Agriculture

WITH AN ANALYSIS OF GNSS USER TECHNOLOGY

GNSS MARKET REPORT

ISSUE 4

Excerpt from the GNSS MARKET REPORT, ISSUE 4 (2015)

European GNSS Agency

Agriculture

GNSS applications

Precision agriculture is the application of different technologies and solutions to make farming more efficient, improve crop yield and reduce the environmental impact. Key GNSS enabled applications include:

- **Farm machinery guidance** uses GNSS positioning to assist drivers in following the optimal path, thus minimising risks of overlaps.
- **Automatic steering** completely takes over the steering of farm equipment.
- **Variable rate application** combines GNSS positioning with information from other sensors and digital maps to distribute the right amount of agrichemicals.
- **Yield monitoring** enables site-specific monitoring of harvest, combining the output of a yield sensor with the GNSS positioning of the harvester.
- **Biomass monitoring** enables site-specific monitoring of biomass in an agricultural field, providing up-to-date information on crop development.
- **Soil condition monitoring** enables updates on soil moisture levels, fertility or diseases to optimise their management. GNSS positioning and software applications identify the exact position of the soil samples sent to laboratories. Data from soil sampling is then used in VRT application maps.
- **Livestock tracking** and virtual fencing uses GNSS to track animals and provide virtual fencing.

Agri-logistic applications such as:

- **Farm machinery monitoring and asset management** use real-time GNSS information to monitor the location and mechanical status of equipment and to efficiently manage workflows.
- **Geo-traceability** enhances the effectiveness of food, animal and product traceability by using transponders on animals and vehicle GNSS trackers, as well as by geo-referencing location and size of land parcels.
- **Field delineation** is the precise measuring of the boundaries and size of agricultural fields and can be done with GNSS. In the case of the Common Agricultural Policy (CAP) in the EU, GNSS positioning is used by inspectors for on-the-spot checks to investigate non-compliance in the area-based subsidy system.

In this chapter

- **Key trends:** Precision agriculture boosts farming productivity and helps solve societal challenges.
- **Industry:** List of main players by value chain segment.
- **Recent developments:** North America drives the growth of precision agriculture solutions.
- **Future market evolution:** Growth of advanced applications will push revenues despite the pressure on prices.
- **User technology:** The integration of GNSS in cloud-based systems enhances farms management.
- **Focus on European GNSS:** EGNOS and Galileo improve the effectiveness of precision agriculture.
- **Reference charts:** Yearly evolution of GNSS devices' installed base and revenues by segment and geographic area.

Precision agriculture boosts farming productivity and helps solve societal challenges

Key market trends

- The uptake of precision agriculture in Europe and worldwide will continue to grow, thanks to the benefits provided to farmers in terms of increased productivity.
- The Asia-Pacific region will progressively challenge the role of North America as the largest GNSS market.
- More demanding users are driving the evolution of precision agriculture towards all-around farm management solutions.
- GNSS supports the agri-environmental policies on both a regional and global scale.

GNSS applications offer high returns on investment

Precision agriculture is the application of different technologies and solutions to manage the variability of agricultural production, improving crop yield and reducing the sector's environmental impact. Precision agriculture systems **increase productivity** in all phases of the agricultural activity, from soil preparation to harvesting:

- Less time is needed per operation;
- Downtime due to fog or nightfall is reduced;
- Soil compaction is minimised by driving over precisely the same tracks;
- Fuel consumption is reduced;
- Savings on input costs (seeds, fertilizers, pesticides) are achieved;
- Soil and plant physicochemical parameters are monitored to ensure the optimal conditions for plant growth.

