EU SPACE
Market Report

2026
ISSUE 1

#EUSpace

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On the cover: Adriatic coastline, Split, Croatia. Contains modified Copernicus Sentinel data (2026), processed by EUSPA.

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The EU Space Programme: several components delivering a wealth of services to citizens and institutions

GALILEO AND EGNOS

The European Global Navigation Satellite System (EGNSS) allows users with compatible devices to determine their position, velocity and time by processing signals from satellites; it currently comprises Galileo and the European Geostationary Navigation Overlay Service (EGNOS).

Galileo provides improved positioning and timing information with significant positive implications for many European services and users. It offers independent and interoperable services with other GNSSs, including the Open Service, complemented by the Open Service Navigation Message Authentication (OSNMA) anti-spoofing feature, the High Accuracy Service (HAS), Search and Rescue (SAR/Galileo), the secure Public Regulated Service (PRS) for authorised government users, and the future Early Warning System Service (EWSS) to support warning dissemination for natural or man-made disasters.

EGNOS, Europe's regional Satellite-Based Augmentation System (SBAS), augments the US Global Positioning System (GPS) signals. It is being upgraded to also augment Galileo, improving accuracy and providing integrity information. It features four main services: Open Service, Safety-of-Life, the EGNOS Data Access Service (EDAS) and the newly introduced EGNOS Safety of Life (SoL) assisted service for Maritime Users (ESMAS). EGNOS is evolving to EGNOS V3, which will introduce dual-frequency, multi-constellation capabilities, enhanced robustness and built-in security for safety-critical applications.

COPERNICUS

Coordinated and managed by the European Commission, **Copernicus** is the European Earth Observation (EO) and monitoring programme. Copernicus relies on its own fleet of Sentinel satellites, which is complemented by contributing missions from public and commercial operators, and a wide range of in-situ measurement systems covering the atmosphere, land and ocean. Copernicus is set to also benefit from a series of expansion missions to fill observational gaps in support of EU policies.

The accurate and reliable data generated are transformed into value-added information by the **Copernicus Services** across several thematic domains, including monitoring of the atmosphere, marine environment, land, and climate change, as well as security and emergency management.

Copernicus data are made available to users worldwide under a full, free and open data policy and can be accessed through multiple distribution channels, including the Copernicus Data Space Ecosystem (CDSE), services data stores and cloud services, as well as thematic hubs tailored to specific domains that serve as single entry points to relevant data and products, such as Health, Coastal, Energy, the Arctic environment and the most recent World Heritage Hub.

GOVSATCOM AND IRIS²

The EU GOVernmental SATellite COMmunication (**GOVSATCOM**) programme aims to ensure the long-term availability of reliable, secure, resilient and cost-effective satellite communication services for EU and national public authorities. To achieve this, the GOVSATCOM Hub was established as a central component of the programme; it acts as the secure interface between authorised users and accredited satellite operators, pooling and sharing capacities and managing access in a coordinated 'system of systems' approach. The needs of authorities addressed include the management of emergency and security-critical missions, operations and infrastructures. These also include defence and public safety-related operations, as well as diplomatic communication. GOVSATCOM, through its hub-based model, avoids duplication of efforts between EU Member States and helps overcome the existing fragmentation of the Secure SATCOM market.

IRIS² (Infrastructure for Resilience, Interconnectivity and Security by Satellite) is the recent addition to the Secure SATCOM component of the EU Space Programme. IRIS² is implemented via a concession contract with the SpaceRISE consortium and foresees the deployment of a multi-orbit constellation of 290 satellites, combining Low Earth Orbit and Medium Earth Orbit assets to provide secure, resilient connectivity. IRIS² aims to further enhance EU satellite-based connectivity, integrate and expand the GOVSATCOM portfolio, interface with the EuroQCI quantum communication infrastructure, and offer additional services to both authorised government and commercial users.

SPACE SITUATIONAL AWARENESS

Space Situational Awareness (SSA) adopts a holistic approach to supporting Europe's safe and sustainable use of space, by building comprehensive knowledge of space debris, space weather and Near-Earth Objects. SSA covers three main components:

- **Space Surveillance and Tracking (SST)**, which uses a network of sensors and processing capabilities to detect, catalogue and track artificial space objects and predict conjunctions and re-entries;
- **Near-Earth Objects (NEO)**, which focuses on risk monitoring of natural objects in the Solar System whose orbits approach the Earth;
- **Space Weather Events (SWE)**, which provides operational service to users on the space weather effects.

Linked to SSA, **Space Traffic Management (STM)** encompasses the rules, procedures and operational measures needed to access, operate in and return from outer space safely, sustainably and securely, and relies on continuous observation of space traffic. In the EU, the EU SST Partnership and its sensor network provide collision-avoidance, re-entry and fragmentation services and form the operational backbone of the emerging EU STM approach, which is being further reinforced by the new EU STM policy framework and the proposed EU Space Act on safe, resilient and sustainable space activities.

Dear Reader,

For the past years, EUSPA's Market Report has been the go-to-source for insightful information and expertise that policymakers, entrepreneurs and major corporations rely on.

Today's space downstream market isn't limited to Earth Observation and Global Navigation Satellite System (GNSS), neither is our Market Report now.

I'm pleased to introduce the first EU Space Market Report.

In addition to offering the comprehensive overview of key Satellite Navigation and Earth Observation market trends and forecasts, this new issue addresses the evolving secure Satellite Communication (SATCOM) and Space Situational Awareness (SSA) markets.

In the following pages, you will see how the Earth Observation market is poised for significant growth, with global revenues rising from €3.5 billion in 2024 to €7.9 billion by 2034, driven by a fast growth in segments like agriculture, energy and raw materials, climate and infrastructure.

On the Satellite Navigation side, growth is becoming increasingly service-driven, with total revenues expected to increase from more than €300 to over €580 billion between 2024 and 2034, indicating that Satellite Navigation monetization is heavily tied to digital ecosystems and value added applications rather than user devices alone. Nonetheless, the global installed base will reach almost 10 billion units in 2034.

Secure Satellite Communication and Space Situational Awareness are emerging as core enablers of resilience, continuity and sovereignty across civilian and governmental activities in a more connected, and thus risk exposed, society which is increasingly dependent on a sustainable use of space-based services.

Beyond the global market perspective, this Report also examines developments across 16 market segments. Each segment is elaborated in terms of Satellite Navigation and Earth Observation applications, key trends and developments, value chain and market evolution in the coming decade. The use of EU Space data and services is inherently synergetic for most of the addressed market segments.

The Report presents global market data through a comprehensive set of insightful charts, graphs, and practical examples, providing analyses from both supply- and demand-side perspectives, together with geographical breakdowns.

Looking ahead, the downstream sector is expected to enter a decade of sustained growth and transformation, driven by technological innovation, expanding commercial opportunities, and increasing global demand for services and user devices, thereby reinforcing its strategic role in delivering economic value and societal benefits worldwide.

I am confident that our EU Space Market Report will let you to keep your finger on the pulse of the entire space downstream industry and reap the many benefits offered by this rapidly developing market.

Rodrigo da Costa

EUSPA Executive Director

May 2026

How to read this report

The EUSPA and the European Commission welcome all readers to the first issue of the **EU Space Market Report**. The report places downstream users and integrated solutions at its core, providing global coverage of EO and GNSS applications across multiple market segments, as well as synthetic analyses of Secure SATCOM and SSA markets.

For those readers that are new to the report, the EU Space Market Report is a continuously evolving publication that features both **qualitative and quantitative market analysis** and builds on a similar structure and format used for the previous issue, which focused on GNSS and EO. Compared to previous editions of the Market Report, this issue now features a qualitative assessment of the market for Secure SATCOM, supported by quantitative figures on data demand revenues. Moreover, synergies between GNSS, EO and Secure SATCOM are presented across the market segments. Furthermore, a qualitative analysis of the SSA market is also included.

The **16 market segments** are the following: Agriculture; Aviation and Drones; Climate, Environment and Biodiversity; Consumer Solutions, Tourism and Health; EU Border and Internal Security (NEW!); Emergency Management and Humanitarian Aid; Energy and Raw Materials; Fisheries and Aquaculture; Forestry; Infrastructure; Insurance and Finance; Maritime and Inland Waterways; Rail; Road and Automotive; Space; Urban Development and Cultural Heritage.

The report is structured as follows:

- **A general overview of the downstream market** that covers the overarching trends impacting supply and demand; the downstream space application market; a general overview of the EO, GNSS, Secure SATCOM and SSA markets; and quantitative figures on market size and revenues of both EO and GNSS (as well as shipments and installed base in the case of GNSS). It further includes a global industry overview, as well as a general description of the components of the EU Space Programme. Finally, it features specific cross-cutting analyses for timing and synchronisation, IoT, drone services and the dual use of GNSS and EO.
- **The market segments** form the core of the report. All segments, regardless of length, follow a common structure:
    - An overview of **EO** and **GNSS** applications, including a description of each market category, with an introduction to the segment and an explanation of the role of **Secure SATCOM and SSA**, where relevant;
    - **Key** market segment **trends** illustrated with examples;
    - The **industry value chains** including a non-exhaustive list of key stakeholders;
    - **Recent developments**, featuring market data on historical shipments or installed base of GNSS devices and EO data and service revenues by application or region over the past decade, complemented by initiatives and examples that have recently been implemented;
    - **Future market evolution** including GNSS shipment and EO revenue forecasts for the coming decade to 2034. It presents ideas and concepts whose outputs will impact the market in the mid-term and highlights promising applications that might boost the future growth of the segment;
    - **European systems and projects** covering the current use of the services from EU Space Programme components and associated relevant projects within the specific segment; and
    - **Reference charts** that show a forecast of the installed base and revenues of the market segment by region and application.
- The chart data in this market report are presented from two angles. First, **demand data**, quantified in terms of revenues and documented at aggregate and segment level in the charts of this report, shows the regions in which shipments are sold, devices are used and revenues are generated. Possible double counting of revenues is avoided based on a rigorous segmentation of applications and their underlying market drivers. Moreover, the report features an improved methodology for estimating EO service revenues, based on the triangulation of top-down and bottom-up research on service providers and users.
- Second, the market share analysis looks at the **origin of supply** – where a company (or its ultimate parent) offering the product is headquartered – as presented on the dedicated industry pages where **market shares** in **percentage** are presented.
- The general introduction also provides insights in the **Low-Earth Orbit (LEO) revolution**, explaining how LEO constellations are transforming space infrastructure by complementing existing Medium Earth Orbit (MEO) and Geostationary Orbit (GEO) systems, offering benefits including greater resilience and better availability (GNSS), faster revisit time and higher resolution (EO) and lower latency and higher capacity (SATCOM).
- Annexes conclude the report with a description of the methodology behind the data presented (Annex 1), a definition of key performance parameters (Annex 2), a list of application descriptions (Annex 3), a list of acronyms (Annex 4) and information about the authors (Annex 5).

The first issue of the comprehensive **EU Space Market Report** analyses the downstream markets addressed by the EU Space Programme primarily with GNSS and EO but also marks the first step towards the integration of Secure SATCOM and SSA into the underlying economic model. **The EO and GNSS markets**, spanning a variety of applications, are now categorised into 16 segments, with the addition of EU Border and Internal Security. Secure SATCOM is defined around three relevant categories – surveillance, crisis management, and key infrastructure – addressing 12 use cases.
The landscape for downstream space markets is being shaped by a convergence of powerful forces: digital transformation accelerates across industries. Climate change intensifies the need for environmental monitoring; demographic and urban growth are expanding demand for infrastructure and mobility; and energy systems are under pressure from both rising consumption and the transition to sustainability. At the same time, the current geopolitical context is prompting organisations to seek more resilient and autonomous operations.
EU Space Programme components – Copernicus, Galileo, EGNOS, GOVSATCOM, IRIS² and SSA – are critical enablers for downstream space applications. This report demonstrates how European space capabilities deliver unique value and advantages across all market segments, both independently and through integrated solutions.

GNSS

The **global GNSS downstream market**, encompassing both device sales and the value-added services they enable, is projected to grow from more than 300 billion in 2024 to more than €580 billion by 2034.

GNSS global revenues keep rising from more than €300 billion in 2024 to more than €580 billion in 2034

GNSS enabled services will account for almost 80% of total revenues in 2034

The device market is projected to expand from about €82 billion in 2024 to nearly €122 billion by 2034, gradually reaching a more mature stage, whereas the value-added services market is expected to grow steadily, with revenues rising from more than €220 billion in 2024 to €460 billion in 2034.

Annual GNSS **device shipments** are projected to increase from 1.75 billion units in 2024 to more than 2.4 billion units by 2034, with devices for Consumer Solutions, Tourism and Health (smartphones being the main category, with wearables growing) and Road and Automotive (where built-in GNSS capability is now a standard in vehicles) together representing the majority of units shipped by 2034.

Although the GNSS market is mature, the global installed base of GNSS devices will continue to expand, thanks to GNSS capabilities becoming ubiquitous and a pathway of democratisation of multi frequency and increasingly high accuracy. The global installed base will reach almost 10 billion units in 2034.

Towards 10 billion receivers in use and 2.4 billion sold annually in 2034

Looking to **regional market growth**, the economic and demographic expansion of Asia-Pacific has driven the region to become the largest GNSS market. North America and Europe (including both EU27 and non-EU27) will continue growing and will remain large markets. South America and the Caribbean and the Middle East & Africa are expected to expand in both overall value and share of total revenues.

SECURE SATCOM

The **Secure SATCOM** market is rapidly evolving in response to growing demands for resilient, secured and reliable satellite communications across critical sectors such as border surveillance, crisis management, law enforcement and key infrastructure. Secure SATCOM provides distinguishing features across three core pillars: confidentiality, integrity and availability.
The drivers of market growth include the rising demand for secure and resilient connectivity, amplified by the geopolitical instability and increasing cyber threats. The landscape is characterised by the emergence of multi-orbit constellations (GEO, MEO, LEO), new business models and a dynamic ecosystem where European players compete with global organisation.
Strategic EU initiatives like GOVSATCOM and IRIS² aim to strengthen European sovereignty and resilience by pooling resources and providing secure, cost-effective services for authorised users.

EO

The EO market continues seeing growth in data and service revenues, pushed by the need for operational efficiency in segments like agriculture, energy and raw materials, climate and infrastructure. Accessibility of EO-based services for civilian users has improved thanks to dual use spillovers and LEO constellations, innovative business models and AI-driven technological advancements. The EO global downstream market, including both data and value-added service revenues, is expected to grow from €3.5 billion in 2024 to €7.9 billion in 2034.

EO global revenues forecasted to soar from €3.5 billion in 2024 to €7.9 billion in 2034

Value-added EO services represent the largest market and will grow to more than €6.7 billion in 2034

The **EO value-added services market** is considerably larger than the EO data market. EO value-added services generated a total of around €2.8 billion in 2024. The EO value-added services market is expected to experience sustained double-digit growth, achieving total revenues of more than €6.7 billion by 2034.

In 2024, more than 50% of revenues were generated by five segments: agriculture, the largest contributor with 21% of total revenues, driven by EO helping to address productivity constraints in light of the growing food demand; energy and raw materials; climate; environment and biodiversity; and insurance and finance.

Focusing on **regional growth**, EO demand will grow steadily at global level, with faster uptake in Asia-Pacific, South America and the Caribbean, and the Middle East & Africa. North-America was the largest regional market in 2024.

The European industry leads the market with 42% supply of global revenues

On the **supply side** of the market, US and European companies have a combined market share of more than 83%, with Europe accounting for 42% of the market.

SSA

SSA is becoming increasingly critical as the number of satellites, orbital activities and items of space debris continues to grow. SSA is composed of three sub-components: SST (Space Surveillance and Tracking), NEO (Near-Earth Objects), and SWE (Space Weather). SST, which focuses on monitoring and managing objects in orbit, plays a key role in addressing space debris and ensuring the safe operation of satellites.
The EU's SST component is designed to safeguard satellites, critical infrastructure and citizens by providing continuous monitoring and risk assessments. The EU SST Partnership, which brings together national capabilities from 19 EU Member States, together with the SST Front Desk at EUSPA, deliver services like collision avoidance, re-entry analysis and fragmentation detection.
Demand for these services is steadily increasing, with hundreds of satellites and organisations relying on EU SST for protection against in-orbit collisions and uncontrolled re-entries.

A comprehensive Market Report to address an expanding EU Space Programme

The evolution of the European Union Space Programme

The European Union's Space Programme has evolved from scientific and technological collaboration into an integrated policy and operational framework that now encompasses four cornerstone components: Galileo and EGNOS for satellite navigation; Copernicus for Earth observation; Space Situational Awareness (SSA); and Secure Satellite Communications (GOVSATCOM and IRIS²). This broadening reflects Europe's ambition to deliver strategic autonomy and cutting-edge services in space that support security, sustainability and innovation across sectors.

Over time, strong partnerships between the European Union, the European Space Agency, industry and user communities enabled the launch of flagship programmes that addressed navigation, Earth monitoring and security needs. By the turn of the century, the European Commission spearheaded the development of dedicated policies and funding arrangements, cementing space as a shared competence between the EU and Member States.

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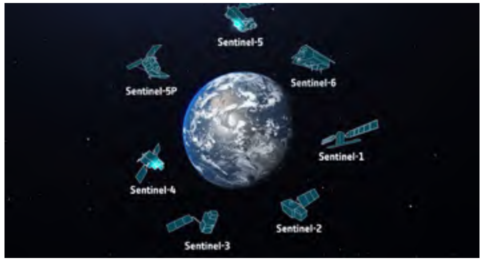
Europe's Galileo, with its 30 satellites, supports everything from smartphone navigation to timing services essential for banking and power grid.



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Copernicus, with its network of eight Sentinel satellites and contributing missions orbiting the Earth, acquires high resolution images and information about our planet.

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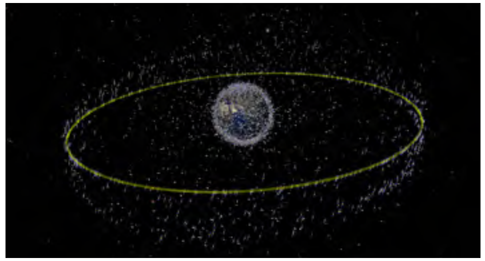
GOVSATCOM is a user-centric programme with a strong security dimension established by pooling the capacity of governmental and commercial satellite communication providers and sharing that capacity with authorized governmental users. The IRIS² constellation will consist of 290 satellites in LEO and MEO, aiming to provide the EU with secure, resilient and sovereign connectivity for both public and commercial use.



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Space Situational Awareness (SSA) supports comprehensive knowledge of space hazards, including space debris, near-Earth objects, and space weather.

Different programme components serving downstream users in synergy

Downstream users are at the heart of the EU Space Programme, and their evolving needs drive the integration of its four components. In fields like agriculture, disaster response, transport and public safety, users require robust, innovative, cost-efficient and scalable solutions that depend on the synergy of space technologies , including Earth observation data from Copernicus, accurate and trustworthy positioning from Galileo/EGNOS, secure connectivity, and space-based infrastructure safeguarded by SSA/SST. These integrated capabilities not only satisfy demanding operational requirements but also maximise the societal and economic benefits of EU space investments, delivering highly reliable services and safeguarding the continuity of the space assets that underpin all downstream applications.

A comprehensive downstream space market report

As the synergies between the four components of the EU Space Programme are most powerfully realised in downstream applications, **the Market Report has evolved into an overarching EU Space Market Report** that places **downstream users and integrated solutions at its core**.

Modern space-based products and services often **combine navigation, Earth observation, secure communication** and benefit from **space asset protection** in ways that support start-up and SME innovation and enable market growth across sectors such as transport, agriculture and emergency response. **By focusing on the downstream, the report captures the market potential and real-world impact of these synergies**, informs policy and funding decisions, and strengthens Europe's leadership and resilience in a competitive, user-driven space economy.

Macroeconomic forces reshaping space markets: urbanisation, geopolitics, climate, and deglobalisation

The geopolitical context: navigating global uncertainty

Geopolitical instability – which includes armed conflicts, trade disruptions and the reconfiguration of international alliances – **is increasingly shaping global economic activity**. This creates heightened uncertainty for both governments and businesses. In 2024, 61 state-based armed conflicts were recorded across 36 countries, up from 59 the previous year[1] to the highest level observed since World War II according to conflict monitoring datasets.

Beyond its humanitarian consequences, **geopolitical instability drives supply chain disruptions, energy insecurity, inflationary pressures and declining market confidence**. These effects complicate long-term planning and increase the need for enhanced risk assessment, operational resilience and real-time visibility across critical systems and geographies. Specific market segments face this pressure more acutely. As an example, in agriculture, rising food demand, land resource constraints, input costs, and labour shortages are driving the market to EO analytics and GNSS-enabled solutions, which aid in achieving the necessary operational efficiencies.

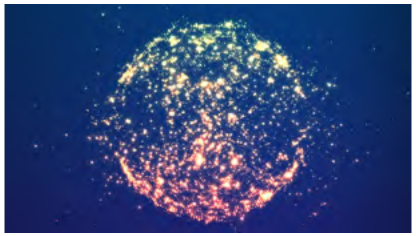
EO, GNSS, as well as Secure SATCOM increasingly function as strategic tools allowing for near **real-time responses to conflict-driven instability and heightened security requirements**. By enabling situational awareness, border and maritime surveillance, infrastructure protection and supply chain monitoring, and secure communication and connectivity, **EO, GNSS and Secure SATCOM** help governments and businesses anticipate disruptions, verify developments on the ground and maintain operational control in volatile and remote environments. As geopolitical risks persist, reliance on space-based data is expected to grow, positioning **these systems as critical enablers of security, resilience and informed decision-making** across sectors such as energy, transport and international trade.

Deglobalisation: the rise of regional ecosystems

Deglobalisation is altering international trade and investment patterns as **countries place greater emphasis on domestic production, strategic autonomy** and **economic resilience**. The increasing use of protectionist measures, including tariffs and export controls, **is disrupting established global supply chains** and increasing operational complexity for businesses.

Global average tariff rates increased from 4.8% in 2013 to 6.1% in 2024, reflecting rising trade tensions among major economies, according to international trade statistics.[2] These developments contribute to **higher costs, reduced efficiency and a shift towards regionalised supply chains**.

While satellite signals and coverage remain inherently global, the space sector itself is not insulated from deglobalisation. Trade barriers, export controls, semiconductor supply constraints and data sovereignty regimes affect critical components, launch services and data flows. As a result, deglobalisation trends can raise the cost of receivers, sensors and ground equipment, constrain access to key technologies and markets, and fragment regulatory environments for space services. In parallel, these dynamics may slow the growth of downstream industries that rely on space-based services, as higher costs, reduced interoperability and market fragmentation limit adoption and innovation.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1 Source: UCDP: Sharp increase in conflicts and wars
2 Source: Tariff rate, applied, weighted mean, all products (%)

Urban boom: the Southeast Asia's economic surge

Demographic and economic growth in the Southeast Asia region, combined with rapid urbanisation, is driving increased demand **for infrastructure, mobility, energy and public services**, expanding the **addressable market for downstream space-enabled solutions**.

Urbanisation in the Southeast Asia has accelerated markedly, with the share of the population living in urban areas increasing from 22% in 1967 to nearly 50% today and projected to reach 66% by 2050, according to the UN.[3] This trend is expected to result in a tripling of urban travel demand between 2015 and 2050.[4]

Rapid urban expansion and rising population density are placing increasing pressure on transport networks, land use, energy supply and public services across the Southeast Asia. As cities sprawl outward while becoming denser, governments face growing challenges in coordinating infrastructure development, managing congestion and ensuring efficient service delivery.

In this context, EO and GNSS technologies jointly enable more effective urban management and infrastructure planning. EO provides large-scale, up-to-date insights on land-use change, urban sprawl and environmental impacts, while GNSS enables precise positioning and timing for mobility management, transport optimisation and infrastructure operations. In a context of growing urbanisation. Secure SATCOM technologies enable resilient backup for critical services and protect critical infrastructure. Together, these technologies support more secure and sustainable urban development, improved energy and utility management, and long-term growth of the downstream space-enabled solutions market.

