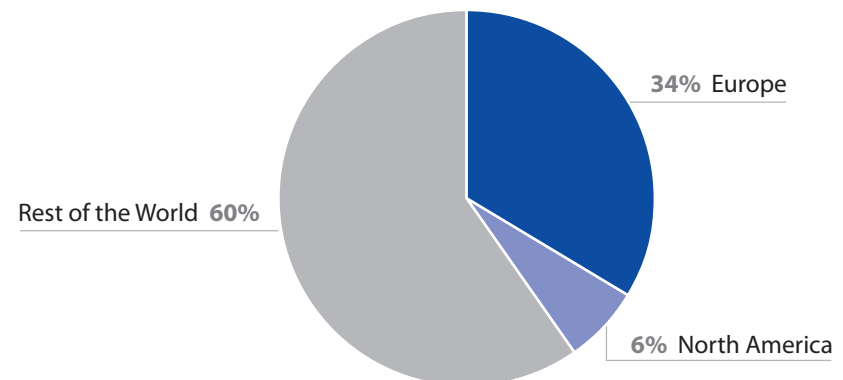
The price per device currently ranges from €500-800 for search and rescue beacons through to €5,000+ for a beacon to serve homeland security applications. These prices are expected to fall marginally over time.

Equipage in the merchant fleet is driven by equipment replacement and by new build vessels entering the global fleet. Growth in recent years has been driven by the expanding economies of Asia and South America.

GNSS revenue share per application (m EUR)



Merchant fleet GNSS receiver market 2010





European GNSS adds value in maritime applications



The Galileo Search and Rescue (SAR) service will be one of the early Galileo services. SAR/Galileo will be Europe's contribution to the "MEOSAR Programme" of the Cospas-Sarsat programme, founded by Canada, France, Russia and the USA. The SAR/Galileo service will provide:

- ▶ A "forward link" which allows the detection and localisation of distress signals worldwide (in cooperation with Cospas-Sarsat infrastructure).
- ▶ A "return link" which allows the worldwide transmission of short messages to distress beacons, for example acknowledging that a distress signal has been received. This function is new and specific to Galileo.



Example of R&D project: SAFEPORT

SAFEPORT is an FP7 project that takes its cue from the aviation industry, which has addressed safety issues created by increased traffic through increasing automation and the use of sophisticated traffic management systems.

SAFEPORT has developed and demonstrated an EGNOS based Active Vessel Traffic Management and Information System (A-VTMIS) to manage vessel movements within their jurisdiction. This will ensure that vessels follow safe paths and don't collide with other ships while at the same time improving the efficiency of port operations.

Furthermore, an EGNOS based pilot aid (SafePilot) which will ensure that harbour pilots can safely and efficiently navigate the courses provided by the A-VTMIS has been developed. Trials undertaken in Dublin Harbour has helped to validate the concept.

Additionally, the implementation of GNSS based authentication mechanisms to support identification and safe recognition of assets, cargo, ships, etc. is considered essential for safety-related operations.



API	Application Programming Interface	GPS	Global Positioning System
APV	Approach with Vertical Guidance	IFR	Instrument Flight Rules
ADAS	Advanced Driver Assistance Systems	IOC	Initial Operational Capacity (of Galileo)
ARPU	Average Revenue Per User (annually)	LBS	Location Based Services
ASP	Average Selling Price	p.a.	Per Annum (per year)
ATM	Air Traffic Management	PDA	Personal Digital Assistant
AWU	Annual Work Unit	PND	Personal Navigation Device
CA	Commercial Aviation	POI	Point Of Interest
CAGR	Compound Annual Growth Rate	ROW	Rest of the World
CAT	Category	RTK	Real Time Kinematic
CS	Commercial Service (of Galileo)	RUC	Road User Charging
DDC	Delays, Diversions and Cancellations	SBAS	Satellite Based Augmentation System
DGPS	Differential GPS	SDK	Software Development Kit
EC	European Commission	SESAR	Single European Sky ATM Research
EGNOS	European Geostationary Navigation Overlay Service	TTFF	Time To First Fix
ESA	European Space Agency	VAT	Value Added Tax
EU	European Union	VFR	Visual Flight Rules
GA	General Aviation	WAAS	Wide Area Augmentation System
GNSS	Global Navigation Satellite System	Wi-Fi	Wireless Fidelity (a common wireless networking technology)
GSA	European GNSS Agency		



The European Commission

The European Commission, mainly through its Directorate General for Enterprise and Industry, is the programme manager of Galileo.

The Full Operational Capability phase of the Galileo programme is managed by the European Commission and is fully funded by the European Union. The Commission and the European Space Agency (ESA) have signed a delegation agreement under which ESA acts as design and procurement agent on behalf of the Commission.

The European Commission is also promoting the use of EGNOS and Galileo by end-users and decision makers alike in order to foster the development of cutting-edge GNSS applications and user services and devices.



The European GNSS Agency (GSA)

The European GNSS Agency (GSA) is the authority formed by the European Union to accomplish specific tasks related to the European GNSS programmes. Its current mission is to:

- ensure the security accreditation of the systems and the operation of the Galileo security centre;
- contribute to the preparation of the commercialisation of the systems, laying the foundations for the economic sustainability and maximising the economic, social and public benefits;
- accomplish other tasks entrusted to it by the Commission, such as the promotion of applications and services and managing the R&D programmes on satellite navigation.