Innovative applications combine GNSS with other technologies

- **GNSS** enables the precise and reliable positioning of tractors, implements and other assets.
- **Earth Observation** will increasingly support digital applications used for precision agriculture. The European Copernicus Programme aims to develop a comprehensive Earth Observation capability. It provides different sets of information on land cover and valuable information to support precision agriculture solutions that leverage GNSS for positioning.
- **Aerial photography** from airplanes and UAVs can cost-effectively capture data for digital application maps.
- **Optical systems** can be utilised when crops have a row or a trim line that can be followed.

Sophistication of user needs drives the generation of new services

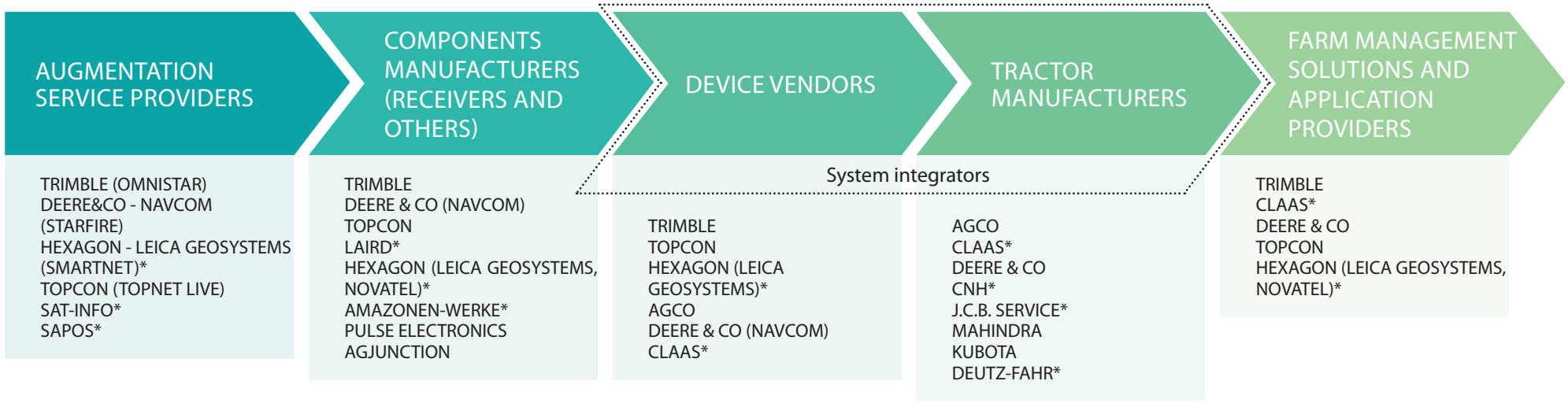
Farmers consider the type of cultivation and the size of their agricultural holding in selecting the optimal GNSS solution to satisfy their needs. High levels of **positioning accuracy** support the most demanding applications, such as automatic steering.

As with any other technology, precision agriculture solutions are also evaluated based on their **reliability** and **cost-effectiveness**.

With time, decision making power by end users has progressively increased. Farmers increasingly demand **ease of use** and **interoperability** of different services offered by various providers. This includes the possibility to integrate precision agriculture, digital mapping and asset management solutions into a single system.

The industry has reacted by starting to offer integrated platforms for **farm management**, which in the future could incorporate and replace services and products focusing only on in-field activities. Apart from reliability and cost-effectiveness for farmers, by addressing the challenges of limited land availability and increasing population, precision farming ensures **sustainability of agriculture**, reduction of **environmental footprint** and **food safety** for society.

Agriculture Value Chain



The EU GNSS industry in the global arena

In terms of components and receiver manufacturers, European companies have a 10% share of the overall market, with the leading players being Laird, Amazonen-Werke and Hexagon. For system integrators, European companies have a market share of 28%, with the top three players being Hexagon and its subsidiary Leica Geosystems, Claas and CNH. Claas is an application provider and tractor manufacturer. CNH also produces tractors (formerly New Holland and Case).