Managing climate impact: the new economic reality

Climate change is increasingly **affecting economic activity, infrastructure and public safety** through rising temperatures, more frequent extreme weather events and long-term environmental change. According to the World Meteorological Organisation, the period 2015 to 2025 represents the warmest nine years on record, with global average temperatures reaching around 1.42°C above pre-industrial levels.[5]

These trends **increase risks related to food security, water availability, health and critical infrastructure**, while also raising the **need for effective adaptation and mitigation measures**. Governments and businesses are therefore facing growing **pressure to assess climate-related risks**, monitor environmental conditions and **support evidence-based decision-making**.

EO solutions play a central role in **monitoring climate variables, tracking environmental change and assessing the impacts of extreme events**, while GNSS supports applications such as **disaster response, infrastructure resilience and environmental management**. As climate-related risks intensify, the demand **for reliable, timely and large-scale data is expected to further support the uptake of downstream space-enabled services**.


© pexels

3 Source: https://www.unescap.org/kp/2025/urban-transformation-asia-and-pacific-growth-resilience
4 Source: Growth Trajectory: Performance insights and future trends in urban mobility - Southeast Asia Infrastructure
5 Source: 2025 set to be second or third warmest year on record, continuing exceptionally high warming trend

Europe's space policy as a market engine: strategic frameworks driving competitiveness, resilience and growth

From vision to value: towards a unified space framework

Recent EU initiatives on space, including the proposed EU Space Act, the Commission's Vision for the European Space Economy and the European Competitiveness Fund, **reflect a stronger ambition to position the space economy as a strategic pillar of Europe's long-term competitiveness**. These and other initiatives are a rection to geopolitical and economic pressures and aim to move beyond fragmented national approaches **towards a more coherent EU-level framework**.

The EU Space Act seeks to **improve regulatory coherence across the internal market by reducing fragmentation, clarifying legal rules and supporting cross-border space activities**. It aims to create a more predictable environment for industry, particularly for downstream actors such as start-ups and SMEs using EO and GNSS data.

The Commission's Vision – whose overarching objective is to position the EU as a leader in the global space economy by 2050 – **sets strategic priorities for the entire space value chain**, focusing on resilience, sustainability and **technological leadership while promoting greater uptake of space data** in non-space sectors. In parallel, the proposed European Competitiveness Fund aims to strengthen Europe's industrial and technological base, including in space, by improving access to finance for innovation, scale-up and deployment of space-based solutions.

EU preparedness strategy: resilience by design for security and crisis readiness

The EU's preparedness agenda brings together civil protection, security and defence policies to **strengthen Europe's ability to anticipate, absorb and recover from crises**, including climate events, hybrid and cyber threats and disruptions to critical infrastructure. It **moves away from a reactive model by promoting shared risk assessments**, EU-level early-warning systems and coordinated response capacities such as the Union Civil Protection Mechanism and RescEU assets.

Within this framework, **space systems are increasingly seen as strategic enablers for resilience and crisis management**. Copernicus provides **continuous environmental and security monitoring**, supports **multi-hazard risk assessments** and feeds early-warning systems for floods, wildfires, droughts and other extremes. During disasters, the Copernicus Emergency Management Service delivers rapid mapping for damage assessment, evacuation planning and humanitarian logistics. The EU preparedness strategy also proposes creating an **EU Earth Observation Governmental Service (EOGS)** to improve the resilience and frequency of high-resolution observations.

GNSS and EGNOS provide **secure PNT functions across transport, energy, telecommunications and finance, all essential for continuity of services during crises**. For security and defence, GNSS supports military mobility and coordination. For civil protection, it is critical for search and rescue, routing, geofencing and cross-border coordination. As part of the preparedness agenda, the EU also highlights the need to strengthen PNT resilience against jamming and spoofing through authenticated Galileo services and complementary protective measures.

The growing importance of access to space

Over the last decade, **global launch activity has accelerated dramatically** in terms of number of launches, number of payloads deployed, as well as mass brought into orbit. It is anticipated that the 2024–2034 period could see another significant growth in orbital activity.

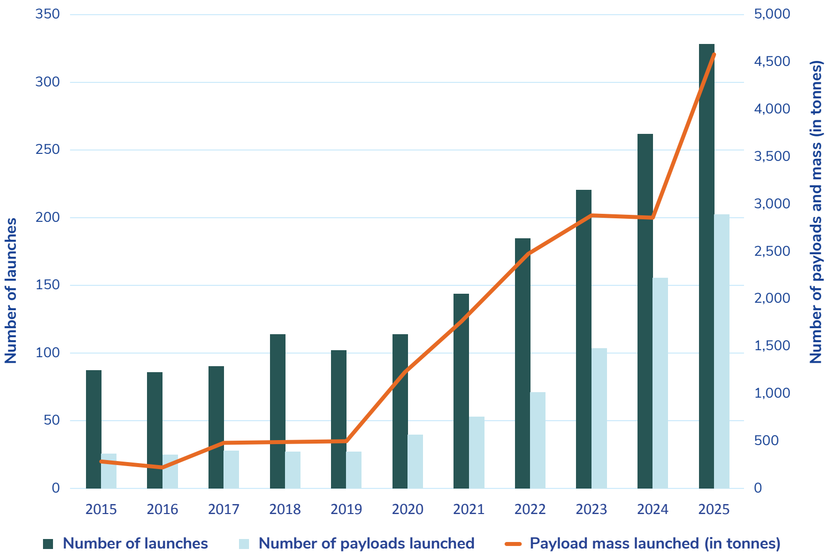
Launch activity is largely driven by the deployment of LEO constellations in combination with booster reusability. However, this acceleration **has not taken place equally throughout the world**. The launch market today is dominated by the US. The two busiest US spaceports, Cape Canaveral and Vandenberg, each launched more mass into orbit individually than all non-US spaceports combined so far in 2025. Launch activity in China is also starting to catch up on US developments, following the plans for commercial and governmental LEO constellations. The rest of the world is falling behind this trend.

Even though launch activity is steadily increasing, current debates revolve around a **bottleneck in launch capacity and launch pad congestion**. With launch capacity as a scarce commodity that only a few actors are reliably capable of supplying in a consistent schedule, it also becomes a tool for interstate diplomacy.

In the EU, while there are several initiatives for the development of small launchers for LEO orbits, the challenge is related to integrating resources to achieve a more effective approach. In the rapidly evolving international landscape, space is no longer a **neutral domain but a critical infrastructure** underpinning the EU's security, economic prosperity and digital ambitions.

Recent years have seen the **EU raise the policy priority of space autonomy and resilience to the highest strategic level**, as reflected in the EU Space Strategy for Security and Defence, the Strategic Compass, and the landmark 2025 proposal for the EU Space Act. These initiatives reflect heightened awareness of the risks posed by launcher crises, global instability, supply chain disruptions, cyber threats and intensifying commercial and military competition in space.

Global launch activity 2015-2025



European Space Policy Institute. "ESPI Launch Dashboard". ESPI. Information extracted in April 2026

Space's downstream layer is increasingly becoming software-defined

AI-powered decisions: turning EO and GNSS data into real-world action

Artificial Intelligence (AI) is increasingly **embedded across sectors**, where it enables **advanced data processing, pattern recognition and predictive analytics** on large, complex and heterogeneous datasets. This trend is steadily improving the ability of organisations to **transform raw data into actionable information and operational insights**, including in time-critical settings.

In the space downstream domain, AI already plays a **central role in exploiting EO and GNSS data**. AI-driven analytics automate the interpretation of large volumes of imagery and sensor data for applications such as agricultural, environmental and infrastructure monitoring, as well as disaster management, enabling **faster processing cycles and more consistent, accurate insights** for routine operations and crisis response. In GNSS, AI contributes to **positioning performance** (e.g. via sensor fusion and anomaly detection), predictive maintenance of infrastructure and assets, enhanced maritime navigation support and the development of smart mobility solutions that combine GNSS with other data sources.

AI systems not only use space-derived data, but they are also increasingly integrated into space-enabled platforms and services themselves, for instance by **optimising tasking, data selection and onboard processing to deliver more relevant EO and products to end users**. By enabling real-time processing, higher levels of automation and predictive decision support, AI increases the **scalability and commercial viability of space-enabled services** and supports their deployment at larger scale and across more diverse user communities. In Secure SATCOM, the adoption of AI techniques together with cloud migration are increasingly used to boost performance and to optimise how systems are operated and managed.

Trust that travels: secure data and transactions from ground to orbit

Blockchain is emerging as a core technology for **secure, transparent and tamper-resistant data sharing across distributed systems**, especially as connected devices proliferate. Market studies project the global blockchain technology market to grow from tens of billions of dollars today to well over a trillion by 2030, while blockchain-IoT solutions are expected to expand from well below €900 billion[1] to almost €1,500 billion segment over the same period.[2] **This reflects growing demand for trusted data exchange and automated transactions in complex multi-stakeholder environments**.

Blockchain enables new operational and commercial models that depend on high data integrity and auditability. EO- and GNSS-enabled applications in logistics, agriculture and remote monitoring can use blockchain to secure sensor readings, track assets and record service performance, while smart contracts can automatically trigger payments or service-level verifications when predefined conditions based on space-derived data are met.

In space-enabled architectures, **blockchain is increasingly combined with satellite communications and satellite-IoT networks to authenticate data, manage identities and control access across distributed ground infrastructure** and satellite constellations. Designs where satellite links connect remote IoT devices to blockchain nodes help ensure that data originating from satellites or remote sensors can be verified and shared only with authorised users, even in regions with limited terrestrial connectivity.

Hands-off missions, real-time markets: automated end-to-end space services

Automation is gaining momentum across the global economy, with the operational stock of industrial robots reaching 4.9 million units in 2025, according to the International Federation of Robotics.[3] It is also **increasingly influencing how services are produced, delivered and consumed**. This trend goes beyond factories; automation now **shapes logistics, mobility, agriculture, ports and consumer devices**, where systems act with greater autonomy, react faster to changing conditions and rely on continuous data flows rather than direct human control.

GNSS is a core enabler of this shift because precise positioning and timing are prerequisites for automated behaviour. In agriculture, GNSS-guided machinery supports automated steering and task execution for planting, fertilisation and harvesting, improving productivity while optimising inputs and reducing overlaps. In the maritime sector, GNSS underpins automated route planning, port approach and docking assistance, and forms part of the sensor fusion for increasingly autonomous ships and port robotics, contributing to safer and more efficient operations. In consumer settings, GNSS supports localisation and navigation for home and service robots such as outdoor robotic lawn mowers and small delivery bots, helping them follow routes and avoid restricted areas with limited human input.

EO complements GNSS by providing the environmental intelligence that automated systems require to plan and adapt their actions. Automated processing chains convert satellite imagery into operational products such as crop condition indices, soil moisture maps, flood and fire risk layers, ship-detection feeds or urban change maps, which can be ingested directly into farm management platforms, logistics and insurance systems or emergency management tools. This allows downstream services to move from manual map interpretation toward closed-loop workflows where EO detects change, GNSS locates assets and automated systems implement responses in near real time, while raising new requirements for robustness, cybersecurity and oversight of increasingly autonomous space-enabled operations.

Secure SATCOM strengthens automation in industry and transport by providing reliable infrastructure for machines, sensors and control systems. It ensures continuous, secure communication for automated operations, and in the future will offer robust two-way links even in areas where terrestrial networks are weak, intermittent or unavailable.

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1: Exchange rate: 1 EUR = 1.1 USD
2: Source: Blockchain Technology Market To Reach $1,431.54 Bn By 2030
3: Source: World Robotics 2025 report – INDUSTRIAL ROBOTS – released by IFR

Industry and citizens, connected by space: a new engine for growth, resilience, and better daily living

INDUSTRY

Cybersecurity rising protecting a hyper-connected world

Growing dependence on digital and connected systems makes cybersecurity a central concern for governments, businesses and operators of critical infrastructure. As satellite communications and GNSS become embedded in transport, energy, finance and emergency response, vulnerabilities to spoofing, jamming and data interception have more systemic consequences, including disrupted navigation, timing and communications.

In this context, **secure GNSS functionalities**, such as signal authentication and more resilient receiver designs, are **gaining importance to ensure that positioning and timing information can be trusted** in safety- and mission-critical applications. At the same time, **secure satellite communications** with strong encryption, hardened terminals and cyber-resilient ground infrastructure are increasingly valued to maintain operational continuity in contested or degraded environments, **reinforcing the role of space systems as trusted components of wider cyber-resilient architectures**.

Hyper-connectivity & 5G: instant networks

Advances in connectivity, especially 5G and edge computing, are creating a **hyper-connected environment where devices, systems and platforms can exchange data with high bandwidth and low latency**. Edge architectures push processing closer to where data is generated, which improves responsiveness, reduces backhaul loads and limits dependence on central cloud infrastructure for time-critical functions.

Hyper-connectivity is increasingly positioning satellites as one element of a broader "network of networks" alongside terrestrial 5G and IoT infrastructure. In this setting, satellite links extend coverage into rural, remote and maritime areas and, when combined with edge processing on satellites and user terminals, allow EO- and GNSS-enabled applications in logistics, agriculture and environmental monitoring to operate with shorter latencies and more localized, pre-processed information, thereby tightening the link between observation, connectivity and operational decision-making.

Industry 5.0: driving human-centric and sustainable growth

Industry 5.0 reflects a shift from **purely efficiency-driven automation towards production models that are resilient, environmentally sustainable and human-centric**. It also refers to technology that prioritises human needs, values, skills and well-being over mere efficiency or automation. It builds on Industry 4.0 technologies: automation, AI, digital twins and advanced analytics, but puts more emphasis on worker well-being, adaptive factories, reduced environmental footprints and circular economy practices.

As manufacturers redesign processes around **real-time data, traceability and lifecycle optimisation, Industry 5.0 naturally increases the pull for space-enabled services**. EO offers independent monitoring of land use, emissions proxies and supply-chain disruptions, while GNSS and SATCOM provide precise location and resilient connectivity for synchronised logistics, circular material flows and distributed, low-carbon production sites, making space infrastructure a core enabler of this new industrial model.

CITIZENS AND SOCIETY

Smart cities: services that think

Smart cities reflect a shift towards data-driven, highly connected urban environments, where digital services, sensors and platforms are used to improve mobility, energy efficiency, environmental quality and public services for both citizens and businesses. As more urban systems are managed in (near) real time, **city authorities, operators and service providers increasingly rely on timely, location-accurate information** to plan infrastructure, optimise operations and design new citizen-facing applications.

This evolution increases **the role of space technologies in city operations**. GNSS underpins navigation, traffic management, shared mobility and logistics, while EO provides city-wide views for planning, environmental monitoring and disaster preparedness, feeding regularly updated spatial information into smart-city services.

Mobility: from vehicle to network

Mobility is moving towards systems that are electric, highly connected and increasingly automated, under tightening safety and sustainability expectations. Vehicles, infrastructure and traffic managers **depend on continuous, reliable information on where things are and how they are moving to optimise flows, increase safety, reduce emissions and coordinate multimodal transport**.

In this setting, **space technologies sit at the heart of the mobility data layer**. GNSS delivers the precise positioning needed for navigation, fleet tracking, traffic control and new services such as autonomous driving and shared mobility platforms, while satellite communications extend connectivity and remote monitoring into areas where terrestrial networks are sparse, so connected vehicles and infrastructure can keep exchanging data along the whole journey.

Well-being: Rising Priority

People and societies are placing greater emphasis on health and wellbeing, with more attention to prevention, lifestyle choices and mental health. This shift **increases interest in tools that help individuals monitor their condition, stay active and detect issues early**. It also reinforces demand for connected health services and technologies that can support healthier, safer everyday living.

GNSS and space-enabled connectivity reinforce this growing societal focus on health and wellbeing by adding precise location and resilient coverage to a wide range of digital health tools. **Accurate positioning enables more granular activity and performance tracking**, supports location-based safety features and involves reliable emergency response functions when incidents occur indoors, outdoors or on the move. Ubiquitous connectivity, including in areas with limited terrestrial coverage, allows **continuous remote monitoring, coaching and telemedicine services to follow users throughout their daily routines, rather than being confined to clinical settings**.

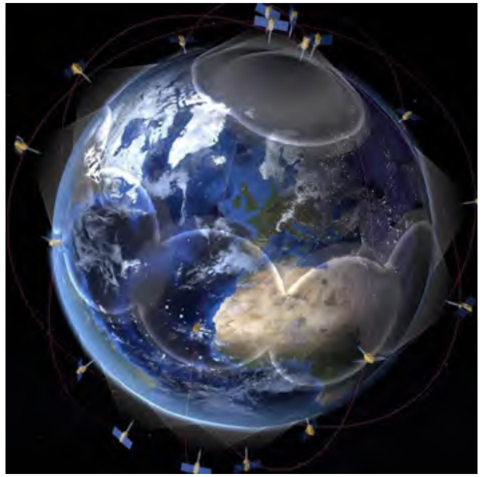
The LEO Revolution: the next frontier for enhanced and more resilient PNT

Next-generation Low Earth Orbit (LEO) constellations are reshaping space infrastructure by **complementing existing** Medium Earth Orbit **(MEO)** and Geostationary Earth Orbit **(GEO) systems with lower latency, higher capacity and enhanced resilience** in multi-orbit architectures. LEO-based initiatives across **satellite communications (SATCOM), Earth Observation and emerging capabilities** are increasingly conceived as interoperable and multi-purpose systems, **designed to integrate with established European programmes such as Galileo, EGNOS and Copernicus**.

LEO services enable **faster data delivery, stronger signal performance and more flexible tasking, reducing single points of failure** and **supporting more robust downstream applications**; their maturity, however, differs by segment. LEO SATCOM is already operating at global scale with one operator; moreover, LEO constellations are becoming a core layer for Secure SATCOM as they combine resilience with performance. LEO EO is rapidly expanding through growing constellations, and LEO-PNT (Positioning, Navigation and Timing) is still at an early development stage, although some demonstration constellations have been launched.

LEO-PNT initiatives aim at enhancing GNSS and creating pathways for new applications

LEO is emerging as a **complementary capability to existing GNSS, driven by the recognition that GNSS alone cannot meet the resilience, availability, accuracy, latency and robustness requirements of an increasing number of applications**. While GNSS remains the backbone of global services, its reliance on weak signals from MEO makes it inherently vulnerable to interference, jamming, spoofing and performance degradation in dense or obstructed environments. Within this context, commercial players are pioneering LEO-based systems as a practical augmentation to legacy systems. In parallel, public institutions like ESA plan to launch the first two satellites of its Celeste LEO-PNT demonstrator mission in 2026.



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By operating at significantly lower altitudes, LEO systems **can deliver higher received signal power and faster signal acquisition compared to traditional GNSS**. These characteristics translate into **shorter time-to-first-fix, improved availability in challenging environments, such as urban canyons or indoor–outdoor transitions, and greater robustness in the face of both unintentional interference and deliberate disruption**. Modern LEO signal designs, with both open and encrypted services, is tailored to support high-precision and safety- or liability-critical applications that demand assured performance. From a system perspective, LEO can improve overall resilience through diversity in orbit, signal structure and infrastructure. Architectures based on proliferated LEO satellites combined with advanced waveforms and interfaces are typically designed for seamless integration alongside GNSS in multi-constellation, multi-frequency receivers.

The market for LEO is still at an early stage of development. Most initiatives remain in experimental, demonstration, or pre-commercial phases, and technical, regulatory and economic challenges persist. Commercial actors outside the European Union are already deploying LEO satellites providing navigation-related services for IoT and future mobility. In the meantime, **several commercial and governmental actors have already launched initial demonstration satellites and are advancing towards an operational constellation**, while working on spectrum coordination, receiver integration and standardisation activities to ensure interoperability with existing GNSS-based solutions and to facilitate uptake across user communities.

EU LEO-PNT as a pillar of resilient and augmented European navigation

EU LEO-PNT is emerging as a promising **new layer in Europe's positioning, navigation and timing landscape**, designed to **complement Galileo and EGNOS with a diversified multi-orbit architecture**. It is envisaged that it will strengthen redundancy, improve **service availability and enhance robustness against interference** and other disruptions, responding to the growing reliance of critical applications on precise and continuous satellite-based PNT.

A central ambition of **EU LEO-PNT is to boost the performance of key Galileo service features**, such as the urban availability of the Open Service, convergence time of the High Accuracy Service, and dissemination of Early Warning Satellite Service and Timing Service information. **By leveraging the advantages of low-Earth-orbit constellations, the concept aims to deliver faster, more accurate and more reliable data for an expanding range of professional and consumer uses**. In addition, **EU LEO-PNT** is conceived **as a means to increase overall system resilience by mitigating vulnerabilities of traditional GNSS signals to jamming, spoofing and other forms of interference**. By introducing an independent LEO-based layer with distinct signal characteristics and geometry, **it can support continuity of service and graceful degradation in situations where existing Galileo signals are degraded or unavailable**.

At this stage, however, **EU LEO-PNT remains at the demonstration phase rather than a committed deployment programme**, with technical, programmatic and budgetary aspects still under assessment. Its future implementation path will depend on the outcomes of these studies and subsequent decisions on scope, governance and funding, ensuring that any eventual system is **well aligned with user needs and the overall evolution of the European architecture**.

The LEO Revolution: powering downstream markets with connectivity, observation and secure space services

LEO EO constellations reshape downstream Earth observation applications

The expansion of **LEO EO constellations is driven by lower launch costs, satellite miniaturisation, and the integration of AI and cloud-based processing** that enables near real-time analytics. Recent industry estimates indicate that there are already around 350 to 400 LEO EO satellites in operation, with the total expected to roughly double by 2030 as new commercial constellations are launched[1]. Commercial operators, alongside national and institutional programmes, are **deploying increasingly large constellations**, while multi-orbit and multi-constellation approaches improve data continuity, revisit rates and overall system resilience. Providers are also moving beyond raw imagery, offering analytics and ready-to-use, decision-support services that compress the time from observation to actionable insight.

The **availability of high-revisit, rapidly taskable LEO EO data is fundamentally reshaping downstream markets**. Near real-time monitoring enables more responsive, data-driven applications across agriculture, urban development, environmental monitoring, logistics, insurance, and disaster and crisis management. Frequent updates support predictive analytics and, in some cases, semi-autonomous decision-making, improving efficiency, compliance monitoring and risk management for both public and private stakeholders.

At the same time, **LEO EO constellations lower barriers to entry by improving the accessibility and affordability of EO data, enabling SMEs and new market entrants to develop services that were previously constrained by data cost, latency or limited coverage**. This shift makes interoperability and multi-source data fusion increasingly critical to extracting value from diverse constellations and platforms. Overall, LEO EO is accelerating the speed, scale and impact of downstream EO applications across commercial, public and scientific domains, and is set to play a central role in the broader LEO economy over the coming decade.

The importance of LEO-focused space situational awareness

As **LEO becomes increasingly populated** with **satellites and debris, SSA** in this region is becoming **a core enabler of safe and sustainable operations**, encompassing three domains: **Space Weather Events (SWE), Near-Earth Objects (NEO) and Space Surveillance and Tracking (SST)**. The latter delivers precise information on the **position and motion of objects in LEO**, which is needed to characterise the environment, anticipate close approaches and avoid harmful collisions. Because all spacecraft must transit through LEO when accessing higher orbits, the long-term usability of LEO is foundational for the entire space ecosystem. A major debris cascade in LEO would not only compromise operations in Low Earth Orbit but could also restrict access to MEO, GEO and beyond.

For operators of GNSS, communication and EO missions, **robust LEO SSA underpins service continuity by protecting spacecraft from accidental loss or service interruptions**. Reliable knowledge of the local traffic and debris environment allows operators to plan manoeuvres efficiently, **manage fleet operations and maintain user confidence in LEO-based infrastructure**.

At the systems level, enhanced LEO SSA also supports long-term orbital sustainability by informing debris-mitigation strategies, responsible constellation deployment and the future evolution of space traffic management measures. By improving transparency and predictability in a congested orbital layer, it reduces overall operational risk and helps ensure that LEO remains a viable resource for future space services.

1 Source: Global EO Manufacturing in Focus: Market Share, Segment Leaders, and Regional Shifts

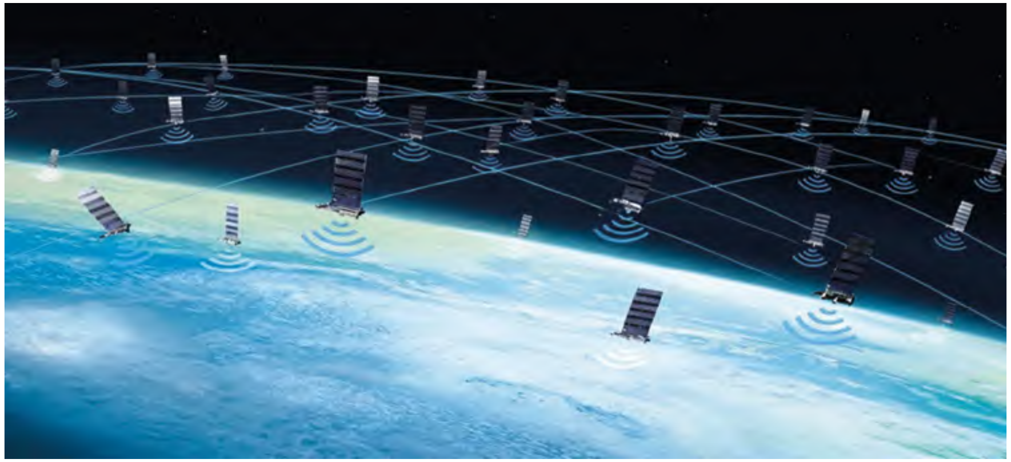
LEO SATCOM accelerates downstream connectivity and enables secure applications

LEO satellite communications is ramping up rapidly, with one leading **constellation already operating at global scale** and several other systems still comparatively smaller or focused on specific regional or niche markets. This early but impactful deployment has been enough to **reshape the SATCOM landscape, positioning LEO SATCOM as a new paradigm for high-capacity, low-latency connectivity that complements, rather than replaces, traditional GEO and terrestrial networks**.

Enabled by reusable launch, satellite miniaturisation, digital and regenerative payloads, and phased-array user terminals, **LEO SATCOM can now deliver cost-effective broadband across consumer, enterprise, governmental and defence segments**. In parallel, it is increasingly integrated into hybrid architectures as **a complementary 5G layer within non-terrestrial networks, extending coverage and backhaul to remote, rural, maritime and aeronautical environments** while supporting seamless handover with ground networks.

High-speed, low-latency LEO links are expanding downstream markets in maritime and aviation communications, logistics, industrial IoT and emergency response by improving throughput, latency and service continuity where terrestrial networks are absent or fragile. Emerging direct-to-device and direct-to-sensor services further broaden this impact by enabling connectivity directly to smartphones, vehicles, and low-power IoT terminals, simplifying deployment and unlocking new business models for public and private actors.

Beyond commercial broadband, **secure LEO SATCOM capabilities are becoming a strategic enabler for governments, defence and critical-infrastructure operators through strong encryption**, traffic segregation, and resilient multi-orbit architectures that maintain service under stress or attack. **European initiatives such as IRIS² aim to leverage these features in a sovereign, multi-orbit framework**, providing secure connectivity that strengthens strategic autonomy, supports crisis management and defence operations and reduces dependence on non-European providers.



The EO downstream market and market estimation methodology

WHAT IS EO?

EO refers to the collection of data and information about Earth's physical, chemical and biological systems using remote sensing and in-situ technologies. EO combines satellite-based sensors with ground, airborne and marine measurements to monitor the land surface, oceans and inland waters and atmosphere over time. Satellite EO uses instruments mounted on orbiting platforms to record quantitative measurements and imagery of Earth's characteristics, enabling consistent tracking of conditions and changes at local to global scales for environmental, economic and societal applications. Once processed and often merged with in-situ observations, EO data can be assimilated into numerical and statistical models to produce policy- and business-relevant information and intelligence, such as weather and air-quality forecasts, climate reanalyses and projections, risk and impact assessments, and behavioural or trend analyses.

HOW ARE EO CAPABILITIES EVOLVING?

From an upstream perspective, satellite EO today relies on a growing mix of optical, radar, hyperspectral, thermal, altimetry and GNSS-radio-occultation missions that provide global, all-weather coverage with revisit times from minutes to days. Commercial and institutional radar constellations already offer multiple observations per day over many regions, while RF-sensing small-sat fleets support maritime situational awareness and detection of radio-frequency emitters at sea and on land.

Over the coming decade, **new systems will significantly expand capabilities**. ESA's BIOMASS mission is the first spaceborne P-band synthetic-aperture radar dedicated to measuring forest biomass and aspects of the terrestrial carbon cycle. EUMETSAT's Meteosat Third Generation (MTG) system is providing higher-resolution imagery, lightning mapping and hyperspectral sounding. GNSS-based techniques such as radio-occultation, complemented by emerging tomography, will provide increasingly detailed atmospheric profiles for weather and space-weather services.

Focusing on EU systems, **Copernicus evolution** is driven by Sentinel-1 and Sentinel-2 Next Generation missions, which ensure data continuity and enhanced monitoring capabilities, including better spatial resolution and faster revisit times by the 2030s. Moreover, six **Sentinel Expansion missions** will deliver enhanced radar and optical imaging, dedicated greenhouse-gas monitoring, polar and sea-ice variables, land-surface temperature, imaging spectroscopy and L-band SAR.

At the same time, many countries are developing sovereign EO constellations in partnership with New Space companies, which build and sometimes co-own satellites for national customers, strengthening strategic data access while leveraging commercial agility and investment.

KEY EO PERFORMANCE PARAMETERS

Different types of sensors utilise different EO technologies:

- **Passive sensors** (optical or thermal) are payloads monitoring the energy received from the Earth due to the reflection or re-emission of the sun's energy by the Earth's surface or atmosphere. They operate between the visible and infrared wavelengths of the electromagnetic spectrum.
- **Active sensors** (radar and LiDAR) are payloads operating in the lower part of the spectrum (longer wavelengths). Most of these sensors transmit energy to Earth and measure the reflection from the Earth's surface or atmosphere, enabling day and night monitoring during all-weather conditions.

The essential parameters in EO include the sensor resolution (spatial, temporal, spectral, radiometric), as well as **swath range, geolocation accuracy**, the **spectral range** and **latency**.

More details on EO performance parameters and requirements are provided in **Annex 2**.

EO MARKET

This Market Report considers the EO market to encompass activities where satellite EO-based data and value-added services enable a variety of applications across multiple segments. It is noteworthy that the present report does not include applications belonging to the defence domain.

The EO market presented in this report displays **EO data and EO value-added service revenues** separately, as well as combined into a single chart. This illustrates the different ways in which users in different segments access information based on satellite remote sensing. **Data revenues** arise from a financial transaction between an EO data provider and a user (this user can be either a service provider or an end-user with processing capabilities). **Value-added service revenues** are generated further along the value chain and stem from a transaction between EO products and services provider, or information provider (that uses free and/or commercial input data) and an end-user*.

This report covers only the commercial EO market, meaning that the market quantification captures only activities based on commercial transactions. Grant-funded activities in the EO domain are therefore outside the scope of this Market Report.

Although EO data and services, combined with data from meteorological satellites, contribute to the generation of weather data and services, **weather services are not included in this market report as an EO segment**. Dedicated weather services at segment level (e.g. agriculture) are included since these are specific EO applications with a commercial business model.

ON CHARTS AND METHODOLOGY

Data contained within the charts starting from the year 2025 are estimated, and might be subject to update in the next edition of the Market Report.

Terminology used in charts:

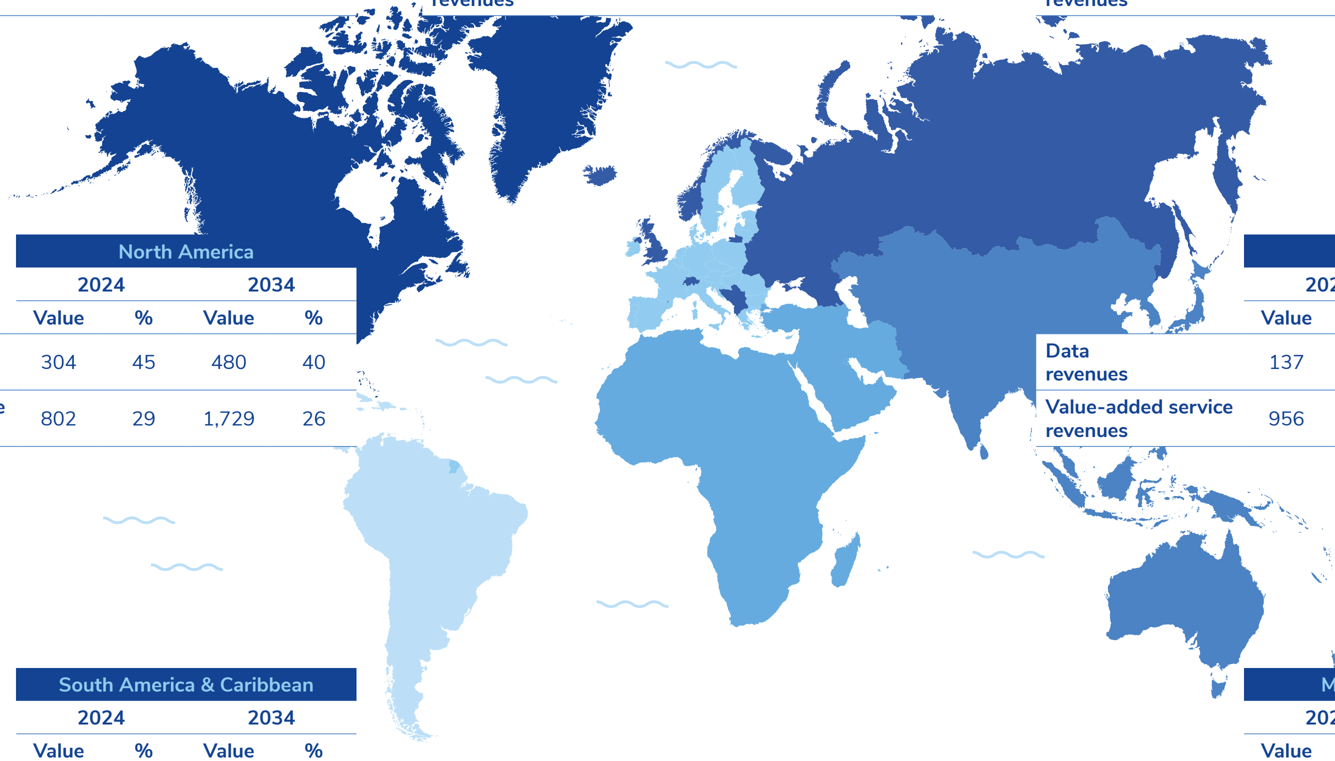
- **Revenues**: The revenues from data/services sales in a given year.
- **Regions**: European Union (EU27), North America, Asia-Pacific, Russia & Non-EU27 Europe (Non-EU27 Europe), Middle East & Africa, and South America & Caribbean.

Revenues are presented from two different angles. First, EO demand, documented at aggregate and segment level in the charts of this report, indicates the region in which revenues are generated. Moreover, the report features an improved methodology for estimating EO service revenues, based on the triangulation of top-down and bottom-up research on service providers and users. Second, the market share shows the origin of supply – i.e. the headquarters of the company (or its ultimate parent) offering the product – as presented on the dedicated industry and market share pages. The difference between the EO demand data and the supply-driven market share analysis data thus gives an indication of the trade balance between regions.

For methodology and sources, and for abbreviations used within the report, please see **Annex 1** and **Annex 4**, respectively.

* The Market Report now features an updated methodology for the estimation of value-added service revenues. All transactions along the EO value chain (see p20) are considered within these revenue streams, without overlap or omission.

Global EO demand will grow steadily, with faster uptake in Asia-Pacific, South America & Caribbean and Middle East & Africa[1]



European Union (EU27)	2024 Value	2024 %	2034 Value	2034 %
Data revenues	118	17	215	18
Value-added service revenues	473	17	1,094	16

Global	2024 Value	2034 Value
Data revenues	685	1,212
Value-added service revenues	2,814	6,714

Russia & Non-EU27 Europe	2024 Value	2024 %	2034 Value	2034 %
Data revenues	54	8	98	8
Value-added service revenues	167	6	412	6

North America	2024 Value	2024 %	2034 Value	2034 %
Data revenues	304	45	480	40
Value-added service revenues	802	29	1,729	26

Asia-Pacific	2024 Value	2024 %	2034 Value	2034 %
Data revenues	137	20	282	23
Value-added service revenues	956	34	2,396	36

South America & Caribbean	2024 Value	2024 %	2034 Value	2034 %
Data revenues	37	5	67	5
Value-added service revenues	239	8	629	9

Middle East & Africa	2024 Value	2024 %	2034 Value	2034 %
Data revenues	35	5	70	6
Value-added service revenues	177	6	454	7

1: All values are presented in m €, and percentages are rounded to the nearest whole percent.

Role of EO across the market segments

The use of EO is relevant across all the market segments covered in this report, with the exception of the Space segment. For each of these segments, a brief summary of the scope is presented below. More insights into segment-specific trends can be found on the respective 'Key Trends' page.

AGRICULTURE – EO delivers field-level insights on crop performance, soil moisture, and input use, enabling variable-rate applications and reduced fertiliser reliance. It supports farm management and policy analysis with consistent, scalable data for smarter, more sustainable decisions.

AVIATION AND DRONES – EO supports prediction and monitoring of volcanic ash, contrails and airport pollution, and provides digital elevation models for flight procedure design. It underpins U-space planning and ground-risk assessments in Specific Operations Risk Assessment (SORA) by combining elevation and population datasets.

CLIMATE, ENVIRONMENT AND BIODIVERSITY – EO provides auditable, repeatable measurements for climate monitoring, forecasting and modelling, covering Greenhouse Gases (GHG) emissions, snow/ice dynamics, sea-level rise, extreme weather and soil moisture. It enables large-scale ecosystem and habitat monitoring to support biodiversity protection and nature-based solutions.

CONSUMER SOLUTIONS, TOURISM AND HEALTH – EO enriches location-aware apps with context such as weather, air quality, and environmental conditions. Integrated with device sensors and cloud services, it powers personalised, real-time experiences across navigation, fitness, tourism and smart environments.

EMERGENCY MANAGEMENT AND HUMANITARIAN AID – EO supports risk and exposure analysis, preparedness planning, and rapid damage mapping for floods, fires, landslides, and conflicts. By comparing new imagery with archives, it guides search-and-rescue, access planning and accountable recovery operations.

ENERGY AND RAW MATERIALS – In energy, EO supports the mapping of natural hazards, the forecasting of renewable energy generation, and informs curtailment, storage and flexibility markets. In raw materials, it supports mineral exploration and compliance monitoring, helps detect illegal mining and assesses tailings stability to improve safety and traceability across supply chains.

EU BORDER AND INTERNAL SECURITY – EO strengthens situational awareness at land and sea borders through wide-area surveillance and vessel detection. It supports monitoring of irregular migration and smuggling, production of damage maps for conflict zones, and the provision of evidence for law-enforcement and justice actions.

FISHERIES AND AQUACULTURE – EO helps characterise ocean conditions and modelling fish habitats to improve catch planning and combat illegal, unreported and unregulated fishing. In aquaculture, it supports site selection and continuous monitoring of temperature, water quality, and harmful algal blooms to safeguard stock health and resilience.

FORESTRY – EO enables remote monitoring of forest inventories and health. It is used to detect illegal logging and deforestation. Finally, it supports precision forestry with frequent, scalable observations for planning, sustainability and compliance in vast and remote areas.

INFRASTRUCTURE – EO supports the full lifecycle, from site selection and construction monitoring to environmental impact tracking. Combined with AI and digital twins, it enhances risk assessment, resilience design and maintenance planning for safer, more productive infrastructure.

INSURANCE AND FINANCE – In insurance, EO powers event footprints for claims, indices for parametric products, and weather-risk models. In finance, it enables investment risk screening, monitors production and shipping flows, and provides Environmental, Social and Governance (ESG) indicators to assess both returns and impact.

MARITIME AND INLAND WATERWAYS – EO enhances corridor and coastal awareness, as well as supporting monitoring pollution, ecosystems, and traffic patterns. It strengthens port security and safety and supports just-in-time operations and maritime digital twins by providing timely, wide-area environmental intelligence.

RAIL – EO enables network-wide ground-motion and track-deformation monitoring, as well as assessing natural-hazard risks and reducing on-site inspection costs. Continuous observations support predictive maintenance and safer, more reliable operations.

ROAD AND AUTOMOTIVE – EO provides base map layers and real-time traffic and road-weather intelligence for navigation and mobility services. It supports smart-city transport planning, operational coordination and safer journeys in areas with limited terrestrial sensing.

URBAN DEVELOPMENT AND CULTURAL HERITAGE – EO informs urban planning, monitoring of informal dwellings and urban greening, and tracking of air quality and emissions. It helps the assessment of ground subsidence and environmental pressures on heritage sites, improving resilience and conservation.

EO data and service growth is driving steady rise of revenues[1]

The global market for EO data and services in this report spans 15 segments, with Space being the only one where EO is not applicable. The market is defined based on an analysis of over 100 applications. While EO use cases are identified across all relevant segments, robust revenue figures for data and value-added services are quantified for 13 of them; for Aviation and Drones, as well as Rail, EO intelligence is assessed qualitatively only.

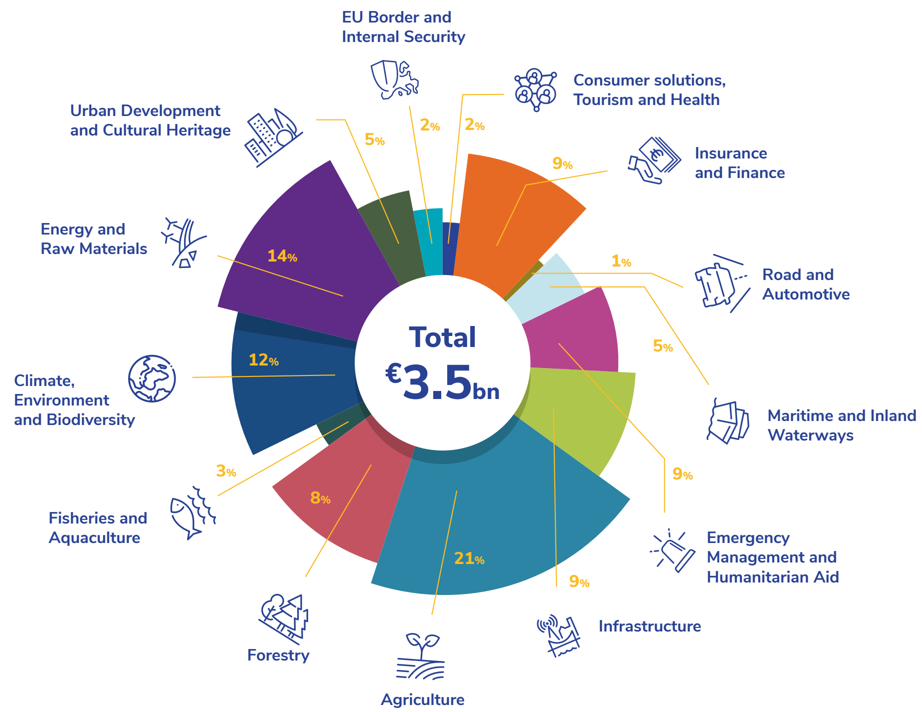
In 2024, EO data and value-added services generated around €3.5 billion worldwide. Following an improvement of the quantification methodology (see Annex 1), the three largest segments together account for almost half of the total market revenue, while several other segments, including Insurance and Finance, Infrastructure, Emergency and Management, and Forestry, contribute comparable shares to the remaining market.

EO markets will keep growing. **By 2034, the overall revenues of the global EO data and value-added services market are projected to reach €8 billion**. The progressive deployment of LEO constellations, driven also by dual use synergies, along with user-centric business models enabled by AI advancements, are pushing market growth at a faster pace than previously estimated.

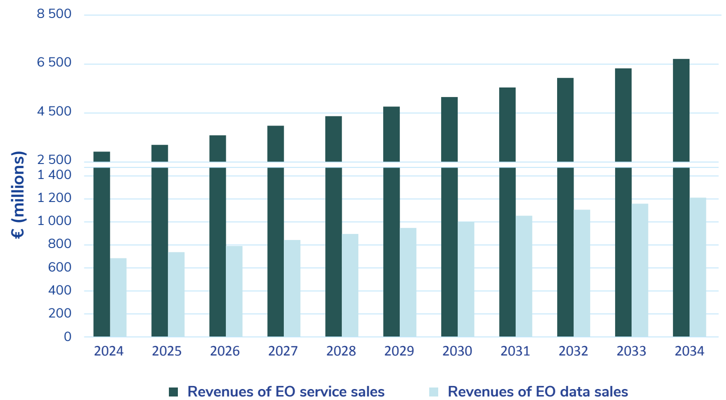
EO data and service **revenue growth** is increasingly **driven** not only **by climate resilience** needs but also by clear **return on the investment** and **operational efficiency gains**, with agriculture forecast to be among the fast-est-growing segments. EO value-added services help agriculture and forestry optimise inputs, increase yields, reduce operational costs, and document compliance with sustainability and biodiversity regulations, reinforcing both business and policy incentives for uptake. In agriculture, rising input costs, labour shortages and increasing wage costs alongside growing global food demand are increasing the need for space-enabled efficiency gains. As climate impacts intensify, EO remains indispensable for monitoring climate, environment and ecosystems, providing continuous, consistent information that cannot be matched by in-situ networks alone. In energy and raw materials, space data increasingly play a role in environmental impact assessments and social licenses to operate, beyond planning and monitoring of raw material and energy assets.

In Insurance and Finance, EO growth will be driven by the expanding role of commodity trading as a core financial hedging and supply-chain tool, as well as by the increased demand for risk modelling solutions. In infrastructure management and urban planning, market growth will derive from the increasing number of available constellations and their performance, automation of analysis and deeper integration of EO into digital twins.

Distribution of revenues by segment (%, 2024)



Revenue from EO data and service sales



As shown in the chart on the left, global EO revenues are projected to grow strongly between 2024 and 2034, driven by rapid expansion in both EO data and value-added services.

In 2024, **EO data revenues** exceeded **€680 million** across all segments. The EO data market is expected to grow at a CAGR of nearly 6% through **2034**, exceeding **€1.2 billion** in total revenues.

The EO **value-added services** market is substantially **larger and growing faster**. In **2024**, EO value-added services generated around **€2.8 billion** in global revenues. From 2024 onwards, this segment is forecast to expand at a CAGR of 9.3%, reaching nearly **€6.8 billion by 2034**.

1: All results rely on the same forecasting methodology detailed in Annex 1. Because input data and attribution bases differ across segments, figures are not directly comparable. Annex 1 provides full clarification on inputs and EO/GNSS-service attribution.

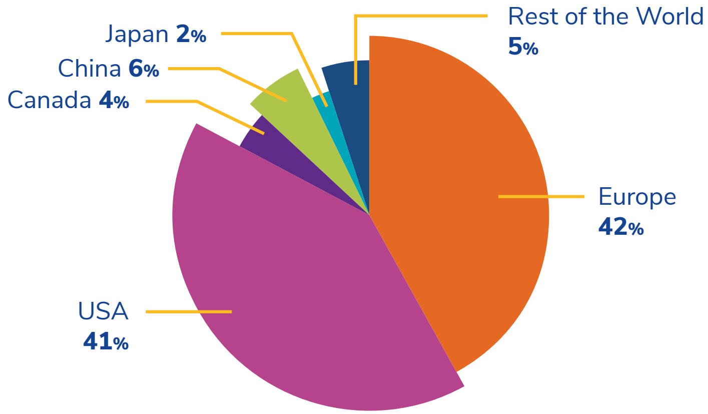
EO industry overview

Europe[1] and the **USA** account for **the largest shares of revenues**[2] from EO data and value-added services. The pie chart below presents **revenues from a supply-side perspective**, illustrating the geographic origin of EO data and service providers. This differs from the EO demand world map (see page 17), which shows the regions where EO data and services are consumed and revenues are generated.