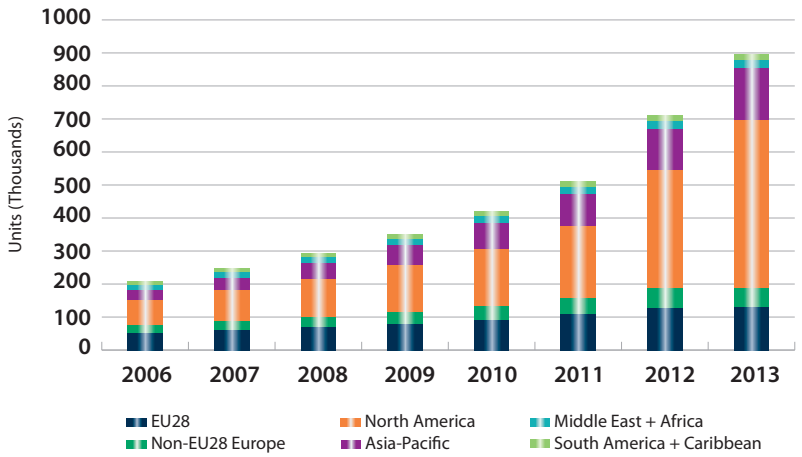
Overall, the GNSS agriculture industry is concentrated in North America, which hosts 63% of the components and receivers market and 46% of the system integrators.

* European companies

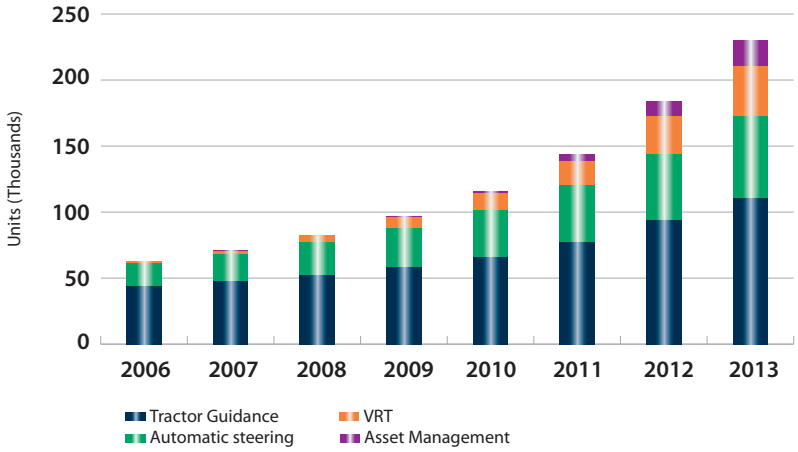
Value chain considers the key global and European companies involved in the GNSS dowstream activities.

North America has driven the growth of precision agriculture solutions

Installed base of GNSS devices by region



Shipments of GNSS devices by application



Between 2006 and 2012, the installed base of GNSS devices worldwide more than tripled, from 200,000 to some 700,000 units.

North America is the most technologically advanced region, accounting for 57% of all GNSS devices in 2013, which are diffused in the 2.5 mln farms found across the United States and Canada. Agricultural holdings are typically large-sized, wealthy and farmed using machine-intensive techniques. Additionally, high costs of labour relative to capital make labour-saving techniques particularly attractive. Major crops include corn, soybeans, wheat and alfalfa.

Asia-Pacific, which is made up of countries with very different agricultural features, is the fastest-growing region in terms of GNSS devices in use – from 0.3% of the total installed base in 2006 to 17% in 2013. **Europe** also experienced an increase in the installed base of GNSS devices, from 51,000 units in 2006 to 129,000 units in 2013. However, this growth has been at a slower pace than the rest of the world (14% per year).

The most mature market is Australia. The increased efficiency provided by GNSS allows farmers there to address such challenges as water shortage and soil fertility, that affect many of Australia's very large farms.

From 2006 to 2013, **Tractor Guidance** remained the most widespread GNSS-based application in Agriculture, accounting for almost 500,000 units in 2013 and a corresponding share of 54% of all devices.

Automatic Steering, which requires a higher level of accuracy, grew significantly thanks to increased adoption in developed countries. This trend confirms that high-accuracy solutions are "addictive" to farmers in that they are not likely to abandon top-end solutions after implementing them.

Variable Rate Technologies (VRTs) are also starting to be increasingly adopted by farmers. GNSS shipments in VRTs grew from near zero in 2006 to 38,000 in 2013.

Asset Management solutions are now starting to complement in-field solutions. Their shipments increased from close to zero in 2006 to 43,000 units in 2013

Growth of advanced applications will push revenues despite the pressure on prices

From 2013 to 2023, annual shipments of GNSS devices are expected to increase more than fivefold – up to almost 1.2 mln units worldwide. Overall, **GNSS penetration*** is foreseen to experience a steady increase over the next decade, reaching 50% by 2023.

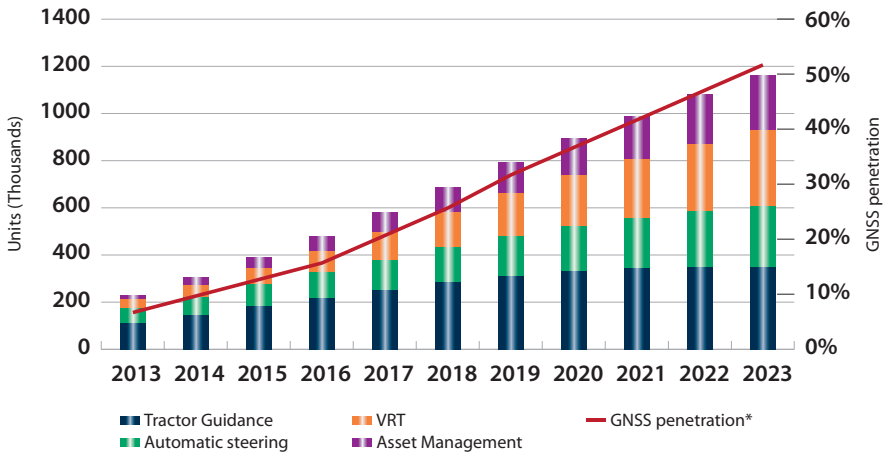
Increasing competition, bargaining power of end users and economies of scale are all expected to contribute to a progressive **decline in the average price** of devices, with the effect of technological advancements only partially compensating price erosion.

However, thanks to the sustained growth in GNSS device shipments, and in particular advanced applications, **global revenues** are **expected to increase** in all GNSS-enabled agricultural applications.

Variable Rate Technologies will progressively gain momentum, with revenues increasing from €135 mln in 2013 to €723 mln in 2023. Likewise, revenues from **Asset Management** will grow from €11 mln in 2013 to €102 mln in 2023.

Automatic Steering will generate the largest share of revenues and remain the most expensive application in terms of average price per device. However, it is also expected to experience the fastest price decrease, as high-accuracy applications will become increasingly commoditised worldwide. Overall, revenues associated with **Tractor Guidance** are expected to peak in 2018, at which point they will begin to decline as farmers shift towards more advanced solutions.

Shipments of GNSS devices by application



* GNSS penetration is defined as the proportion of all high-powered tractors in use that is equipped with GNSS

GNSS can improve productivity and help Asia-Pacific tackle challenges

Asia-Pacific is expected to take the driver's seat in terms the adoption of GNSS devices, growing from 156,000 units in 2013 to 2.3 mln units by 2023. In particular, China and India are high-potential countries who play a prominent role in the agriculture-related economy (respectively absorbing 35% and 47% of total employment) and thus exhibit significant room for improvement in terms of production efficiency.

GNSS applications target the **major crop productions** in China and India, including wheat, sugarcane and cotton.