Taken together, **companies** from **Europe** and the **USA account for 83% of the global EO market supply**. Europe and the USA lead at 42% and 41%, supported by a broad and diverse ecosystem of EO service providers. Chinese companies account for 6% of the market, while Canada accounts for 4% and Japan for 2%.

The downstream EO industry is structured around three main value-chain categories: **data processing and analysis, insights and decision support**. The table in the top-right corner shows, in alphabetical order, the 10 leading companies in each category. While market leaders differ across value-chain segments, several major players, including Airbus, Alphabet, Amazon and Vantor, maintain a presence across multiple categories.

Revenues generation in the EO industry by key regions (% split of revenues 2024)



Top 10 companies across the value chain based on 2024 revenues (in alphabetical order)

Data acquisition and distribution		Data processing		Analysis, insights & decision support		Users
Alphabet (Google)	US	Alphabet (Google)	US	21AT	CN	Users of EO products and services across the different market segments
Airbus	NL	Airbus	NL	Airbus	NL	
Amazon	US	Amazon	US	BASF	DE	
BlackSky	US	Capgemini	FR	Beijing Piesat	CN	
ICEYE	FI	Cyient Ltd	IN	CGI	CA	
KSAT	NO	ESRI	US	Leonardo	IT	
Leonardo	IT	Garmin	US	NEC Corporation	JP	
Planet	US	Oracle	US	Trimble	US	
Vantor	US	Trimble	US	Vantor	US	
Viridien	UK	Vantor	US	Viridien	UK	

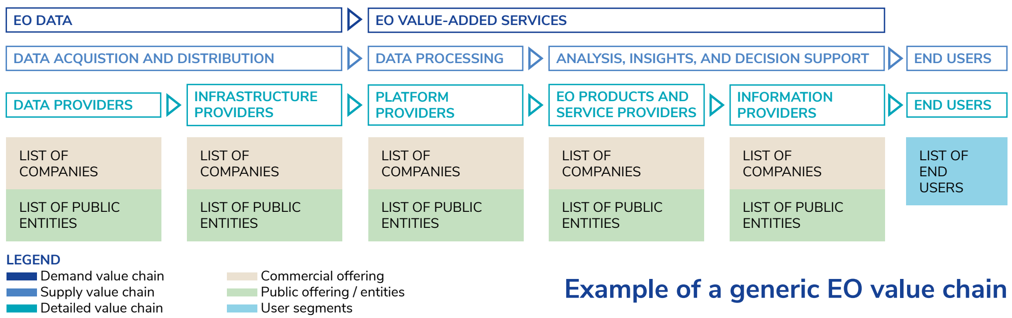
1: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the United Kingdom.
2: A different methodology was used to calculate EO revenues compared to rest of the report. This methodology measures the size of EO industry from a supply perspective based on a bottom-up approach which quantifies revenues attributable to EO of more than 2000 individual companies for which financial data are available (those with turnover greater than the threshold exempting small firms from financial reporting – this threshold is not universal so smaller companies may be included in some regions than in others). Companies are allocated to a single region based on the registered headquarters of the company (or its ultimate parent), which indicates the regions in which the demand for EO data and services are generated. In contrast, the methodology in the rest of the report attributes the size of the EO market to the region where data or services are sold and used. Specifically, this means that the European share of the EO market presented on this page is a methodologically different statistic to the share of revenues presented for EU27 in the map on page 17. For further information on the methodology, please refer to Annex 1.

The EO value chain

The EO value chain is presented at three levels. At the highest level (dark blue), the market is split by EO data and EO value-added services. At the next level (light blue), industry players fit into three categories: data acquisition and distribution; data processing; and analysis, insights & decision support. At the lowest level (turquoise), the detailed value chain includes:

- **Data providers**: Providers of unprocessed or pre-processed EO data from multiple sources (i.e. satellites and in-situ (non-space) measurements), typically operating a data-as-a-service business model.
- **Infrastructure providers**: Providers of various types of computing infrastructure upon which EO data can be accessed, stored, distributed or manipulated, typically operating an infrastructure-as-a-service business model.
- **Platform providers**: Providers of online platforms and/or digital services, through which users can utilise tools and capabilities to analyse EO data, develop algorithms and build applications, typically, operating platform-as-a-service and/or software-as-a-service business models.
- **EO products and service providers**: Providers of products (e.g. land cover classifications) or services (e.g. ground motion monitoring) that make full use of EO data and processing capabilities offered by data and platform providers, typically operating an analytics-as-a-service business model.
- **Information providers**: Providers of sector-specific information that incorporates EO data along with non-EO data, typically operating an insights-as-a-service business model.
- **End Users**: Final users benefitting in their decision making or operations from the solutions offered by EO services and/or information providers.

The entities listed in the value chains of the different segments are to be considered as representative examples and non-exhaustive of the entire market.



Example of a generic EO value chain

The European EO industry covers more than a third of the global processing market

European EO market share by value chain categories

The **EO value chain** begins with **data acquisition and distribution**, where companies operating EO constellations generate and supply raw, unprocessed, or pre-processed satellite data to the market. This step is largely led by North America, which accounts for around 50% of global market share. **Europe follows with around 40%**, supported by a strong combination of institutional programmes and commercial data providers.

The next phase centres on data processing, converting EO data into digital products through cloud-based platforms and services. In 2024, North American companies accounted for roughly 55% of the data processing market. North America's main market leading segments are in Consumer Solutions, Tourism and Health, Forestry and Road and Automotive. **Europe represented around 35%** of the market and held strong positions in the Aviation and Drones, Fisheries and Aquaculture, Climate, Energy, Maritime and Inland Waterways, Rail and Insurance and Finance sectors. Other regions outside the Union play a small role across most segments.

The EO value chain category following data processing is **analysis, insights and decision support; Europe retains more than a 60%** share of this global market, while North America has nearly a quarter. In this stage of the value chain, European service providers, mostly SMEs, have successfully specialised in delivering customised, sector-specific solutions that address complex operational and policy challenges across areas such as environmental monitoring, transport, agriculture and risk management.

Please note the changes in market share are driven by general market trends, mergers and acquisitions, and exchange rate fluctuations.

NOTES: The footnotes presented on page 20 also apply to this page. For further information on the methodology, please refer to Annex 1.

EO Regional market shares in data processing, by market segment - 2024

	Europe	North America	Asia+ Russia
	40%	45%	15%
	75%	20%	5%
	60%	25%	15%
	20%	65%	15%
	35%	40%	25%
	60%	25%	15%
	65%	35%	0%
	40%	50%	10%

	Europe	North America	Asia+ Russia
	35%	60%	5%
	40%	50%	10%
	75%	25%	0%
	60%	30%	10%
	60%	10%	30%
	35%	65%	0%
	40%	45%	15%

NOTE: Segment share for the 'rest of the world' is not shown nor accounted for in this table. Rounding is performed to the level of 5%.

CASSINI for EO: EU's Deal Flow Engine for the Next Generation of EO Champions

CASSINI, the EU's flagship space entrepreneurship initiative, bolsters commercial entrepreneurship across all components of the EU Space Programme, including Earth Observation. The initiative bundles hackathons, prizes, a business accelerator and a dedicated investment facility into a single ecosystem that helps EO founders validate ideas, build products and raise capital. By bringing together these elements, CASSINI builds a European deal-flow machine around EU space-aware entrepreneurs, lowering entry barriers for new ventures, helping mobilise private investment and scaling the most promising European companies. EO enthusiasts and teams seeking to validate their ideas can get their first industrial touchpoint with Copernicus at **CASSINI Hackathons**. Eleven hackathon editions have already generated dozens of EO-driven concepts – ranging from border surveillance to critical infrastructure monitoring – with financial prizes and six-month mentoring packages for the top teams.
The **CASSINI Challenges** contest targets close-to-market solutions, offering EU-level visibility and €1.2 million cash prize pot for solutions that solve pressing social, commercial and environmental challenges by leveraging EU space data and services. Once EO companies have early traction, the **CASSINI Business Accelerator** offers a six-month, high-intensity programme focused on growth. Each accelerator batch consists of 20 startups and scaleups and provides them with tailored coaching on sales, fundraising, go-to-market and procurement, and connects them with a powerful network of corporates, investors and institutional customers. Since its launch in 2023, the accelerator has supported six cohorts and 120 companies in many areas of business, from securing funding for demonstrator EO satellites to refining commercial strategies in downstreammarkets.

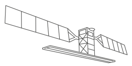
To further strengthen market uptake and commercial partnerships, CASSINI also operates dedicated Matchmaking activities connecting EO startups with corporates, institutional users, investors and public procurers.Through curated networking events, thematic brokerage sessions and targeted one-to-one meetings, **CASSINI Matchmaking** helps EO companies translate technological capability into concrete business opportunities. These activities facilitate access to early customers, pilot projects and strategic partnerships across sectors such as agriculture, insurance, energy and climate services, thereby accelerating commercialisation pathways and reinforcing Europe's EO industrial ecosystem. On the financing side, the **CASSINI Space Investment Facility**, implemented by the European Investment Fund, mobilises risk capital for space startups. By spring 2026, the facility has committed funds to 21 venture capital funds across Europe, thus expanding the pool of available investment capital and enabling multi-million euro co-investments into prominent space startups.

Copernicus: powering a growing community of users and application domains

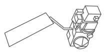
Copernicus: Europe's Eyes on the Earth for Environment, Climate, Security and Emergency Management

Copernicus delivers **accurate, consistent and reliable information** on the **state of the planet and its environment**, supporting a wide range of EU and national policies in areas such as agriculture, climate action, environment, energy, fisheries and aquaculture, forestry, transport, regional and urban planning, civil protection, EU border and internal security and emergency management. While the services are primarily tailored to the needs of public authorities, Copernicus is equally used by research and academic communities, commercial companies and other private users worldwide. The system consists of **three main components**: a Space Component, providing data from the Sentinels' satellite families and Copernicus Contributing Missions; an In-Situ Component, which coordinates and accesses observations and geospatial reference data collected by a wide range of ground-based, airborne and seaborne monitoring networks; and a Service Component, which processes these data into timely, value-added information products in six thematic areas (land, marine, atmosphere, climate change, emergency management and security). The programme is coordinated and managed by the European Commission and implemented in partnership with the Member States and a set of entrusted entities: the European Space Agency and EUMETSAT for the Space Component, and for the Service Component the European Environment Agency, the European Centre for Medium-Range Weather Forecasts, Mercator Ocean International, the Joint Research Centre, the European Maritime Safety Agency, the EU Satellite Centre (SatCen), the European Border and Coast Guard Agency (Frontex) and the EU Agency for the Space Programme.

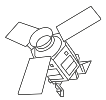
THE SPACE COMPONENT



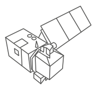
Sentinel-1 is a **C-band radar mission** providing all-weather, day-and-night imagery for Copernicus land, marine, emergency, climate and security services. Sentinel-1A is currently complemented by Sentinel-1C, and Sentinel-1D (launched November 2025) takes over from Sentinel-1A to ensure service continuity in the lead-up to the Sentinel-1 Next Generation series.



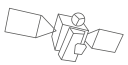
Sentinel-3 is a **multi-instrument mission** delivering global measurements of sea-surface topography, sea and land surface temperature, and ocean and land colour to support Copernicus marine, land, climate and emergency services. Sentinel-3A and 3B provide consistent observations of the oceans and continents that underpin long-term climate records and operational oceanography.



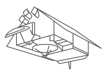
Sentinel-5 is an atmospheric-monitoring mission in low-Earth polar orbit providing daily global maps of trace gases and aerosols affecting air quality, climate and public health, building on ENVISAT heritage. Sentinel-5P delivers the current operational data record, while Sentinel-5A, launched in 2025, jointly supports Copernicus services and environmental policy monitoring.



Sentinel-2 is an optical imaging mission that provides observations in support of Copernicus land, emergency, climate, marine and security services, with a focus on vegetation, soil, inland and coastal waters, and zones. Sentinel-2A and 2B will be replaced by Sentinel-2C and 2D, to secure continuity of surface reflectance and biophysical time series ahead of future Sentinel-2 Next Generation missions.



Sentinel-4 is an atmospheric composition mission in geo orbit providing high-frequency measurements of trace gases and aerosols over Europe and North Africa to support air quality forecasting, climate monitoring and public-health applications. The first Sentinel-4 unit (Sentinel-4A), launched in 2025, delivers hourly regional maps in support of Copernicus atmospheric services and environmental policy.



Sentinel-6 is a radar altimetry mission that delivers measurements of sea-surface height, significant wave height and surface wind speed to monitor the global ocean and sea-level rise. It underpins Copernicus marine and climate services by improving ocean circulation models, storm-surge forecasting and assessments of how climate change is affecting the oceans.

The Copernicus Contributing Missions (CCM) provide complementary Earth-observation data to the Copernicus Sentinel portfolio, with 30+ existing and planned missions supplying SAR, high-resolution optical, hyperspectral, thermal-infrared, atmospheric-composition and altimetry measurements to close observational gaps. Long-standing ESA, Member State and EUMETSAT missions are now **complemented** by missions from the European **New Space ecosystem**, with a range of providers already contracted or onboarding. A second wave – Marble Imaging, SatVu, Unseenlabs, GEOSAT, ORUS and Aerospacelab – will introduce new very-high-resolution optical, thermal and maritime-surveillance capabilities into the Copernicus data offer.

Six **Sentinel Expansion missions** are under development to close identified gaps in Copernicus services. CHIME will deliver hyperspectral imaging for sustainable agriculture, soil and biodiversity monitoring, while CIMR will provide microwave observations of sea-surface temperature, sea-ice and salinity for Arctic users. CO2M will map atmospheric carbon dioxide from human activities to assess climate-policy effectiveness, and CRISTAL will monitor sea-ice thickness and overlying snow for safer polar navigation. LSTM will supply high-resolution land-surface temperature data to support water and crop-management decisions, and ROSE-L will use L-band radar to track forests, soil moisture, ground deformation and crop types for improved land and disaster management.

COPERNICUS SERVICES

Copernicus Services transform satellite and in-situ observations into value-added information products organised in six thematic areas: **Land, Marine, Atmosphere, Climate Change, Emergency Management and Security.**

Each service integrates **multi-mission EO data** with **modelling** and **expert processing chains** to provide operational maps, forecasts and indicators that directly support EU policies and user operations, from agriculture and urban planning to maritime surveillance, disaster response and climate adaptation.

Land	Marine	Atmosphere	Climate Change	Emergency	Security
CLMS	CMEMS	CAMS	C3S	CEMS	CSS

EO: a strategic decision engine for public policy and a competitive edge for business

ANSPs, airport authorities, drone/U-space operators	Farmers, agro-food companies, farm advisors, and paying agencies	App providers, digital platforms, tourism boards, environmental agencies, public-health authorities	First responders, civil protection agencies, humanitarian organisations	Energy utilities, oil & gas, renewable and mining companies, grid and pipeline operators
Public safety authorities, utilities and network operators, local governments	Fisheries authorities, RFMOs, coast guards, fishing fleets, aquaculture operators	Forest agencies and owners, timber companies, certification bodies, carbon projects	Infrastructure managers, utilities, pipeline operators, telecom infrastructure owners	Banks, insurers, reinsurers, risk-modelling firms, asset managers
Shipping companies, port authorities, IWW managers, coast guards, maritime safety and environmental agencies	Infrastructure managers, rail-operators, safety authorities, rail engineering and maintenance firms	Road authorities, highway operators, traffic centres, logistics fleet, and public transport operators	Environmental agencies, NMHSs, river-basin authorities, conservation NGOs, research centres	City authorities, urban planners, utilities, real-estate developers, cultural-heritage and monument managers

Copernicus demonstrators are targeted proof-of-concept projects led by EUSPA and sector partners, highlighting how **Copernicus EO** data can be **integrated** into everyday business, public administration and operational processes to **produce tangible impacts for end users**. By directly engaging with private stakeholders, these **demonstrators showcase operational value** and **help drive adoption** in sectors that have potential for scaling up the use of EO. The following demonstrators have been successfully launched:

- **Aircraft Emission Measurement & Monitoring:** This demonstrator shows how Copernicus atmospheric data, such as Sentinel-5P, CAMS and C3S, can be fused with detailed flight tracks and aircraft performance models to produce far more accurate aviation emission indicators. By doing so, airlines, airports, Air Navigation Service Providers (ANSPs) and regulators gain higher-resolution CO_2 and NO_2 insights and can streamline the Monitoring, Reporting, and Verification (MRV) activities under the EU Emission Trading Scheme (ETS) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).
- **Emergency Preparedness & Flood Early Warning:** By integrating Copernicus Sentinel-1/2 imagery, hydrological–hydraulic modelling and weather forecasts, this demonstrator delivers earlier and more reliable flood-risk intelligence. Municipalities, water authorities, utilities, hydropower operators and civil protection agencies benefit from clearer asset-at-risk maps and more actionable early warnings.
- **Autonomous Navigation & Ship Route Optimisation:** This demonstrator illustrates how (CMS) data, general metocean data and Sentinel imagery, combined with AIS vessel tracking and ship models, can enhance voyage planning. The result is safer navigation, reduced fuel consumption and better detection of conditions such as biofouling risks, supporting both today's fleet operators and the future of autonomous shipping.
- **Renewable Energy Acceleration Areas (RAAs):** By combining CLMS, CAMS and C3S products with Sentinel-1/2 imagery, national planning layers, grid capacity and environmental constraints, this demonstrator helps authorities and developers pinpoint low-impact zones suitable for fast-tracked renewable deployment. It supports the implementation of the Renewable Energy Directive (RED) III by making the identification of candidate areas more transparent and evidence-based.
- **ESG Monitoring for Green Finance & Corporate Sustainability Reporting Directive (CSRD):** Here, Copernicus climate, atmospheric, land and marine datasets are linked with corporate asset information to produce auditable ESG metrics at both asset and portfolio level. This enables banks and insurers to strengthen their green finance frameworks and meet CSRD reporting needs with more objective, data-driven indicators.
- **Seaweed Farming Optimisation:** This demonstrator uses Copernicus Marine Service data, Sentinel-3 and Sentinel-2 observations, and EMODnet bathymetry data alongside farm layout and logistics information to support smarter site selection and daily farm management. Seaweed producers gain better insight into environmental suitability, operational risks and potential production optimisation.

Catalysing climate-smart innovation: EUSPA Proof-of-Concepts help turn space data into market-ready solutions

Proof-of-Concepts (PoC) developed by EUSPA demonstrate how Copernicus data can be transformed into operational, climate-smart solutions by validating tools that support early warning, risk management, urban planning and economic monitoring, effectively bridging the gap between raw satellite data and actionable insights. The aviation and drones segment contains the PoC about Aircraft Emission Measurement on page 65, while the emergency management and humanitarian aid contains the PoC on flood awareness through the Waterjade demonstrator on page 99. Finally, the insurance and finance segment contains the PoC on the use of EO data by the ECB for commodity trading and economic activity tracking on page 158.

The EU Space Programme is making data access easier and listening to user needs

Copernicus Data Space Ecosystem: one gateway for all Earth data

The Copernicus DataSpace Ecosystem (CDSE) is the **main doorway into Europe's Earth Observation system**: a single, free platform on which to search, visualise and process all Copernicus Sentinel data and an increasing share of Copernicus service products. It replaces the previous legacy hubs with a **unified environment** offering **map-based exploration, downloads and modern APIs** so that workflows in Python, GIS tools or cloud environments can pull data directly from the same backbone. Storage and computers are co-located, so users can process the data, chain it with other services in the ecosystem, and only export the final information product. At the end of 2025 **CDSE passed the landmark of over 500,000 registered users**. CDSE is the largest EO data platform in Europe and a reference entry point for researchers, public authorities and commercial providers. Recent developments focus on **scale, usability and integration**. As of 2024 more than 78 PB of data were stored online and over 100 million Sentinel products, with more than 200 PB of data delivered to users in 2024 alone; these figures continued to rise in 2025 as new missions and products were onboarded. In 2025 the **migration of the global Copernicus Land Monitoring Service portfolio** – including global dynamic land cover, water bodies, vegetation, and temperature and reflectance – took place, so these analysis-ready layers are now primarily distributed via CDSE, alongside the underlying Sentinel products. The web portal was refreshed with **better navigation and search**, and subscriptions now alert users when products are added, updated or withdrawn. Finally, an onboarding and **service-registry framework highlights third-party apps** and processors directly inside the portal, turning CDSE into an active marketplace and innovation hub for Copernicus-based services.

Copernicus Thematic Hubs: focus gateways to Europe's environmental intelligence

The **Copernicus Thematic Hubs** are specialised portals serving as single entry points to data and products, organised around specific **thematic areas or regions**. The first hubs, launched in November 2023, are to be complemented by two additional hubs. They will streamline access to Copernicus resources for specific user communities, making it easier for policymakers, researchers and practitioners to find relevant EO data and services on the same theme without navigating each service separately.

- **Health Hub** – Coordinated by CAMS, it centralises environmental data (air quality, climate, UV radiation, pollen, infectious disease vectors) from CAMS, C3S, CLMS and other services to support public health policy, urban planning and epidemiology.
- **Coastal Hub** – It is managed by CMEMS and aggregates marine, land, atmosphere, climate and emergency data for European coastal zones to support maritime spatial planning, coastal erosion monitoring, sustainable fisheries, tourism and biodiversity conservation.
- **Energy Hub** – Coordinated by C3S, it provides climate forecasts, real-time observations and historical data to support renewable energy site selection (wind, solar, tidal), grid planning and energy policy (RepowerEU, European Green Deal).
- **Arctic Hub** – Under the management of CMEMS, it delivers data on sea ice extent, permafrost thawing, ocean conditions and climate trends in the Arctic to support EU Arctic Policy implementation, shipping operations and climate research.
- **World Heritage Hub** – Launched in 2026 by EUSPA, this hub serves as a one-stop shop for monitoring and protecting cultural and natural heritage sites using Copernicus EO data, supporting UNESCO, national heritage authorities, and climate adaptation planning.
- **Water Hub** – Discussed in the Water-ForCE roadmap (2024) as a potential thematic hub to address fragmentation of inland and near-coastal water products across multiple Copernicus services.

The User Consultation Platform (UCP) for the EU Space Programme: focusing on EO User needs and requirements

The UCP engages with **user communities, industries, service providers and R&D**, bringing together expertise and insights from different applications, sharing their experiences and knowledge concerning the data and services provided by the EU Space Programme components. In the specific case of EO, the UCP focuses on non-core users, exploring relevant use cases and operational scenarios and investigating associated user needs and requirements. The **2025 edition of the UCP**, held in Prague, discussed EO user needs and requirements across application areas including food security and nature credits, transport (CCAM, Rail, and Public Transport), and EU security.

The **food security and nature credits** session covered topics such as the need for better accuracy and standardisation to support carbon assessment, as well as how reliable access to harmonized and high-quality EO data can support food security.

The **transport** sessions acknowledged the growing maturity of EO solutions for infrastructure monitoring, urban transport planning, and climate-risk mapping, together with associated user needs.

Finally, the **EU Border and Internal Security** session covered how EO is already in use to increase situational awareness across diverse applications and operating scenarios of response to threats and challenges.

The outcomes of the UCP are used to compile and update a series of **Reports on User Needs and Requirements** per market segment. The objective of these documents is to constitute a reference for each market segment's user communities by collecting and analysing the most up-to-date user needs and requirements across the application domains. At the same time, these reports serve as a key input for the evolution of the EU Space Programme and for supporting the uptake of Copernicus services and data.

The full reports of the UCP 2024 and 2025 are available here.

The GNSS downstream market and market estimation methodology

WHAT IS GNSS?

Radio Navigation Satellite Services (RNSS) are space-based navigation infrastructure that enable users with compatible receivers to determine their position, velocity and time by processing radio signals from satellites. RNSS signals come from global and regional constellations, complemented by Satellite-Based Augmentation Systems (SBAS) that enhance accuracy, integrity and availability for critical applications such as aviation.