Sustained productivity growth in these countries is needed to solve a series of societal challenges:

- **Urbanization:** as the rural population continues to relocate to cities, there is an increasing shortage of agricultural labour force.
- **Increasing population:** food demand is growing when population is increasing (especially the case of India).
- **Chronic land and water shortages:** available land for cultivation is limited and it is not expected to increase over the coming years. Water shortage is also an increasing issue affecting Agriculture.

By improving agricultural productivity, precision agriculture will significantly help tackle these challenges, in particular as the trend towards mechanisation continues. Growth in the average size of holdings will also play a major role in boosting the uptake of GNSS.

The integration of GNSS into cloud-based systems enhances farm management

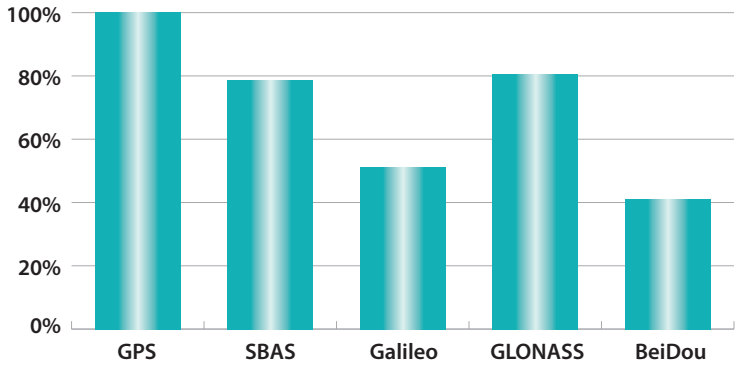
The integration of GNSS positioning in **Farm Management Information Systems (FMIS)**, together with the use of additional information coming from various sensors, has revolutionised precision farming. FMIS is a system for collecting, processing, storing and providing data in the form needed to manage a farm. GNSS links this data to specific geographical coordinates. Additional sensors can be used to enable remote sensing with additional information being provided by Earth Observation systems and meteorological stations.

All these data - integrated into a cloud-based platform for farm management - provide farmers with an **effective decision making tool** capable of improving overall productivity and supporting farmers' activities and choices. In particular, the data is used for monitoring costs, managing human resources and machinery, providing powerful reporting, planning for the future, and monitoring yields.

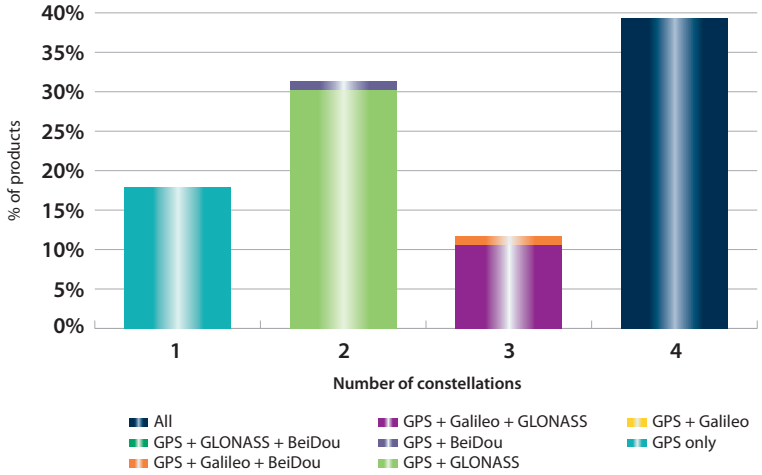
The emergence of more affordable, **dual-frequency and multi-constellation receivers**, as well as evolutions of PPP solutions, will further support precision farming – contributing, for example, to the improvement of GNSS-based machine auto guidance.

The charts below underline how agriculture is one segment making use of advanced GNSS, with almost 80% of devices integrating SBAS and almost 40% of models able to track all 4 constellations*.