- **Global constellations i.e. Global Navigation Satellite System (GNSS):** GPS (USA), GLONASS (Russian Federation), Galileo (EU), and BeiDou (People's Republic of China).
- **Regional constellations:** QZSS (Japan), NavIC (India), and BeiDou regional component (PRC).
- **Satellite-Based Augmentation Systems (SBAS):** WAAS (USA), EGNOS (EU), MSAS (Japan), GAGAN (India), SDCM (Russian Federation), BDSBAS / SNAS in China. KASS (Republic of Korea) and SouthPAN (Australia / New Zealand).
- **Emerging LEO constellations:** New low-Earth orbit systems under development and demonstration to provide complementary or backup PNT services alongside traditional GNSS.

KEY GNSS PERFORMANCE PARAMETERS

GNSS technology is used for many types of applications, covering the mass market, professional and safety-critical applications and critical infrastructure. Depending on user needs, important GNSS user requirements include:

- **Accuracy:** The difference between true and computed solution (position or time). This is expressed as the value within which a specified proportion, usually 95%, of samples would fall if measured.
- **Availability:** The percentage of time the position, navigation or timing solution can be computed by the user. Values vary greatly according to the specific application and services used but typically range from 95-99.9%.
- **Calibration:** The process of measuring the different biases of the GNSS signal's propagation through the antenna cable and equipment hardware in order to characterise and consider them when computing the timing solution (only relates to GNSS Timing Receivers).
- **Continuity:** The ability of a system to perform its function (deliver services with the required performance levels) without interruption once the operation has started. It is usually expressed as the risk of discontinuity and depends entirely on the timeframe of the application.
- **Integrity:** The ability of the system to provide warnings to users when it should not be used. It is the probability of a user being exposed to an error larger than the alert limits without timely warning.
- **Robustness:** Relates to spoofing and jamming and how the system can cope with these issues.
    - **Robustness to jamming** is the ability of the system to mitigate radio frequency (RF) interference and continue operations within stated service performance limits.
    - **Robustness to spoofing** is the ability of the system to prevent, detect and mitigate spoofing attacks. Authentication relates to the system's ability to assure the users that they are utilising signals and/or data from a trustworthy source and thus enhance its robustness level.
- **Time To First Fix (TTFF):** A measure of a receiver's performance covering the time between activation and output of a position within the required accuracy bounds.

Parameters not directly related to GNSS performance are also important. Such parameters include **power consumption, resilience, connectivity, interoperability and traceability**.
More details on GNSS performance parameters and requirements are provided in **Annex 2**.

GNSS MARKET

This Market Report considers the GNSS market defined as activities where GNSS-based PNT is a significant enabler of functionality. The GNSS market presented in this report comprises **device** and **service** revenues. The latter include revenues derived from **augmentation services** and **other services** attributable to GNSS.

Augmentation services include GNSS augmentation subscriptions (PPP, RTK, PPP-RTK and DGNSS). Revenues deriving from **other services** include software products and content such as digital maps for in-vehicle systems (IVS), as well as data downloaded through cellular networks specifically to run location-based applications (such as navigation), as well as the GNSS-attributable revenues of smartphone apps (sales revenues, advertisements and in-app purchases), subscription revenues from asset management services, drone service revenues across a range of industries. Both services are shown on the World Map (next page) together as 'Services'.
For multi-function devices, such as smartphones, the revenues include only the value of GNSS functionality – not the full device price. Therefore, a case-specific correction factor is used:

- **GNSS-enabled smartphone:** Only the value of GNSS chipsets is counted.
- **Aviation:** The value of the GNSS receiver inside the Multi-Mode Receiver is taken into account, in addition to the GNSS-specific revenues driven by the certification process.
- **Precision agriculture systems:** The retail value of the GNSS receivers, maps and navigation software is counted.
- **Search and rescue devices:** For personal locator beacons and emergency locator transmitters, only the price differential between GNSS and non-GNSS devices is included.

ON CHARTS AND METHODOLOGY

Data contained within the charts starting from 2025 are estimated and will be updated in the next edition of the Market Report.

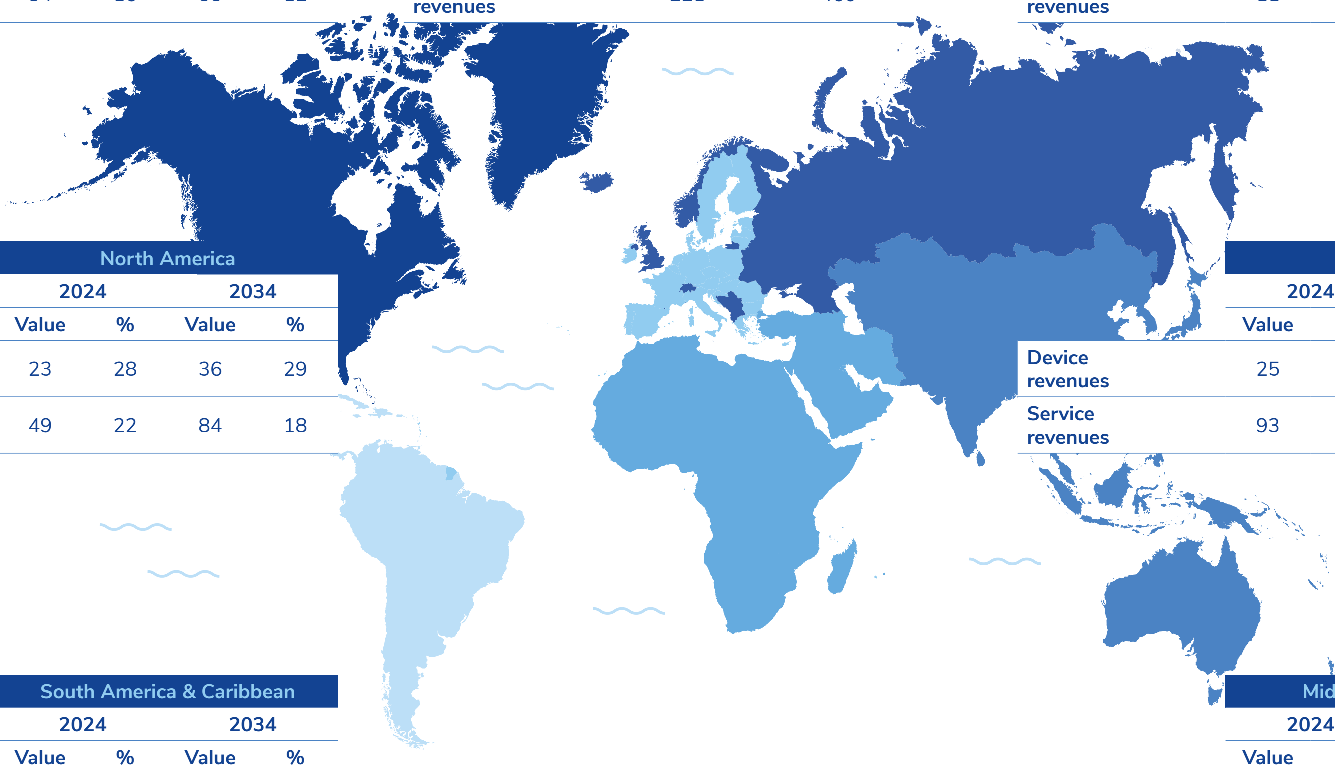
Terminology used in charts:

- **Shipments:** The number of devices sold in a given year.
- **Installed base:** The number of devices currently in use.
- **Revenues:** The revenues from device/service sales in a given year.
- **Regions:** European Union (EU27), North America, Asia-Pacific, Russia & Non-EU27 Europe (Non-EU27 Europe), Middle East & Africa, and South America & Caribbean.

The chart data are presented from two angles. First, **GNSS demand**, documented at aggregate and segment level in the charts of this report, shows the regions in which shipments are sold, devices are used and revenues are generated. Second, the **market share analysis** looks at the origin of supply – where a company (or its ultimate parent) offering the product is headquartered – as presented on the dedicated industry pages where market shares are presented. The difference between the GNSS demand data and the supply-driven market share analysis data thus gives an indication of the trade balance between regions.

For methodology and information sources, see **Annex 1** and for any abbreviations used within the report, please refer to **Annex 4**.

Strong mobile-app economy and urban growth make Asia-Pacific the top GNSS service market[1]



European Union (EU27)	2024 Value	2024 %	2034 Value	2034 %
Device revenues	22	26	31	26
Service revenues	34	16	55	12

Global	2024 Value	2034 Value
Device revenues	82	122
Service revenues	221	460

Russia & Non-EU27 Europe	2024 Value	2024 %	2034 Value	2034 %
Device revenues	7	8	12	10
Service revenues	11	5	22	5

North America	2024 Value	2024 %	2034 Value	2034 %
Device revenues	23	28	36	29
Service revenues	49	22	84	18

Asia-Pacific	2024 Value	2024 %	2034 Value	2034 %
Device revenues	25	31	34	28
Service revenues	93	42	211	46

South America & Caribbean	2024 Value	2024 %	2034 Value	2034 %
Device revenues	2	3	4	3
Service revenues	12	5	27	6

Middle East & Africa	2024 Value	2024 %	2034 Value	2034 %
Device revenues	3	4	5	4
Service revenues	22	10	61	13

1: All values are presented in bn €, and percentages are rounded to the nearest whole percent.

Role of GNSS across the market segments

GNSS applications have a pervasive role in each of the 16 market segments presented in this EU Space Market Report. For each of these segments, a brief summary of the scope is presented below. More insights into segment-specific trends can be found on their respective 'Key Trends' page. The Climate, Environment, and Biodiversity segment cover GNSS only from the qualitative perspective.

AGRICULTURE – GNSS enables the efficient guidance of agricultural machinery and supports the deployment of precision and automated farming practices. It allows improved monitoring of operations, variable-rate applications and autonomous equipment, leading to increased productivity, reduced resource use and lower environmental impact.

AVIATION AND DRONES – GNSS is an indispensable component of aviation, supporting navigation, surveillance and approach procedures. In the drone sector, GNSS enables certified beyond visual line-of-sight operations and traffic management within U-space, the European framework for managing unmanned aircraft traffic. Aviation safety, efficiency and regulatory compliance rely heavily on GNSS-based services.

CLIMATE, ENVIRONMENT AND BIODIVERSITY – GNSS supports geodetic and atmospheric applications that measure key Earth properties such as crustal motion, sea level and atmospheric conditions. In biodiversity applications, GNSS enables the tracking of animals and ecosystems to monitor migration patterns, habitats and behaviour.

CONSUMER SOLUTIONS, TOURISM AND HEALTH – GNSS is ubiquitous in everyday life through smartphones, wearables and connected devices. It supports a wide range of applications including navigation, fitness and health monitoring, tourism services, location-based services and emerging augmented reality use cases.

EMERGENCY MANAGEMENT AND HUMANITARIAN AID – GNSS provides precise timing and synchronisation for electricity grids, supporting stable and secure energy operations. In the raw materials sector, GNSS supports machinery guidance, asset tracking, site monitoring and the deployment of autonomous and remote-controlled systems.

ENERGY AND RAW MATERIALS – In energy, GNSS provides precise timing and synchronisation for electricity grids, supporting stable and secure energy operations. In raw materials, it enables machinery guidance, asset tracking and site monitoring, supporting autonomous and remote-controlled operations.

EU BORDER AND INTERNAL SECURITY – GNSS provides accurate positioning and timing for border surveillance, customs operations, and law enforcement. It enables vessel tracking, asset monitoring and geolocation of sensors and personnel, supporting risk assessment, crisis response and evidence collection in complex environments.

FISHERIES AND AQUACULTURE – GNSS contributes to the detection and prevention of illegal, unreported and unregulated fishing through vessel tracking systems. It improves safety at sea and supports sustainable fisheries management, while also enabling monitoring of aquaculture installations.

FORESTRY – GNSS supports the effective management and long-term sustainability of forests. It enables accurate mapping, inventory management, monitoring of forest health and the tracking of timber supply chains.

INFRASTRUCTURE – GNSS contributes to the efficient construction, operation and maintenance of infrastructure. High-accuracy positioning supports construction activities and structural monitoring, while GNSS timing and synchronisation are essential for telecommunications networks and data centres.

INSURANCE AND FINANCE – The financial sector relies on GNSS timing and synchronisation for the accurate timestamping of transactions. GNSS also supports risk assessment and the development of insurance products linked to location-based data.

MARITIME AND INLAND WATERWAYS – GNSS is a fundamental tool for navigation, vessel traffic management and port operations. It supports digitalisation and automation across maritime transport, inland waterways and port environments, enhancing safety, efficiency and environmental performance.

RAIL – GNSS is increasingly used for train localisation and traffic management. It supports maintenance planning, operational optimisation and safety-related applications, contributing to the increased capacity, efficiency and reliability of railway systems.

ROAD AND AUTOMOTIVE – GNSS plays a crucial role in road transport safety and efficiency. It supports connected and automated vehicles, traffic management, emergency services and asset tracking, while contributing to reduced congestion and emissions.

SPACE – GNSS supports spacecraft navigation and Earth observation missions. Its use is expanding beyond Low Earth Orbit, supporting a wider range of space operations and the growing demand for space-based navigation solutions.

URBAN DEVELOPMENT AND CULTURAL HERITAGE – GNSS enables precise location-based data for urban planning and infrastructure development. It supports the mapping, monitoring and preservation of cultural heritage sites through accurate documentation and restoration activities.

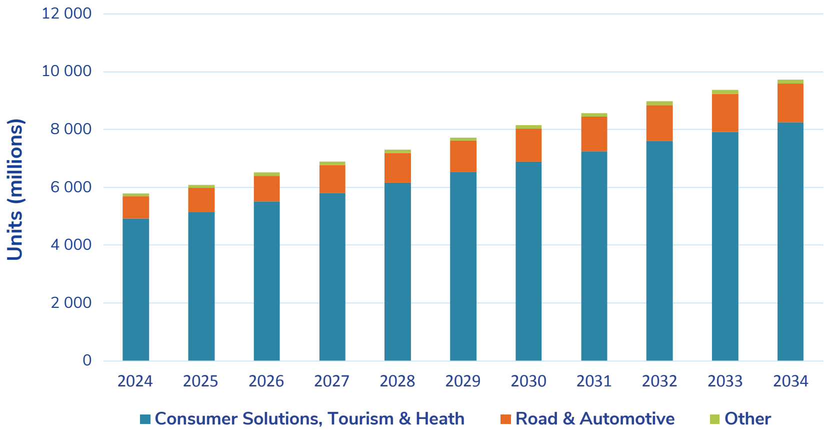
Sustained GNSS growth driven by consumer uptake, automotive integration and global expansion[1]

Growth in GNSS device shipments (upper-right chart) by region is driven primarily by the **continued expansion of the Asia-Pacific market**. Global shipments increase from around 1.75 billion units in 2024 to around slightly less than 2.5 billion units in 2034, with **Asia-Pacific accounting for the largest share of this growth**. The region's role as both the main consumer market and a key manufacturing hub sustains its dominance over the entire period. **North America and the EU27 show steady but more moderate growth**, reflecting stable demand across all applications. Other regions contribute incrementally, reinforcing the overall upward trend without significantly altering the regional distribution of shipments.

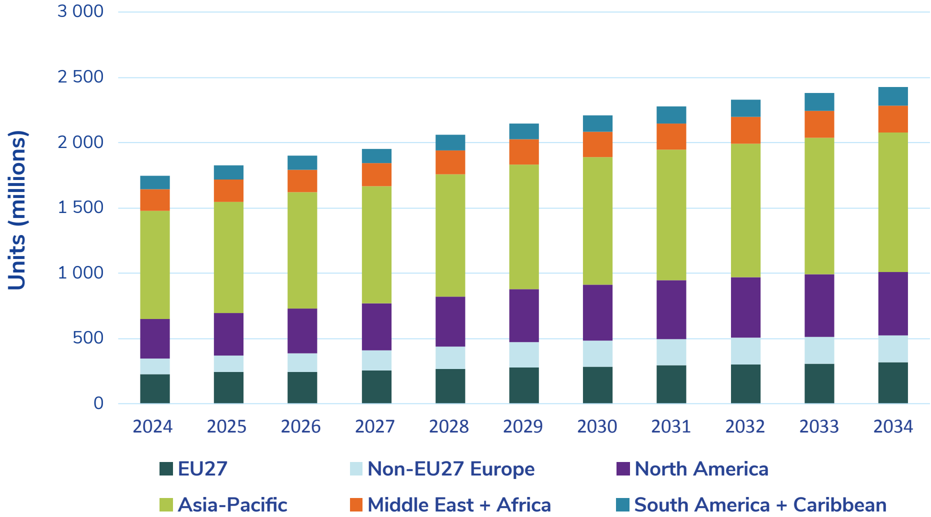
The **total installed base of GNSS devices** (bottom-left chart) continues to expand steadily, increasing from around 5.8 billion units in 2024 to 9.75 billion units by 2034. This growth is primarily driven by the increasing popularity of consumer devices such as smartphones and wearables, which remain the dominant contributor to the installed base throughout the period. **Consumer Solutions, Tourism and Health account for the largest share of installed devices**, remaining close to 85% over the period. At the same time, the **Road & Automotive** segment maintains a relatively stable share of around 13-14%, supported by growing vehicle fleets worldwide and the increasing integration of GNSS in connected and automated vehicles. Other segments remain marginal in comparison, contributing only a small fraction of the total installed base while growing gradually in absolute terms.

Within the **other segments, Aviation and Drones** remain the largest contributor, increasing from around 42 million units in 2024 to around 50 million units by 2034, followed by the new segment in the scope of this report, **EU border and Internal Security**. **Agriculture** shows the strongest relative growth, expanding from roughly 8.8 million units (9.5% of the other segments) to nearly 29.1 million units (20.5% of the other segments), reflecting the rising use of GNSS in agriculture at global level. **Maritime and Inland Waterways** grow steadily from around 13.5 million to 19.5 million units, maintaining a broadly stable share. **Rail** and other segments such as **Emergency Management and Humanitarian Aid**, **Fisheries and Aquaculture**, and **Urban and Cultural Heritage** increase in absolute terms but remain secondary contributors to the overall installed base.

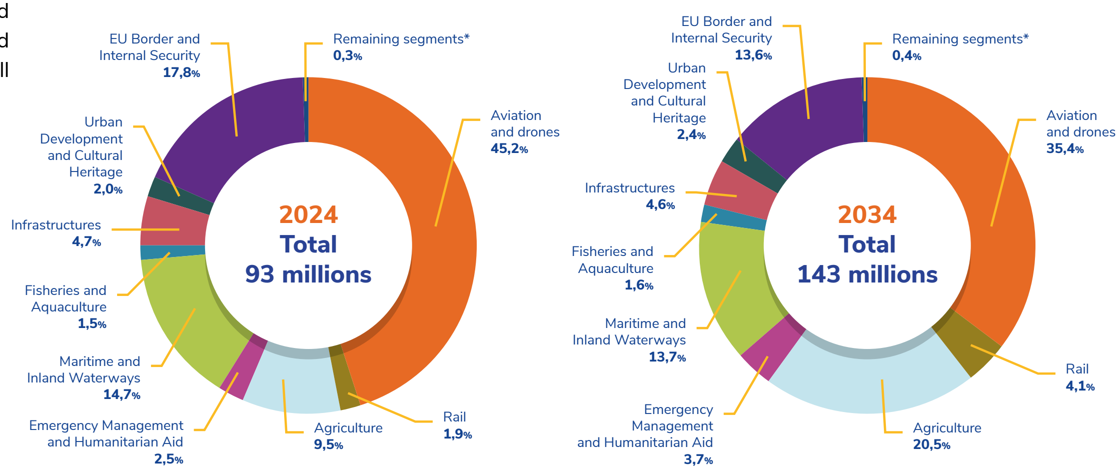
Installed base of GNSS devices by segment



Shipments of GNSS devices by region



Installed base of GNSS devices for other segments than Consumer Solutions, Tourism & Health and Road & Automotive



* Remaining segments include Space, Insurance and Finance, Forestry and Energy and Raw Materials

1: All results rely on the same forecasting methodology, detailed in Annex 1. Because input data and attribution bases differ across segments, figures are not directly comparable. Annex 1 provides full clarification on inputs and EO/GNSS-service attribution.

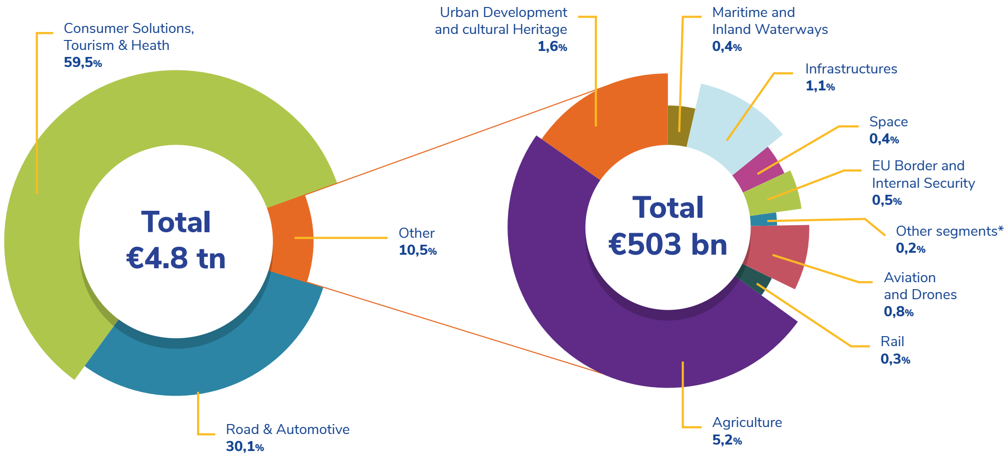
Smartphone uptake and service monetisation push GNSS cumulative revenues to €5.0 trillion by 2034

The GNSS downstream market continues to expand steadily, with total revenues from **devices and GNSS-enabled services** rising from around €300 billion in 2024 to more than €580 billion by 2034. This growth reflects both the increasing scale of GNSS adoption across multiple sectors and the diversification of revenue streams linked to PNT technologies

Revenue growth is supported by the parallel development **of services and devices.** GNSS-related services generate the largest share of revenues, reaching about €460 billion in 2034 and representing roughly 80% of total downstream revenues by 2034. The share of **device revenues** has increased in comparison to the previous edition of the Market report, as revenues now include applications from the EU border and internal security segment. Moreover, GNSS hardware is becoming more capable, more integrated and increasingly embedded in high-performance, but still mass-market applications, such as connected and automated vehicles.

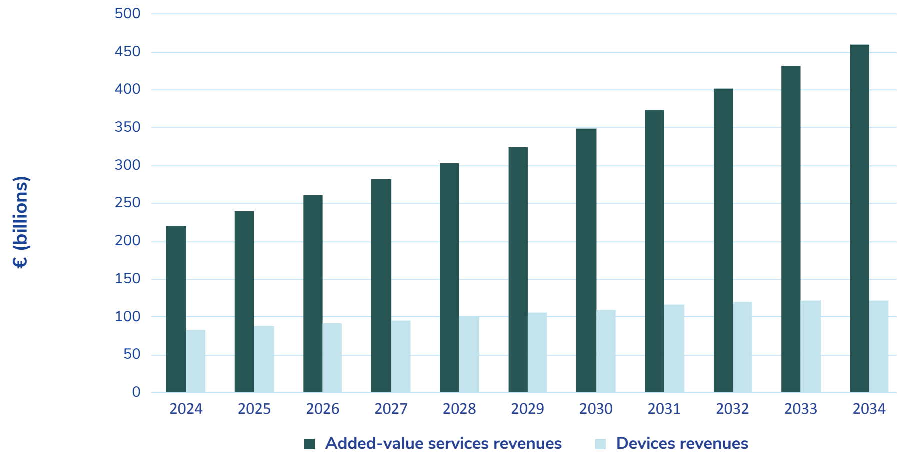
Consumer-facing applications, particularly those delivered via **smartphones**, remain a major source of service revenues, accounting for more than 70% of GNSS-enabled services. However, the evolving balance between devices and services highlights a downstream market that is not only shifting toward service-based models, but also benefiting from sustained demand for advanced GNSS-enabled hardware, resulting in a more balanced revenue structure than previously anticipated.

Cumulative revenue by segment 2024 - 2034



*Other segments includes Emergency Management and Humanitarian Aid, Fisheries and aquaculture, Forestry, Insurance and Finance and Energy and Raw Materials

Revenue from GNSS devices sales and services



Consumer solutions and **road & automotive** will remain the two dominant GNSS market segments over the forecast period, jointly accounting for around 90% of cumulative revenues between 2024 and 2034. While **Consumer solutions, Tourism & Health** gradually reach saturation due to the maturity of smartphone and wearable markets, the **Road & Automotive** segment strengthens its position in the later years covered by this report, as connected and automated driving technologies move from initial adoption to broader market deployment, supported by regulatory momentum and OEM investment.

In 2024, **Road & Automotive** revenues are mainly driven by **in-vehicle systems, map software updates**, and **connected and automated driving** (CAD) applications. Over time, **CAD** becomes a primary growth engine as advanced driver assistance and automation increasingly rely on precise, continuously updated GNSS-based positioning. In contrast, traditional **in-vehicle systems** lose relative importance as their functionalities are progressively absorbed into integrated CAD platforms. **Map software updates** continue to grow, albeit at a more moderate pace, reflecting the need for high-definition mapping without a proportional increase in pricing.

Consumer solutions remain overwhelmingly driven by **GNSS-enabled smartphone applications**, which continue to expand and are expected to generate around €275 billion in revenues in 2034. This growth is underpinned by the sustained monetisation of location-based services across mobility, financial services, tourism, gaming and social media, where GNSS is a foundational technology. Other applications, including **tracking devices, data services and consumer robotics**, play a secondary role, with limited growth potential as markets mature and replacement cycles lengthen.

The remaining revenues, accounting for around 10% of the market, are mainly generated by **Agriculture, Infrastructure, and Urban Development and Cultural Heritage** applications. **Agriculture** leads this group due to the continued adoption of GNSS-enabled guidance and monitoring solutions aimed at improving productivity and reducing input costs. **Infrastructure** provides steady growth through surveying, construction, and site monitoring activities, while **urban development and cultural heritage** contributes through the use of GNSS in urban planning and infrastructure management.

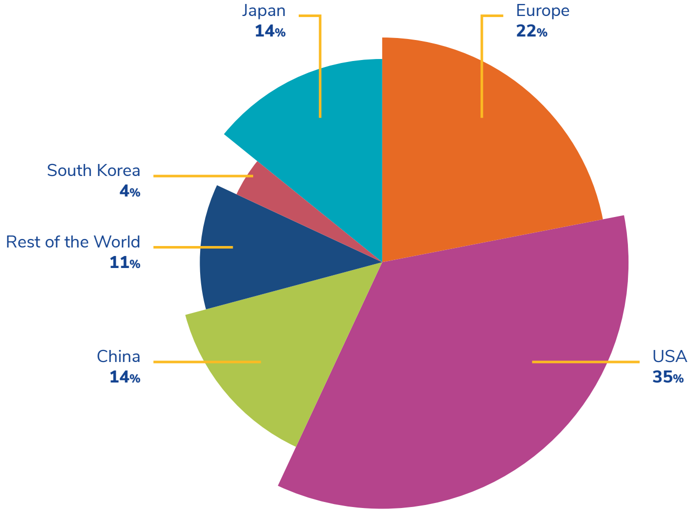
GNSS industry overview

Companies headquartered in the **USA** and **Europe**[1] dominate the GNSS downstream value chain, accounting for the majority of revenues generated from **components and receivers, system integration, and software and value-added services**[2]. The USA holds the leading position with a 35% market share, while Europe follows with 22%.

Japan, China and South Korea combined account for 32% of the global market, with China alone representing 14%.

The downstream GNSS industry is organised around three core value-chain categories: components and receiver manufacturing, system integration, and added-value service provision. The top-right table presents the **ten leading companies** in each segment. In **components and receivers**, companies from the USA dominate the rankings, accounting for five of the top ten players. **System integrators** show greater geographic diversity but are largely driven by consumer device manufacturers and automotive OEMs. The **added-value services segment** is led by a mix of IT and technology giants alongside augmentation service providers.

Revenues generation in the GNSS industry by key regions (% split of revenues 2024)



Top 10 companies across the value chain based on 2024 revenues (in alphabetical order)

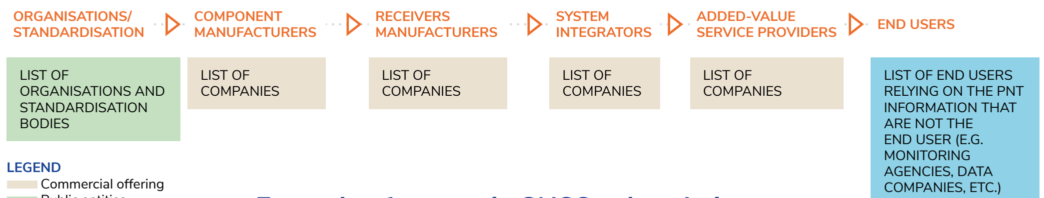
Components & Receivers Manufacturers		System Integrators		Added-Value Service Providers		End users
Avago (Broadcom)	US	Apple	US	Alphabet (Google)	US	Users of GNSS-based solutions across the different market segments
Beijing Bdstar Navigation	CN	China First Automobile Group Corporation	CN	ESRI	US	
Garmin Ltd	US	Ford	US	Garmin	US	
Hexagon AB	SE	General Motors	US	HERE International	NL	
Kongsberg Maritime	NO	Hyundai Motor	KR	Hexagon AB	SE	
Mediatek Inc	CN	Samsung Electronics	KR	Meta Platforms Inc	US	
Qualcomm Inc	US	Stellantis	NL	Microsoft	US	
RTX Corporation	US	Tesla	US	Navinfo	CN	
Topcon Corporation	JP	Toyota	JP	Tencent	CN	
Trimble Navigation Ltd	US	Volkswagen	DE	Trimble Navigation Ltd	US	

1: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland, and the United Kingdom.
2: A different methodology was used to calculate GNSS revenues compared to rest of the report as described in Annex 1. This methodology measures the size of GNSS industry from a supply perspective based on a bottom-up approach which quantifies revenues attributable to GNSS of 1,700 individual companies for which financial data are available (those with turnover greater than the threshold exempting small firms from financial reporting – this threshold is not universal so smaller companies may be included in some regions than in others). Companies are allocated to a single region based on the registered headquarters of the company (or its ultimate parent), which indicates the regions in which the demand for GNSS equipment and services are generated. In contrast, the methodology in the rest of the report attributes the size of the GNSS market to the region where equipment or services are sold and used. Specifically, this means that the European share of the GNSS market presented in this table is a methodologically different statistic to the share of the revenues presented for EU27 in the map on page 26. For further information on the methodology, please refer to Annex 1.

The GNSS value chain

Across the different market segments, the core of the GNSS industry value chain is centralized around the three categories as explained above. Nonetheless, every market segment has its own specific value chain and, therefore, we strongly recommend you explore these per segment. In general, each value will most probably contain all the following categories of stakeholders:

- **(Inter)national organisations and standardisation bodies:** regulated segments, such as Maritime and Aviation, will present a first link in their value chain dedicated to bodies setting GNSS standards and requirements (not present in each segment).
- **Component manufacturers:** these support the industry by producing chips, antennas and other inputs for GNSS receivers.
- **Receiver manufacturers:** added value and market specificities are conferred by device/product manufacturers specialized across segments.
- **System integrators (and design consultancies):** these are responsible for the technical implementation of the GNSS equipment into a complex system.
- **Added-value service providers:** these companies provide either added-value or augmentation services to end users (augmentation providers have different relevance across segments; they are not present in some segments, while they are covered by a dedicated stage of the value chain if they are of key importance in other segments).
- **End users/users of positioning information:** the final users who benefit from the applications and services offered by system integrators.



Example of a generic GNSS value chain

The European GNSS industry leads in crucial segments

European[1] GNSS market share by value chain categories

The table on the right estimates the regional market shares for components and receivers' manufacturers for each market segment in 2024.

European companies are found to hold **almost 20% of the global GNSS components and receivers' market in 2024**. Europe's market share varies across market segments. European companies are leading in segments such as Maritime and Inland Waterways (45%), Space (70%) and Finance (70%) whereas segments such as Consumer Solutions, Health and Lifestyle (5%), Aviation and Drones (15%), and Urban Development (5%) are led by the industry of the other main regions considered.

North America excels in GNSS applications for Aviation and Drones (75%), Consumer Solutions Health and Lifestyle (50%) and EU Border and Internal Security (55%), largely because of its advanced OEM ecosystem, strong aerospace sector, and fast integration of new GNSS capabilities into commercial and governmental systems. Asia + Russia, in turn, performs strongly in Agriculture (50%), Consumer Solutions (45%), Rail (55%) and Urban development (65%), driven by extensive manufacturing capacity, widespread deployment of GNSS-enabled equipment in these sectors, and the ability to scale new technologies quickly across large domestic markets

Europe accounts for 25% of the system integrators' global market share, with a slight decline vs. previous years mostly connected to international competition in Road and Automotive, and for more than 15% in added-value service providers in 2024. By contrast, European companies are growing in the Maritime and Inland Waterways and Fisheries and Aquaculture segments.

Please note that changes in market share are driven by general market trends, mergers and acquisitions, and exchange rate fluctuations.

NOTES: The footnotes presented on page 20 also apply to this page. For further information on the methodology, please refer to Annex 1.

GNSS Regional market shares in components and receiver manufacturers, by market segment - 2024

	Europe[1]	North America	Asia+ Russia
	10%	40%	50%
	15%	75%	10%
	5%	50%	45%
	40%	50%	10%
	35%	20%	45%
	70%	30%	0%
	25%	60%	15%
	70%	20%	10%

	Europe	North America	Asia+ Russia
	15%	45%	40%
	25%	40%	35%
	45%	35%	20%
	15%	30%	55%
	35%	25%	40%
	5%	30%	65%
	30%	55%	15%

NOTE: Segment share for the 'rest of the world' is not shown nor accounted for in this table. Rounding is performed to the level of 5%. The market shares related to the Climate, Environment, and Biodiversity segment are not shown.

1: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland, and the United Kingdom.

CASSINI for GNSS: Turning Galileo and EGNOS Innovation into GNSS Scaleups

CASSINI, the EU's flagship space entrepreneurship initiative, bolsters commercial entrepreneurship across all components of the EU Space Programme, including Navigation and Positioning. The initiative bundles hackathons, prizes, a business accelerator and a dedicated investment facility into a single ecosystem that helps GNSS founders validate ideas, build products and raise capital. By bringing together these elements, CASSINI builds a European deal flow machine around EU space-aware entrepreneurs, lowering entry barriers for new ventures, helping mobilise private investment and scaling the most promising European companies. Aspiring entrepreneurs and teams looking to validate their positioning and timing solutions can participate in **CASSINI Hackathons** to get hands-on experience with Galileo and EGNOS. Eleven hackathon editions have catalysed a wide range of GNSS-driven concepts – from precision agriculture solutions to paragliding assistants – with financial prizes and six month mentoring packages awarded to the top teams.

The **CASSINI Challenges** contest targets close to market solutions, offering EU level visibility and €1.2 million cash prize pot for solutions that solve pressing social, commercial and environmental challenges by leveraging EU space data and services. Once GNSS companies have early traction, the **CASSINI Business Accelerator** offers a six month, high-intensity programme focused on growth. Each accelerator batch consists of 20 startups and scaleups and provides them with tailored coaching on sales, fundraising, go to market and procurement, and connects them with a powerful network of corporates, investors and institutional customers. Since its launch in 2023, the accelerator has supported six cohorts and 120 companies in many business areas, such as securing first large commercial contracts and scaling operations into new international markets. To further strengthen market uptake and commercial partnerships, CASSINI also operates dedicated Matchmaking activities connecting GNSS startups with corporates, institutional users, investors and public procurers. Through curated networking events, thematic brokerage sessions and targeted one-to-one meetings, **CASSINI Matchmaking** helps GNSS companies translate technological capability into concrete business opportunities. These activities facilitate access to early customers, pilot projects and strategic partnerships across sectors such as agriculture, insurance, energy and climate services, thereby accelerating commercialisation pathways and reinforcing Europe's navigation and positioning industrial ecosystem. On the financing side, **the CASSINI Space Investment Facility**, implemented by the European Investment Fund, mobilises risk capital for space startups. By spring 2026, the facility has committed funds to 21 venture capital funds across Europe, thus expanding the pool of available investment capital and enabling multi-million euro co-investments into prominent space startups.

1: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland, and the United Kingdom.

Galileo and EGNOS – the European satellite navigation constellations

Galileo is the European Global Navigation Satellite System (GNSS), providing standalone navigation, positioning and timing information to users worldwide. Unlike other systems, it is under civilian control and has been designed to meet the diverse needs of different user communities. Galileo provides Europe and its citizens with independence and sovereignty in the provision of satellite-based PNT services and offers several high-performance services worldwide, featuring different levels of accuracy, robustness, authentication and security. Galileo entered service in 2016 with the declaration of its Initial Operational Capability (IOC), allowing any user equipped with a Galileo-enabled device to access its signals for PNT.

- The **Open Service** is a free, global service for positioning and timing that is evolving towards full, free and open provision, meaning that the service is fully operational, provided freely and openly accessible without restrictions.
- **The Open Service Navigation Message Authentication**: Galileo's **newly declared authentication feature** for the Open Service. It provides cryptographic authentication of the navigation messages, enabling users to verify that the data used for position computation is genuine and has not been tampered with.
- The **High Accuracy Service**, operational since January 2023, complements the Galileo Open Service by providing free Precise Point Positioning (PPP) corrections through both the E6-B signal and the Internet (IDD). Under nominal conditions, HAS enables real-time user positioning with horizontal accuracy better than 20 cm and vertical accuracy better than 40 cm.
- The **Public Regulated Service** is reserved for government-authorised users and supports sensitive applications requiring high service continuity and enhanced robustness.
- The **Galileo's Search and Rescue Service** forms Europe's contribution to the global COSPAS-SARSAT distress alert and location system, enabling faster detection and localisation of beacons and returning acknowledgement messages to those in distress.
- The **Emergency Warning Satellite Service** is a new Galileo service being prepared to broadcast warning messages via satellite to populations in areas threatened by natural disasters or other major emergencies, supporting rapid public alerting and civil protection.
- The forthcoming **Signal Authentication Service** will provide users with an authenticated Galileo PVT solution for professional and commercial use cases.

The **Galileo infrastructure** is evolving with the **second generation satellites**, now in full development with designs approved for production and first launches targeted for 2027 on Ariane 6. Through gradual integration into the existing fleet alongside first-generation, **G2G will deliver key innovations to users**, expanding Galileo's portfolio with diversified services including new high-accuracy and resilient signals for governmental and safety-critical applications, while featuring frequency diversity, higher power levels, multi-layer authentication and interference-resistant designs for stronger service reliability. Decimetre-level positioning and precise timing will be enabled by advanced atomic clocks, innovative onboard time generation, and enhanced processing capabilities, complemented by state-of-the-art platform elements such as inter-satellite laser links for improved constellation autonomy, full electric propulsion for extended 15-year lifetimes and fully digital, reconfigurable payloads.


@ESA

The **European Geostationary Navigation Overlay Service (EGNOS)** is Europe's regional satellite-based augmentation system (SBAS) that is currently used to improve the performance of GPS. EGNOS improves the accuracy and reliability of GNSS positioning information, while also providing a crucial integrity message regarding the continuity and availability of a signal. In addition, EGNOS also transmits an extremely accurate universal time signal.

EGNOS has been fully operational since 2009 for Open Service, and 2011 for SoL, continuously delivering high-quality services to all users with enabled receivers. The next version of EGNOS (V3) will also augment Galileo signals, allowing the use of Dual-Frequency Multi-Constellation receivers.

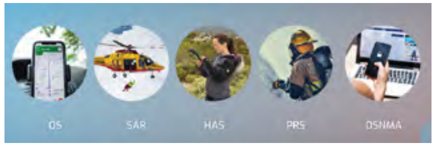
EGNOS delivers four core services:

- **Open Service**: free and open to the public, the Open Service is used for general-purpose and non-safety critical application users;
- **Safety of Life Service**: primarily geared towards civil aviation, the SoL service has potential applicability to a range of safety-critical transport applications which require enhanced and guaranteed performance and an integrity warning system, including maritime and rail;
- **EGNOS Data Access Service**: offered on a controlled access basis, it provides ground-based access to EGNOS data through the internet to customers requiring enhanced performance for professional use.
- **EGNOS SoL assisted service for Maritime Users**: This service provides GPS augmentation service to enable maritime navigation for Safety of Life at Sea operations. ESMAS offers a service tailored to maritime users enabling marine navigation in ocean waters, harbour entrances, harbour approaches and coastal waters in line with IMO Resolution A.1046. ESMAS is the first step towards a dedicated service for maritime users.

For more information, please refer to the European GNSS Service Centre, which is an integral part of the European GNSS infrastructure and provides the single interface between the Galileo system and the users.

Most new receivers entering the market support Galileo

The widespread uptake of Galileo across multi-constellation GNSS receivers is documented by the European GNSS Service Centre (GSC), which helps users and developers identify Galileo-compatible devices as they enter the market.



As Galileo support has become increasingly common, attention is progressively shifting towards receiver-level differentiators, in particular support for advanced Galileo services such as the High Accuracy Service and Open Service Navigation Message Authentication. To support this, the GSC provides dedicated and regularly updated resources tracking receivers implementing these capabilities, including a specific overview of receivers supporting Galileo HAS or receivers supporting Galileo OSNMA.

Beyond Galileo, the European GNSS Service Centre also provides an overview of **EGNOS-compatible** receivers for aviation and drones and offers insights into how airlines and other operators rely on EGNOS-enabled procedures to enhance positioning performance across Europe

The invisible backbone: GNSS powers modern society across all sectors

- Airlines, aviation pilots, air navigation service providers, airport authorities, drone operators
- Farmers, agricultural cooperatives, agricultural contractors and paying agencies
- Smartphone and wearable users, fitness enthusiasts, tourists
- First responders, people in distress, SAR teams, humanitarian organisations, civil protection agencies
- Utility companies, renewable energy firms (wind/solar), mining operators
- Border police, Coast guards, Customs authorities, Law Enforcement agencies and local governments
- Commercial fishermen, aquaculture farm managers, fisheries regulators
- Forest owners and managers, logging companies
- Construction engineers, site managers, telecom operators, utilities
- Banks, payment providers, stock and commodity exchanges
- Ship and offshore operators, port authorities, IWW managers, recreational boaters
- Infrastructure managers, train operators, rail safety authorities
- Vehicle owners, logistics operators, mobility providers, insurance companies, toll collectors, enforcers
- Environmental and climate agencies, research organisations, wildlife conservation organisations
- Satellite operators, launch service providers, ground-segment operators
- Urban planners, construction companies, surveyors, heritage site managers

At the service of users: European GNSS Service Centre and EGNOS user support website

The **European GNSS Service Centre (GCS)** and the **EGNOS User Support Website** are the main 'front doors' for users to understand how Galileo and EGNOS are performing at any moment. Their core added value lies in providing **official and timely information on service status**, performance and planned operations, so users can trust the signals on which they rely.

The **GSC**, operated by EUSPA, offers **centralised access to Galileo service status, Notice Advisory** to **Galileo Users, performance reports** and **technical documentation** for services such as Open Service, High Accuracy Service, SAR and emerging timing and authentication features. It also hosts a helpdesk and technical resources that support receiver manufacturers, application developers and institutional users in interpreting status messages and integrating Galileo into products and operations.

The **EGNOS User Support Website** plays a parallel role for EGNOS, with **dashboards and reports** on the availability, accuracy and integrity of the **Open Service, Safety-of-Life** and the **EGNOS maritime service**, as well as performance reports on the EGNOS Data Access Service. By providing real-time and historical service information, notices to users and specialised guidance material, it underpins safe and compliant use of EGNOS in aviation and other safety-relevant domains.

Galileo and EGNOS user satisfaction surveys confirm high levels of trust and satisfaction

EUSPA's most recent **annual user satisfaction surveys for Galileo and EGNOS** confirm that both European satellite navigation systems continue to meet user expectations while evolving to address emerging needs.

In addition to assessing **service performance**, the surveys **evaluated user experience with the support tools provided through the Galileo and EGNOS Service Centres and ESSP** including helpdesks, technical documentation, websites, and developer guidance materials.

Overall satisfaction levels remain very high. **Galileo's Open Service** achieved a 95% satisfaction rate, while the **High Accuracy Service**, fully operational since 2023, reached 94% satisfaction, reflecting strong performance, reliability and growing user confidence. Similarly, EGNOS services recorded high satisfaction levels (88%), confirming their continued value in safety-critical and professional applications, particularly in aviation and other regulated sectors

More details on the survey are available in the EGNOS User Satisfaction Survey report – 2024 and Galileo User Satisfaction Survey Report – 2024

EGNSS performance continues to evolve in response to user needs and requirements

Across all market segments, users increasingly require **higher accuracy, integrity, availability and robustness of GNSS**, together with authentication and better performance in challenging environments such as urban canyons or under interference. These needs are evident in EUSPA user-needs analyses for mass-market and safety- or liability-critical and professional applications alike.

Consumer devices such as smartphones need improved positioning in dense urban areas, seamless oper tion across constellations and devices, fast start-up and low power use. **Road and automotive** users require lane-level accuracy, integrity and resilience to support advanced driver-assistance systems and automated driving. **Rail, aviation and drone** operators prioritise integrity, continuity and predictable accuracy for si nalling, virtual balises, performance-based navigation and U-space operations. **Maritime and inland waterways** users depend on continuous, trusted positioning and timing for e-navigation, traffic management and port operations, with autonomous vessels further increasing performance needs. Professional sectors including **agriculture, forestry, energy, raw materials, infrastructure and urban development** demand centimetre-level accuracy, high availability and short convergence times. Timing users in finance and critical infrastructure require resilient, traceable and increasingly authenticated time for secure transactions. **Emergency management, humanitarian aid and search-and-rescue** rely on GNSS for rapid situational awareness, asset and team tracking and high-accuracy services in crisis environments, including guaranteed distress detection and fast localisation. **Space** users require globally available, precise and highly reliable positioning and timing for orbit determination, formation flying and autonomous spacecraft operations.

Galileo and EGNOS match evolving GNSS user needs through a complementary set of services that build on a mass-market foundation and add targeted, higher-performance capabilities. Moreover, Galileo and EGNOS services are progressively developed to align with the most demanding user requirements for accuracy, integrity, availability, resilience and trusted alerts across consumer, transport, professional, emergency and maritime segments.

The **Galileo Open Service** provides free, multi-frequency positioning and timing for non-safety-critical applications, forming the baseline for consumer and road business uses. The **High Accuracy Service** delivers free Precise Point Positioning corrections via E6-B and the internet, enabling decimetre-level positioning for professional and demanding transport applications needing affordable high precision. For search-and-rescue beacons, **Galileo SAR** introduces an innovative Return Link Service that confirms distress alert reception to the beacon, strengthening user confidence and supporting faster, better-coordinated rescues. The emerging **Galileo Timing Service** Message targets critical-infrastructure timing with monitored, trustworthy time information linked to UTC, while the forthcoming **Emergency Warning Satellite Service** will broadcast public-warning messages directly over the navigation signal, adding a resilient alerting layer.

The **Safety-of-Life (SoL) service** provides GNSS integrity and continuity in order to answer the needs of the aviation community and other safety-critical domains. The **EGNOS Open Service** supports non-safety-critical users needing better accuracy, for example in precision agriculture and GIS mapping. The **EGNOS SoL assis ed service for Maritime Users** extends SoL-grade augmentation to SOLAS vessels and other maritime users, enhancing reliability in constrained and coastal waters where integrity and robustness are essential.