Capability of GNSS receivers – Agriculture segment



Supported constellations by receivers – Agriculture segment



* For the methodology applied to the charts please go to page 15 of the Report.

EGNOS and Galileo improve the effectiveness of precision agriculture

EGNOS offers an affordable solution for precision agriculture, enabling farmers to optimise yields, increase labour productivity and reduce driver fatigue – all with minimal investment.
EGNOS supports machinery guidance solutions with sub-metre level accuracy, which is suitable for basic-value crop cultivation (e.g. cereals). It also enables more efficient management of such farming activities as spreading, spraying and harvesting.
As a result, the optimised use of seeds, fertilizers and herbicides – as well as a reduction of fuel and driver fatigue – leads to increased productivity. In other words, EGNOS provides advantages to both farmers (higher profits margins) and society (increased food supply and more environmentally friendly agriculture).

Galileo will further improve the performance of GNSS-assisted agriculture. It will offer enhanced availability and continuity in a multi-constellation environment, as well as improved real-time positioning accuracy based on dual-frequency capability.
The Galileo Commercial Service will provide access to two additional robust signals, delivering a higher data throughput rate and high accuracy down to the centimetre level. It will also offer enhanced independence from ground-based augmentation systems.
A demonstrator for Galileo Commercial Service currently being set up will showcase these capabilities.

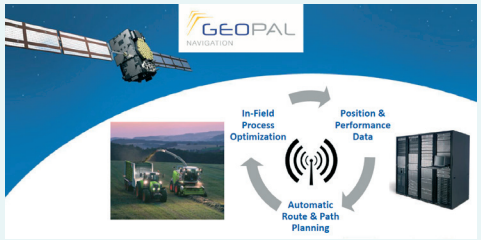
European EGNSS R&D Programmes support the competitiveness of the EU industry

The GeoPal project supports logistics operations on the farm

GEOPAL is a GNSS based system used to plan logistics in Agriculture. The system assists farmers in improving efficiency during in-field and inter-field logistic activities. GEOPAL covers the following activities:

- Fleet management and logistics (operations management tools and the required ICT systems);
- Coordination, mission and route planning functionalities for field machinery;
- Closed loop integrated optimal planning, execution of automated field operations and monitoring.

More information available at http://www.geopal-project.eu/

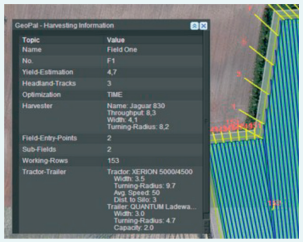


Source: GEOPAL project

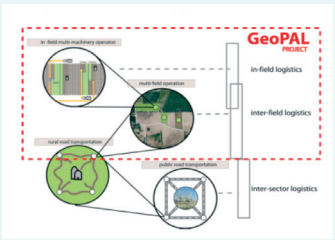
MISTRALE - innovation in flood and soil humidity mapping

The need for efficient water resource management and accurate risk evaluation in Agriculture is increasing, in line with competitiveness and productivity requirements.
The MISTRALE project (Monitoring of Soil Moisture and Water-flooded Areas for AgricuLture and Environment) aims to provide reliable flood and soil humidity mapping to farmers using a small Remotely Piloted Aircraft Systems (RPASs) equipped with a dedicated receiver for GNSS-reflected signals.

This innovative technology will allow for continuous data provision (overcoming both darkness and vegetation issues) with improved mapping and navigation capabilities.
EGNOS and Galileo will be used to improve the navigation capabilities of RPASs.