The User Consultation Platform continues focusing on GNSS user needs and requirements

The UCP engages with **user communities, industries, service providers and R&D**, bringing together expertise and insights from different applications, sharing their experiences and knowledge concerning the data and services provided by the EU Space Programme components. Focusing on **GNSS**, needs and requirements are used to inform EGNSS evolution and support service adoption by users. The **2025 edition of the UCP**, held in Prague, discussed user needs and requirements across key application areas, including food security and nature credits, transport (CCAM, Rail, and Public Transport), EU security, and Space.

In **Food Security and Nature Credits**, users discussed how the need for higher farming efficiency and yield productivity push demand for autonomous machinery and robots, which in turn require high positioning performance coupled with integrity and resilience to interferences. Within the session on **CCAM**, as the demand for GNSS performance increases together with the level of automation, users discussed the added value of HAS and future solutions to address GNSS limitations in urban environments. In the **Public Transport** session, operators expressed the need for affordable solutions capable of offering both positioning performance and security. Rail stakeholders discussed the important progress in the development of safety-critical solutions enabled by EGNOS. The session on **EU Security** highlighted that heterogeneous applications exhibit common needs for positioning robustness, resilience and reliability.

The **Space** session covered both Galileo receivers for space assets and SST. Concerning **Galileo receivers**, discussions revolved around GNSS becoming an integral part of spacecraft system architecture. Underlying drivers include the recognized benefit of GNSS for launch activities, constellation operations, and collision avoidance, as well as the growing maturity of GNSS for remote sensing. As LEO constellations boost market demand, users need receiver antenna technology to improve, so to best leverage high-accuracy GNSS positioning, including HAS. Concerning **SST**, space-based monitoring solutions are also emerging as a complementary layer to ground-based infrastructures for surveillance and tracking purposes.

As explained for EO previously in the report, the **GNSS outcomes of the UCP** are presented in the **reports on User Needs and Requirements**. The full reports of the UCP 2024 and 2025 are available here.

Secure SATCOM and SATCOM: an evolving market

The difference between SATCOM and Secure SATCOM

SATCOM is the use of satellite-based technology to provide two-way communication services for voice, data and video exchange across fixed or mobile users, including specialised secure communications for governmental and defence purposes. The **SATCOM market** has experienced rapid growth in recent years, driven by rising demand for high-speed connectivity in remote and underserved areas, advances in satellite technologies such as very high-throughput and software-defined satellites and LEO constellations, as well as increasing integration with 5G and IoT networks.

Secure SATCOM provides distinguishing features across three core pillars: **availability, confidentiality and integrity**. Availability ensures that satellite communication services are reliable and accessible whenever needed to the maximum extent, even in adverse conditions such as jamming, interference or physical threats, thereby guaranteeing continuous operation for critical missions. Confidentiality protects data from unauthorised access and interception during transmission, ensuring that sensitive information remains accessible only to authorised users. Integrity safeguards the accuracy and completeness of communications by preventing unauthorised alteration, manipulation or corruption of data throughout the transmission path. Together, these pillars provide a highly resilient and trusted satellite communication layer essential for security- and safety-critical missions in defence, border surveillance, governmental emergency response, and critical infrastructure sector.

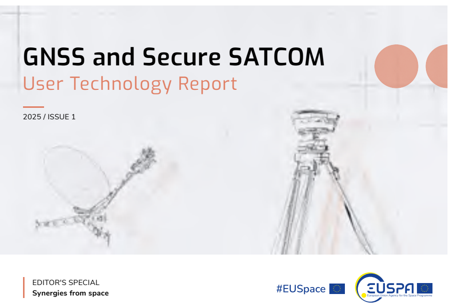
Secure SATCOM provides protected satellite communications, ensuring trusted, reliable and resilient connectivity for critical government, defence and emergency operations. As Europe's dependence on space-based services increases, satellite communication systems are exposed to risks such as interference, jamming, spoofing and cyberattacks. Secure SATCOM mitigates these threats by providing the confidentiality, integrity and availability of communications across all operational domains. It supports critical missions – from crisis management and border security to civil protection and diplomatic operations – ensuring that authorised users can rely on robust connectivity anytime and anywhere.

Secure SATCOM's market landscape is evolving

Geopolitical instability and rising cyber threats are transforming demand for Secure SATCOM, driving **higher requirements for surveillance, critical infrastructure protection and crisis-management capabilities**. Military stakeholders increasingly prioritise resilient, anti-jamming systems and robust encryption to counter electronic warfare, while sectors such as energy, finance and government require reliable, guaranteed, high-bandwidth connectivity to operate securely amid hybrid threats.

At the same time, **rapid technological advances are reshaping the orbital and network landscape**. New LEO constellations, supported by hybrid multi-orbit architectures such as IRIS², are expanding capacity though VHTS and Digital Payload systems, while a new generation of multi-orbit networks and multi-orbit terminals enables seamless handover across orbital layers. These developments are reinforced by **emerging capabilities such as quantum-secure technologies, AI-driven network management, cloud-enabled ground systems, and optical inter-satellite links**, which together strengthen overall performance and resilience. In parallel, **software-defined satellites, multi-frequency operations and growing digitisation trends** improve flexibility and performance, allowing SATCOM to integrate more effectively with terrestrial networks, 5G and IoT. This progress supports mobile broadband, data relays, and backhaul for drones, ships, and connected vehicles.

However, evolution is occurring in **a complex environment of global regulations**, spectrum licensing delays, growing space congestion and significant upfront investments, further challenged by increasing orbital debris and crowded LEO bands. The EU's response to these dynamics, supported by initiatives such as GOVSATCOM and IRIS², emerging national programmes, and complementary commercial efforts, is to **build resilient capacity, reinforce strategic autonomy and position Europe competitively in the rapidly shifting Secure SATCOM market**.



GNSS and Secure SATCOM User Technology Report

From a technology perspective, the findings of this report are reinforced by the strategic insights presented in the **GNSS and Secure SATCOM User Technology Report**, published by EUSPA. This landmark publication represents an evolution of EUSPA's market intelligence, combining the legacy of its GNSS research with the definitive Secure SATCOM Market and User Technology Report to address the increasing convergence of these two domains. Secure Satellite Communications (SATCOM) are recognised as a cornerstone for the resilience and strategic autonomy of the European Union. As highlighted by EUSPA, these services provide the essential communication layer for security- and safety-critical missions, ranging from crisis management and border surveillance to the protection of key infrastructure.

With major initiatives like GOVSATCOM and the IRIS² multi-orbital constellation currently underway, this report serves as a roadmap for both public and private actors to identify emerging business opportunities and navigate the transition toward a more integrated space ecosystem. The report is structured around three primary pillars:

- **The Secure SATCOM Market**: A deep dive into 12 comprehensive use cases, providing capacity demand forecasts (projected to grow 14-fold by 2040) and an analysis of the global supply landscape.
- **Technology Trends**: An exploration of the innovations shaping the downstream industry, including the shift toward software-defined solutions, the deployment of multi-orbit (LEO/MEO/GEO) terminals, and the integration of 5G and optical communications.
- **Domain Synergies**: A specialised focus on the interplay between GNSS positioning and secure communications, emphasising how these technologies collectively support autonomous transport, emergency response and cybersecurity through Quantum Communication.

The report is a vital resource for stakeholders looking to realise the benefits of resilient satellite connectivity within the EU and globally.

The Secure SATCOM industrial base: business model dynamics

Landscape of key value chain players and how they are addressing their users

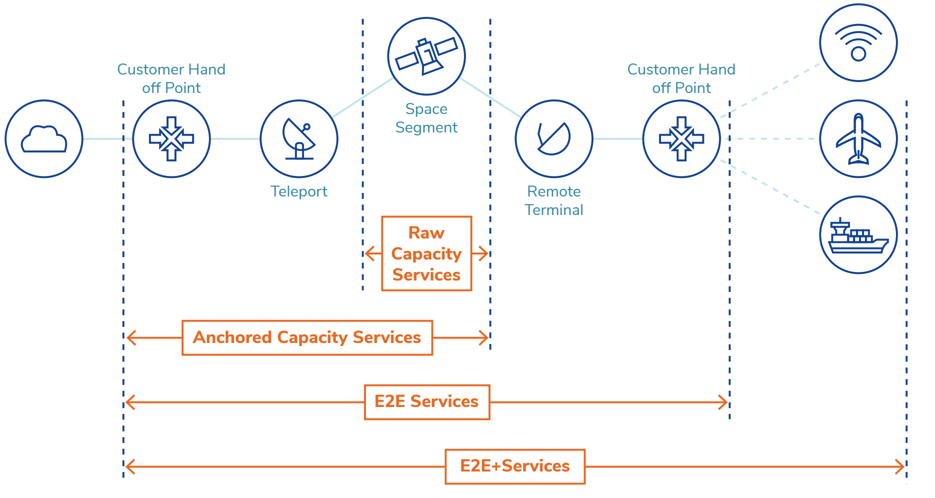
The Secure SATCOM value chain is composed of the following categorised players[1]:

- **Satellite Manufacturers** design and produce the satellites used in secure communication systems, including advanced secure, resilient and high-throughput technologies.
- **Satellite Operators** are companies that own and operate satellite systems providing communication capacity and services to both commercial and governmental users, including Secure SATCOM.
- **Ground Segment Manufacturers** develop and provide ground infrastructure, such as control centres, gateways and hubs, crucial for managing satellite communications and ensuring system security and performance.
- **Service Providers** offer end-to-end secure satellite communication services by leveraging satellite capacity and ground infrastructure, facilitating user access to secure connectivity.
- **Terminal Providers** supply the user equipment (terminals) that enable access to secure satellite communication services, often designed for mobility, multi-band operation and interoperability.

Those players offer different business models depending on the level of service they provide. **Raw capacity services** supply only the space segment; **anchored capacity services** combine space segment with operator-managed ground infrastructure such as teleports; **end-to-end (E2E) services** deliver a complete managed connectivity solution from the ground segment to the user terminal; and **E2E+** services extend standard E2E by adding enhanced service layers, such as integration, advanced monitoring and expanded operational support.

Satellite Operators' business models have evolved to meet end users needs[2]

	Raw Capacity Services	Anchored Capacity Services	End-to-End (E2E) and E2E+ Services
Service Provision	Provides Space Segment-only raw capacity (MHz) while the purchaser supplies teleport and hub equipment, a third-party defines service parameters (SLA/CIR), and provided that the end user is already equipped with User Terminals.	Provides managed Mbps with the operator managing space segment, teleport (anchor station /gateway), and support, with demarcation from the customer handoff to the satellite transponder.	Provides managed Mbps including full space segment/anchor station/remote equipment, complete service integration with QoS, optional added services, and a demarcation running from customer handoff to the remote terminal.
Satellite Band-width / Capacity	Sells unprocessed MHz capacity directly to service providers or end users.	Sells packaged MHz capacity to service providers or end users.	Operator fully manages bandwidth between the anchor station and the customer's router or switch.
Ground Infrastruc-ture	Offers only the space segment, requiring customers or third parties to provide or lease teleports, ground infrastructure and and User Terminals.	Uses operator's managed ground infrastructure, which may be co-located with feeder links.	Uses operator's managed ground infrastructure with vendor-specific configurations.
Network Opera-tions	Requires the customer to arrange routing, optimisation and terrestrial network integration with third parties.	Requires third-party arrangements for routing and terrestrial network integration, supported by the operator.	Provides operator-managed smart routing, optimisation and seamless integration with the terrestrial network.



From MHz to Mbps: evolving satellite pricing models in the era of HTS and managed services

Historically, the satellite operator industry was structured around fixed prices that were applicable to a contract for several years. As such, pricing was often expressed in €/MHz/year. Lately, pricing contracts have been using **Mbps or GB Gbps (as opposed to using raw MHz capacity (in MHz))**; this trend has developed in parallel with the growth of data services and the services provided by HTS systems. In addition, and in correlation with a market decrease in satellite capacity, an increasing number of operators have started to **move down in the value chain** by offering managed capacity directly using Mbps or Gbps (as opposed to using raw MHz capacity). Beyond those trends, several factors have affected the price of satellite capacity including frequency-band, power, back up duration and the volume of the lease. Other operator specific factors (e.g. unique beam or interconnectivity scheme, exclusive coverage/power level, teleport service, backhaul service) have come into play. These factors help differentiate satellite bandwidth from a commodity and highlight satellites' ability to provide services that could not exist without them (e.g. aero/maritime connectivity) or that alternative terrestrial solutions would not provide as cost efficiently.

1: EUSPA, Secure SATCOM Market & User Technology Report 2023, page 27.
2: This service categorisation reflects a standard SATCOM service structuring approach commonly used by satellite communication operators, and is also adopted within the EU GOVSATCOM framework, as defined in Commission Implementing Decision (EU) 2023/1054 of 30 May 2023.

A deep dive into the Secure SATCOM value chain ecosystem

SATELLITE MANUFACTURERS ▷ SATCOM OPERATORS ▷ GROUND SEGMENT MANUFACTURERS ▷ SERVICE PROVIDERS ▷ TERMINAL MANUFACTURERS ▷ END USERS

SATELLITE MANUFACTURERS

- THALES ALENIA SPACE (EU)*
- AIRBUS DEFENCE AND SPACE (EU)*
- OHB SYSTEM (EU)*
- SSTL (U.K.)*
- BOEING SATELLITE SYSTEMS (US)*
- LOCKHEED MARTIN (US)
- VANTOR (US)
- NORTHROP GRUMMAN INNOVATIONS SYSTEM (US)
- ENERGIA (RUSSIA)
- ISS KHRUNICHEV (RUSSIA)
- MITSUBISHI (JAPAN)
- CAST (CHINA)
- ISRO (INDIA)
- TAI (TURKEY)
- IAI (ISRAEL)
- INVAP (ARGENTINA)

SATCOM OPERATORS

- **SES/INTELSAT (EU)***
- **EUTELSAT/ONEWEB (EU)***
- **HISPASAT (EU)***
- **HELLAS SAT (EU)***
- **HISDESAT (EU)***
- **OVZON (EU)***
- **LUXGOVSAT (EU)***
- **DGA (DÉLÉGATION GÉNÉRALE DE L'ARMEMENT) (EU)***
- **ITALIAN MOD (EU)***
- **GERMAN MOD (EU)**
- TELENOR (NORWAY)*
- AVANTI (U.K.)*
- TELESAT (CANADA)
- VIASAT/INMARSAT (US)
- ECHOSTAR (US)
- ARABSAT (KSA)
- STAR ONE (BRAZIL)
- MEASAT (MALAYSIA)
- CHINA SATCOM (CHINA)
- NSG (KSA)
- SPACEX/STARLINK (US)
- **SPACEX/STARSHIELD (US)**
- AST SPACEMOBILE (US)
- IRIDIUM (US)
- AMAZON LEO/KUIPER (U.S)
- **GUOWANG (CHINA)**
- **SFERA (RUSSIA)**
- YAHSAT/THURAYA (UAE)

GROUND SEGMENT MANUFACTURERS

- THALES (EU)*
- SSC (EU)*
- INTELLIAN (SOUTH KOREA)
- HUGHES (US)
- GILAT (ISRAEL)
- ST ENGINEERING (SINGAPORE)
- VIASAT (US)
- COBHAM SATCOM (DENMARK)
- L3 HARRIS (US)
- KYMETA (US)
- ALL.SPACE (U.K.)
- KSAT (NORWAY)
- SPACEBRIDGE (CANADA)
- OHB (EU)*

SERVICE PROVIDERS

- AIRBUS CIS (EU)*
- TELESPAZIO (EU)*
- MARLINK (EU)*
- IEC TELECOM (EU)*
- OTESAT MARITEL (EU)*
- ATCO (AIRBUS TELESPAZIO CAPACITY OPERATOR)(EU)*
- SPEEDCAST (US)
- SAGENET (US)
- GALAXY BROADBAND (CANADA)
- PSN (INDONESIA)
- BHARTI (INDIA)
- SENCINET (BRAZIL)

TERMINAL MANUFACTURERS

- ACTIA (EU)*
- ADS INTERNATIONAL (EU)*
- ALCAN SYSTEMS (EU)*
- COBHAM SATCOM (EU)*
- GREENERWAVE (EU)*
- HONEYWELL (US)
- INSTER (EU)*
- LARS THRANE (EU)*
- ND SATCOM (EU)*
- OESIA GROUP (EU)*
- OVZON (EU)*
- SAFRAN (EU)*
- SATCUBE (EU)*
- TELESPAZIO (EU)*
- THALES (EXCL. COBHAM) (EU)*
- INDRA (EU)*
- LEONARDO (EU)*
- SATCUBE (EU)*
- SENER AEROSPACE (EU)*
- STARWIN (CHINA)
- VITES (EU)*

END USERS

- MILITARY FORCES
- BORDER SURVEILLANCE AUTHORITIES
- MARITIME COMMUNITY
- POLICE AND HOMELAND SECURITY FORCES
- CIVIL PROTECTION ENTITIES
- HUMANITARIAN AID RESPONDERS
- CIVIL AND MILITARY OPERATORS OF KEY INFRASTRUCTURE SUCH AS:
- INSTITUTIONAL AND DIPLOMATIC NETWORKS
- TRANSPORT INFRASTRUCTURE (AIR, RAIL AND ROAD)
- SPACE INFRASTRUCTURE AND SERVICES

LEGEND

The value chain considers the key global players involved in systems manufacturing, satellite integration, satellite operations and downstream services creation and distribution.

The lists of the presented companies are not exhaustive.

*Indicates the company whose HQs are based in the EU.

BOLD indicates the Secure SATCOM Operators to distinguish from SATCOM Operators

Categorisation in terms of SATCOM vs. Secure SATCOM Operators

- **SATCOM Operators**: SES/Intelsat, Eutelsat/OneWeb, Hispasat, Hellat, Ovzon, Hisdesat, Telenor, Avanti, Viasat/Inmarsat, Telesat, Echostar, ArabSat, StarOne, MeaSat, China SATCOM, NSG, SpaceX/Starlink, AST SpaceMobile, Iridium, Amazon/Kuiper, Iridium,
- **Secure SATCOM Operators**: SES/Intelsat, LuxGovSat, Eutelsat/OneWeb, Hispasat, Hisdesat, Hellas Sat, SpaceX/Starshield, Guowang, SFERA, Ovzon, National MoDs

Categorisation in terms of GEO/MEO/LEO Secure SATCOM

- **GEO**: SES/Intelsat, LuxGovSat, Eutelsat, Hispasat, Hisdesat, HellasSat,
- **MEO**: SES/Intelsat/O3b mPOWER
- **LEO**: Eutelsat/Oneweb, SpaceX/Starshield, Guowang, SFERA,

Categorisation in terms of Broadband/Narrowband Secure SATCOM

- **Broadband Secure SATCOM**: SES/Intelsat, LuxGovSat, Eutelsat/OneWeb, Hispasat, Hisdesat, HellatsSat SpaceX/Starshield, Guowang, SFERA (RU)
- **Narrowband Secure SATCOM**: N/A

Secure SATCOM supply moving towards hybrid models and service-oriented offerings

The supply landscape in the Secure SATCOM sector is shifting rapidly, driven by the growing **adoption of hybrid models that combine GEO, MEO and particularly LEO constellations**, which are on the rise and recognised as complementary for delivering optimal performance. **Business models are also evolving**, moving beyond traditional long-term contracts towards more flexible, **service-oriented offerings** that leverage advancements in satellite and ground segment technologies. Established players now face **fierce competition from new entrants** and strategic partnerships, as the market transitions into a more dynamic and diverse ecosystem in which interoperability and multi-orbit solutions are key differentiators.

The Secure SATCOM ecosystem is rapidly evolving, with **major European players like SES/Intelsat, Eutelsat/OneWeb, and new entrants increasingly competing with global giants such as SpaceX's Starlink**, which dominates market share outside Europe. Commercial companies are expanding their involvement in Secure SATCOM, addressing both governmental and commercial demands. At the same time, Europe is advancing strategic initiatives like IRIS² and GOVSATCOM to ensure sovereignty, resilience and competitiveness, but must maintain robust innovation and investment to keep pace with the accelerating commercial and technical developments seen globally, especially as **multi-orbit, high-throughput, and secure connectivity become baseline market expectations**.

The Secure SATCOM use cases and revenues mapped

Multi-domain resilience: Secure SATCOM enables many use cases

For the sake of the present report, the Secure SATCOM market is defined around **12 use cases** grouped into three categories: surveillance (land border and maritime); crisis management (maritime emergency, humanitarian aid, civil protection, law enforcement and EU external actions); and key infrastructure (transport, space, institutional communications, and other critical infrastructure).

Surveillance

Land Border
(i.e., surveillance of sea and land borders)

Maritime Surveillance
(i.e., surveillance of illegal activities)

Key Infrastructure

Transport Infrastructures
(i.e., Air, Road, Rail and Maritime traffic management)

Space Infrastructures
(i.e., support of GNSS, EO and SSA activities)

Institutional Communications
(i.e., SATCOM for embassies, EU representations offices)

Other Critical Infrastructures
(i.e., SATCOM link for critical infrastructure such as energy grid and financial ones)

Crisis Management

Maritime Emergency
(i.e., Search & Rescue missions and response to maritime disasters)

Humanitarian Aid
(i.e., assistance in case of disasters/conflicts to refugees and telemedicine)

Civil Protection
(i.e., activation of Emergency Medical Services (EMS) in case of disasters)

Law Enforcement Interventions
(i.e., national police missions and fight against international organized crime groups)

EU External Actions
(i.e., CSDP missions, election observation and contribution to UN missions)

Forces Deployment
(i.e., deployment of EU Member States' forces as part of national/European missions)

Surveillance

- **Land Border**: Requires secure, near-real-time data from ground sensors, drones, patrols, border agents, cameras and Unmanned Aerial Vehicles (UAVs) to command centres through encrypted links, enabling territory monitoring, intelligence sharing and coordinated responses against illegal crossings.
- **Maritime**: Supports naval vessels and coastal radars with guaranteed bandwidth for EEZ patrol, vessel tracking and anti-piracy operations.

Crisis Management

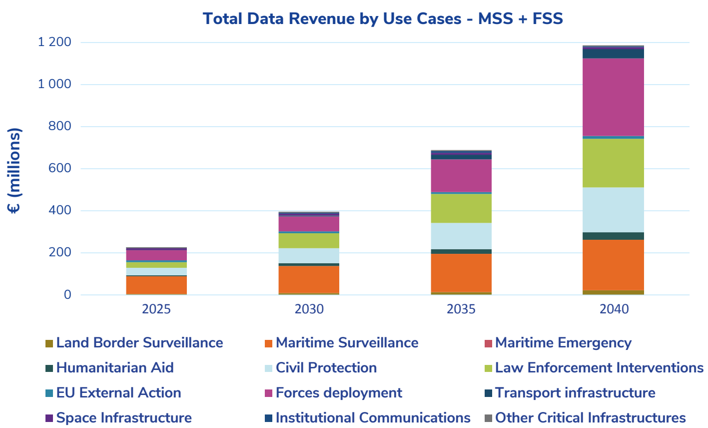
- **Maritime Emergency**: Provides distress signalling, SAR coordination, and voice/data relay for ships in distress beyond terrestrial coverage.
- **Humanitarian Aid**: Ensures resilient comms for NGOs in disaster zones, linking field teams to logistics hubs for supply drops and evacuations.
- **Civil Protection**: Facilitates firefighting, flood response and evacuations with video feeds and command links in jammed areas.
- **Law Enforcement Interventions**: Offers tactical voice/data for police raids or pursuits in remote terrains with anti-jam protection.
- **EU External Actions**: Secures diplomatic missions and CSDP ops abroad via independent SATCOM bypassing hostile networks.
- **Forces Deployment**: Supplies Command and Control (C2) for troop movements, integrating with GNSS for expeditionary military logistics.

Key Infrastructure

- **Transport Infrastructure**: Monitors rail/road/air networks with secure backhaul for anomaly detection and disruption response.
- **Space Infrastructure**: Relays data and Telemetry, Tracking and Command (TT&C) for satellite ops centres, hardened against cyber threats.
- **Institutional Communications**: Powers EU bodies' crisis lines and diplomatic nets with sovereign encryption.
- **Other Critical infrastructure**: Protects energy grids, finance and data centres via resilient trunking and failover links.