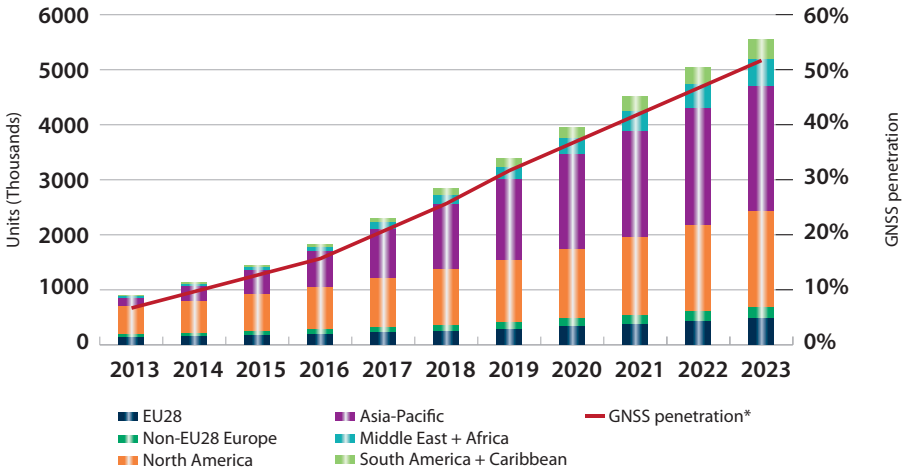


Source: GEOPAL project



Source: GEOPAL project

Installed base of GNSS devices by region



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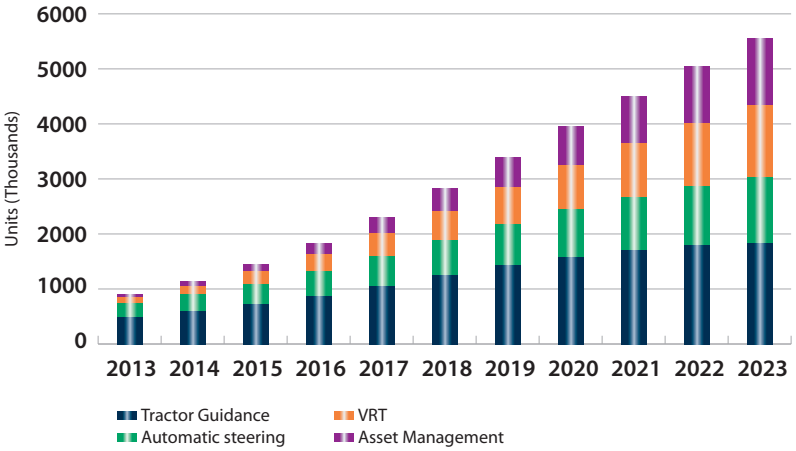
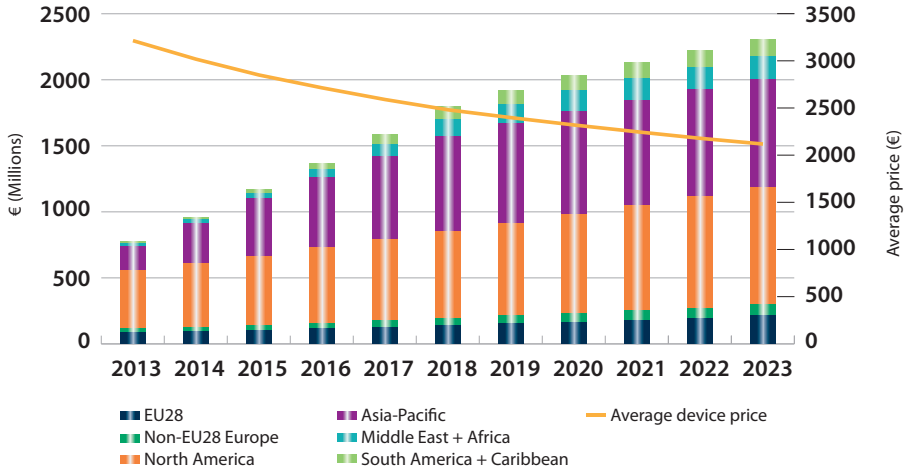
Installed base of GNSS devices by application



Revenue of GNSS device sales by region



Core revenue of GNSS device sales by application