Secure SATCOM use cases linked with EUSPA's market segments and covered across segments in this report

Secure SATCOM is essential across EUSPA's key market segments. It supports government and public safety by enabling encrypted communications for security and emergency response. In **emergency management and humanitarian aid**, it guarantees connectivity where terrestrial networks fail or are congested or unreliable. It secures **critical infrastructure**, such as energy, finance and datacentres, ensuring service continuity. In **transport such as aviation, rail, road and maritime**, it enables coordinated, safe operations and emergency communications. Secure SATCOM also facilitates timely EO and GNSS data dissemination, enhancing space mission operations. Additionally, it provides vital coverage for maritime search-and-rescue, supports first responders in emergencies, protects institutional and diplomatic communications, and underpins urban resilience and smart city data security. Together, these uses highlight its critical role in enabling secure, reliable communications for diverse and strategic EU sectors.



Secure SATCOM (MSS + FSS), a growing market*

Satellite data revenues for Mobile Satellite Services (MSS) and Fixed Satellite Services (FSS) are forecast to grow significantly, rising from just **over €200 million in 2025 to nearly €1.2 billion by 2040**. These figures refer exclusively to satellite data service revenues and do not include revenues from user terminal sales, which are outside the scope of this market quantification. Maritime surveillance dominates demand in 2025 but is overtaken by law enforcement interventions, civil protection and forces deployment by 2040. This expansion is driven by strong regulatory initiatives for security and resilience, increasing demand for reliable connectivity in remote and high-risk areas, and a growing focus on crisis response and space infrastructure development.

Secure SATCOM connectivity is important for a broad range of users

- Air navigation service providers and operators, civil protection aviation units, state drone operators
- Paying agencies Agricultural inspectors in the field
- Governmental field teams and lone workers using secure handhelds in remote areas
- Civil protection agencies, emergency operations, humanitarian HQs, SAR coordination centres and operators
- Gas pipeline operators, mining command centres, Offshore platform operators
- Public safety and surveillance authorities, EU embassies and delegations, law enforcers, customs, governments, military, border agencies, coast guards. NGOs
- Coast guards, fisheries control authorities, Inspection vessels
- Environmental enforcement bodies, national forestry agencies
- Data centres, control managers of critical infrastructure (civil, water management, energy, telco)
- EU-level and national financial authorities, traders, banks
- Maritime safety authorities, offshore safety regulators
- Rail infrastructure managers, railway staff, transport ministries
- Road authorities, traffic management centres
- Space operations centres, satellite control centres, /SST centres, satellite operators
- City-level civil protection and security services

The User Consultation Platform (UCP) now also covers Secure SATCOM

The UCP engages with **user communities, industries, service providers and R&D representatives/experts/groups**, bringing together expertise and insights from different applications, sharing their experiences and knowledge. . Focusing on Secure SATCOM, as of 2024, the UCP is also addressing relevant use cases, along with associated needs and user requirements. The UCP of 2025, held in Prague, focused on two segments, Road and Automotive and Rail.

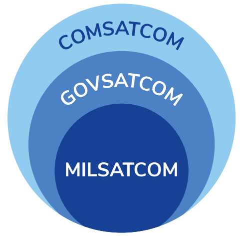
In the **Road and Automotive** segment, Non-Terrestrial Networks (NTN) connectivity is now appearing in the roadmaps of OEMs to complement terrestrial networks for CCAM use cases. Vehicle manufacturers and providers discussed the need for narrowband, wideband and broadband NTN connectivity, acknowledging end users' interest for safety and premium services and discussing the technological challenges to be addressed.

In the **Rail** segment, European railways are transitioning from GSM-R to FRMCS to support data-intensive, safety- and mission-critical applications. SATCOM integration is considered key to guaranteeing a cost-effective service for redundancy and global coverage, especially in rural, remote, and cross-border areas. In the UCP, users discussed the need for a standardised, certifiable framework to encourage infrastructure managers to implement SATCOM.

Leveraging the UCP outcomes, the **Reports on User Needs and Requirements** represent a useful reference for the SATCOM user communities in different market segments, thanks to the up-to-date information on associated user needs and requirements.

The full reports of the UCP 2024 and 2025 are available here.

GOVSATCOM and IRIS²



There are three main types of SATCOM services[1], each offering different levels of security and assured access:

- **COMSATCOM** refers to commercially procured satellite communications services, generally offering **on-demand access with lower security** compared to GOVSATCOM and MILSATCOM.
- **GOVSATCOM** delivers **government-tailored secure satellite communications**, positioned between commercial and military tiers to offer **robust security and reliable access**.
- **MILSATCOM** provides the **highest level of protection**, designed for military operations with **strong anti-jamming capabilities and sovereign control**.

EU GOVSATCOM: State of the art

The EU GOVSATCOM programme aims to deliver secure, resilient and cost-efficient satellite communication services for governmental and security-critical missions across the EU and its Member States. Its objectives focus on consolidating satellite communication capacities to improve coverage and efficiency, strengthening European strategic autonomy for protection and humanitarian actions, and ensuring affordable, secure satellite communications with high confidentiality and robust protection for government security and defence actors. In doing so, EU GOVSATCOM provides assured and priority access for critical missions such as crisis management, surveillance and key infrastructure protection. The EU GOVSATCOM service portfolio delivers secure, resilient and cost-efficient satellite communications by offering three kinds of services: end-to-end services operated by providers; anchored capacity services using satellite capacity and associated stations; and raw capacity services providing direct bandwidth access.

Following the start of GOVSATCOM Initial Services in January 2026, the programme relies on the GOVSATCOM Hub, which serves as its core secure ground infrastructure. The GOVSATCOM Hub connects authorised governmental users to a shared pool of satellite communication services supplied by both governmental and commercial providers. By managing demand and supply, ensuring service continuity, and enforcing security standards, the GOVSATCOM Hub acts as a single, integrated access point. This centralised setup enables a coherent and Secure SATCOM environment for missions including crisis management, surveillance and protection of key infrastructure. Access to the Hub is structured through a defined governance model. Authorised users connect to the service via their national or EU Competent GOVSATCOM Authority (CGA). These CGAs are public authorities of the EU and its Member States, along with authorised entities acting on their behalf. Under specific conditions, third countries and international organisations may also be permitted access. This layered governance ensures that only validated and responsible actors interact with the system. Each CGA is designated by its respective Member State or institution to manage the interface between national (or organisational) users and the GOVSATCOM Hub. CGAs are responsible for threat reporting, service continuity, resource allocation and resolving potential conflicts over satellite capacity among its users. Their coordinating role ensures consistent operational control and efficient use of the pooled satellite resources.

Securing the future: how GOVSATCOM evolves

The future evolution of EU GOVSATCOM will build on its current pooling and sharing model by integrating additional secure satellite capacities from both governmental and commercial providers, improving resilience, coverage and cost efficiency for critical government missions. As the system progressively links with the upcoming IRIS² multi-orbit constellation, existing SATCOM assets will be complemented by new ad-hoc space infrastructure and advanced features such as higher throughput, lower latency and improved anti-jamming performance. GOVSATCOM will provide an increasingly broad portfolio of services tailored to security-related users. Over time, these developments will allow EU GOVSATCOM to evolve into a key pillar of a wider EU Secure Connectivity framework, offering more robust, flexible and scalable secure communications across Europe and beyond.

Establishing digital autonomy: IRIS² as the cornerstone of European connectivity

IRIS² (Infrastructure for Resilience, Interconnectivity and Security by Satellite) is the **EU's planned multi-orbit constellation providing secure, resilient and high-speed satellite communication services for government users, businesses and citizens across Europe and beyond**. The system comprises 290 LEO and MEO satellites, integrating technologies such as quantum cryptography and enhanced cybersecurity to ensure highly secure connectivity.

IRIS² is implemented through a public-private partnership (PPP) between the European Commission, ESA and the SpaceRISE consortium. This consortium includes major European satellite operators, including Eutelsat, SES and Hispasat, alongside industrial and telecom partners such as Thales Alenia Space, OHB, Airbus Defence and Space, Telespazio, Deutsche Telekom, Orange, Hisdesat and Thales SIX. **The concession contract signed in December 2024 spans 12 years and aims to provide both governmental and commercial broadband services while balancing strategic autonomy with market competitiveness**.

According to recent public statements by the European Commission, initial IRIS² services, particularly for governmental users, are now targeted to start in 2029, reflecting an accelerated implementation timeline. Commercial services are expected to follow as the constellation is progressively deployed. IRIS² will offer secure satellite communications, broadband access to underserved regions, and services supporting crisis management, border surveillance and the protection of critical infrastructure.

1: EUSPA, Secure SATCOM Market & User Technology Report 2023, page 11-16.

Secure SATCOM key EU R&D projects

EUSPA stimulates the market development of the EU space downstream sector and supports the uptake of space-based solutions through Horizon Europe (HE) space calls inside the programmes' second pillar. One of the topics addressed in the recent EUSPA Horizon Europe (HE) calls has been EU GOVSATCOM that aims for a safer and more secure EU. As a result of these calls, several key EU R&D initiatives have been selected for funding: GEXTRECS, SAT2Rescue and S5LECT.

The GEXTRECS **(GOVSATCOM Extreme Events Crisis Management Service)** project aims to demonstrate an end-to-end GOVSATCOM service supporting **extreme events crisis management**. In the event of natural or manmade disasters, it is essential to ensure an adequate level of action in terms of provision of proper SATCOM services and response time. During such crisis management situations, multiple and simultaneous requests from different end users are typically addressed to SATCOM resources, with a high risk of network saturation. The GEXTRECS end-to-end solution plays a **crucial role in preserving the security of EU citizens** in such conditions. To address this, the project has developed and demonstrated an innovative component called the **Dynamic Planner**, which will **dynamically, optimally and continuously allocate resources during the crisis**, assigning each service request to the most suitable SATCOM resource. This will be integrated with a **z**, which will enable the required interoperability, ensuring that secure communication is maintained when using different communications networks. Two scenarios have been demonstrated (land natural disaster and maritime emergency) in real end user environments, also exploring the GOVSATCOM synergies with other EU space programme components.

The SAT2Rescue project aims to strengthen the use of satellite communication by government institutions and nongovernmental organisations, in particular in the areas of response to natural and man-made disasters, optimisation of emergency services activities and telemedicine in humanitarian aid. Infrastructure and services under the EU GOVSATCOM initiative will be used. **As part of the project, a portable, rugged satellite communication terminal will be developed, enabling reliable voice and data connectivity on the move, even in the absence of terrestrial networks, through automated satellite tracking, secure GNSS positioning, satellite switching and software-defined networking capabilities.** Usage scenarios will be defined, including mountain and sea rescue and rescue operations in urbanised areas after disasters. Application software will be developed for rescue operations management centres, providing a situational picture of the operation, integrating geoinformation and weather data, image data from the Copernicus system, and geotag data collected via the Galileo system. The system will be demonstrated according to usage scenarios.

The S5LECT **(SATCOM and 5G Link, Edge and Cyber security)** project, led by SNCF, will test a solution for **seamless handover between 5G TN, satellite links and Global System for mobiles-Railways (GSM-R)** communications system. The project studies the **hybridisation of TN and NTN for railway-critical applications**. It aims to define and develop an innovative solution for seamless handover between NTN-TN, assess cybersecurity risk and propose solutions and innovative architecture for edge computing, and provide a **proof of concept** of all the bricks developed in the project thanks to an original laboratory testing platform. The S5LECT project will directly contribute to the development of solutions for the **use of GOVSATCOM satellite communications in the railway domain**. It also contributes to the development and testing activities for delivering more reliable and robust wireless communication prototypes. This should help to enhance the testing activities and minimise time and efforts to deliver the next generation of adaptable wireless communications for all railway segments.

Major operational achievement reached: EU GOVSATCOM HUB launched

In January 2026, the European Union launched its GOVSATCOM programme, with EUSPA activating the secure satellite communications HUB that pools capacity from eight geosynchronous satellites owned by France, Greece, Italy, Luxembourg and Spain to provide connectivity for government and military missions across Member States. Announced by EU Defense and Space Commissioner Andrius Kubilius at the European Space Conference, the programme supports Europe's efforts towards independent communications infrastructure under European control. In a first demonstration of the HUB's operational value, Cyprus completed the first operational use of the service in March 2026, employing Greek governmental satellite capacity via Hellas Sat for safety and security purposes long the EU's southeastern borders. A milestone that, in the wors of EUSPA Executive Director Rodrigo da Costa, proves that space is no longer an extra but critical infrastructure.

Space Situational Awareness (SSA) – Europe's eyes on space

The nature of the SSA component

The growing dependence of societies, economies and citizens on space-based services – particularly for communications, navigation, and Earth observation and scientific missions – has increased the **need to understand and expand the knowledge of space hazards and provide protection against threats from space**. These hazards include space debris and orbital congestion, solar activity and space radiation, and comets and asteroids.

At the same time, the recent rise in satellite constellations, orbital debris and launch activity is intensifying the demand for more advanced and coordinated space safety and security capabilities. In response to these challenges, the EU has established the **Space Situational Awareness component, structured into three sub-components – Space Surveillance and Tracking (SST), Space Weather (SWE), and Near-Earth Objects (NEO)** – to safeguard satellites, critical infrastructure and citizens from space-related threats.

The **SSA component is essential to ensure EU independent space capabilities** by strengthening sovereignty and strategic autonomy in the space domain, becoming a core pillar of the EU Space Programme. It contributes to long-term space sustainability by enhancing capabilities to monitor, track and identify space objects and space debris, thereby supporting space traffic coordination and the protection of space infrastructure. This is complemented by the monitoring of variations in the space environment at the sun and around the Earth, and the natural objects in the solar system which are approaching the Earth.

To support the component, **the EU is increasingly investing in advanced sensor networks, data processing capabilities and predictive modelling to enhance the accuracy and resilience of the SSA services**. International efforts to promote the long-term sustainability of outer space activities are being actively advanced by the United Nations Committee on the Peaceful Uses of Outer Space, and supported by the United Nations Office for Outer Space Affairs through the development of guidelines, best practices and cooperative frameworks that ensure the safe and responsible use of space for future generations. In addition, the growth of private actors and commercial SSA service providers reflects an expansion beyond institutional capabilities. The EU Industry and Start-ups Forum on STM (EISF) is actively fostering and supporting the commercial space ecosystem.

Finally, regulatory developments are expected to shape a harmonised framework for space safety, resilience and sustainability, further reinforcing the core role of the SST subcomponent for secure and responsible space operations in the EU and worldwide.

Sources: Internal elaboration based on ESA NEOCC, NOAA

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Space Traffic Management and Space Traffic Coordination

The rapid increase in spacecraft and satellite launches – particularly the deployment of large constellations – is significantly intensifying congestion in Earth orbit and, consequently, the need for robust Space Traffic Management (STM) policies. This challenge has been addressed at EU level through the **Joint Communication "An EU Approach for Space Traffic Management"**, issued by the European Commission in February 2022 [see JOIN(2022)4].

The Communication formally structures EU STM policy and **defines STM as the set of rules and means enabling safe, sustainable and secure access to operations in space and their return. STM is fundamentally dependent on continuous Space Situational Awareness (SSA) capabilities, with Space Surveillance and Tracking (SST) constituting its operational backbone**. To support this approach, the Communication proposed 10 concrete actions, currently being implemented through the STM stakeholder mechanism. This mechanism consists of a main coordination group and four dedicated subgroups responsible for: collecting civilian and military STM requirements from space operators; identifying research and development priorities for the SST domain through the EU Industry and Start-ups Forum; supporting regulatory and legislative aspects of STM; and promoting STM at international level.

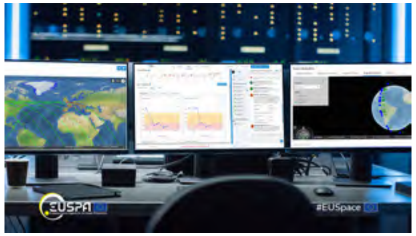
Within this framework, Space Traffic Coordination is closely linked to STM and refers to the day-to-day operational coordination activities, which build directly on SSA and SST capabilities.

SSA: SST – ensuring space safety and sustainability

EU SST
Space Surveillance and Tracking

Front Desk

The Front Desk provides the secure interface for delivering the SST services to users (SST Portal) and ensures user support and engagement



© EU SST

Reporting period: 1 March 2025-1 March 2026

>270k
products delivered through the SST Portal in the last year

314
more users registered than the previous year

113
more satellites registered than the previous year

1712
user requests handled by the SST helpdesk in the last year

>14k
social media followers in total

4
taskforce activations for critical events in the last year

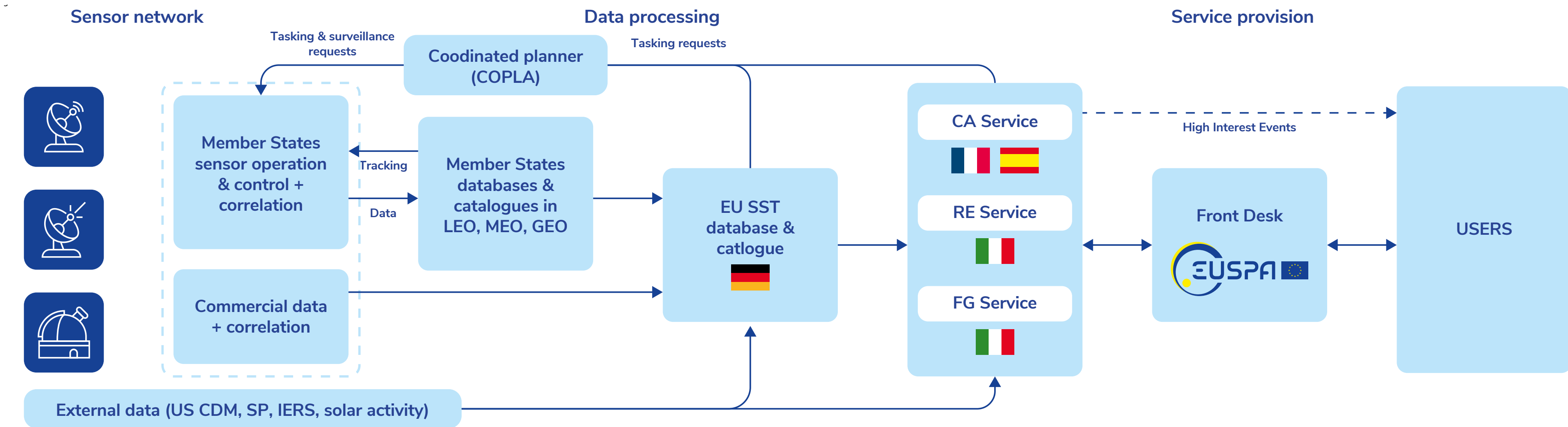
>80
indicators monitored to report on the performance of EU SST

SST sub-component

EU Space Surveillance and Tracking (SST), as part of the Space Situational Awareness component of the EU Space Programme, **is tasked with safeguarding space assets**, especially EU Space Programme satellites (e.g., Galileo, EGNOS, Copernicus), along with the space assets of EU Member States and other space operators.

SST in Europe is implemented through the EU SST Partnership of 19 EU Member States (Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, Romania, Spain and Sweden) together with EUSPA acting as the EU SST Front Desk form the SST Cooperation. **These Member States have networked their national sensors and processing capabilities into the SST system to provide three SST services 24/7 free of charge** to users worldwide – i.e., collision avoidance assessing risks of collisions between active satellites and between satellites and debris; re-entry assessing the risks of an uncontrolled re-entry of a space object into the Earth's atmosphere; and fragmentation detecting and characterising in-orbit fragmentations of space objects. EUSPA manages the EU SST Front Desk, acting as the point of contact for users, and is responsible for service provision, performance monitoring, user engagement and communications.

The demand for SST services is steadily increasing from satellite operators, EU Member States, institutional users and commercial actors, driven by the growing number of space objects and debris, particularly in LEO. In fact, the proliferation of megaconstellations has changed the way space systems are managed. Behaviour and predictability are key for mission planning and daily operations, in which satellite operators rely to manage service continuity and operational risk. Thus, timely knowledge is essential for orbital environment and sustainability, even more relevant for the growing demands expected in the future, and thus EU SST provides the operational capability that underpins the EU approach to STM.



EU SST services

Collision Avoidance service (CA)

CA is a user-tailored service that **provides risk assessment of collision** between spacecraft, or between spacecraft and space debris, **and generates collision avoidance alerts**.

The service analyses around 30,000 close approaches per year, of which **more than 4,000 are classified as high-risk events requiring alerting and potential operator action**, protecting over 640 spacecrafts from more than 105 registered organisations. With the expected growth in satellite constellations, human missions and higher launch rates, in conjunction with debris accumulation, these numbers are expected to continue its increase over the coming years.

These developments are reinforcing **a demand for more accurate predictions, shorter warning times, translated into stronger and further automated coordination mechanisms, with more standardised data formats to enable effective in-house analysis.**

© EU SST

Fragmentation Analysis service (FG)

FG provides the **detection and characterisation of in-orbit fragmentations, break-ups or collisions of space objects**.

The service analyses all the available information (at short, medium and long term) regarding the object(s) involved in the event. In 2025, the service reported four in-orbit fragmentation events, providing detection and characterisation of break-ups and assessing the resulting debris fields.

In line with other SST services, an increase in fragmentation detections has been observed, which in some cases may lead to the activation of the taskforce for critical events. Increased awareness and sustainability policies are expected to help reduce the likelihood of such scenarios.

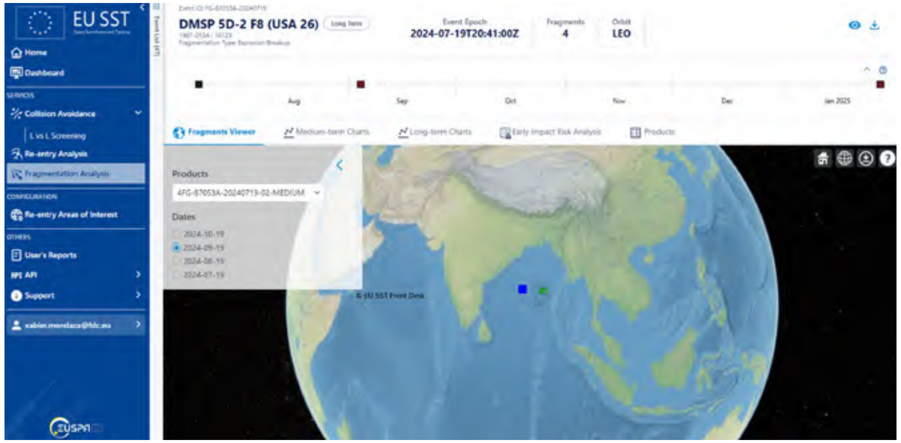
© EU SST

Re-Entry Analysis service (RE)

RE provides **risk assessment of the uncontrolled re-entry of man-made space objects into the Earth's atmosphere** that may constitute a potential risk to the safety of citizens and to terrestrial infrastructure.

The service analyses all the available information regarding the uncontrolled re-entries within 30 days, monitoring more than 130 events of space objects into the Earth's atmosphere in 2025, resulting in over 800 products providing risk assessment, areas and timeframes, among other relevant information.

The RE service is expected to continue evolving, notably in view of the international opening of the service and its further development based on user needs identified through user uptake activities.



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EU SST priorities and future evolutions

PRIORITIES

- Continue the improvement of the EU SST services
- Research and further develop EU SST capabilities
- Develop and use innovative technologies to face challenges raised by STM
- Strengthen and enhance the EU ecosystem in commercial sensors and data provision
- Foster synergies between civil and defense capabilities

Trends and developments

The evolution of the SST sub-component is driven by growing operational demand resulting from an increasingly congested space environment. To **respond to this demand, EU SST continues to progressively integrate commercial data** alongside national and institutional assets, leveraging existing technologies **such as telescopes, radars, and radio-frequency sensors**. In parallel, **advances in sensor technologies and data processing** are expected to **further enhance service provision, supporting improvements in detection, characterisation, modelling, and automation**. In addition, **the rapid deployment of large satellite constellations is contributing to an increase in satellite manoeuvring and collision avoidance activities**. This evolution highlights the importance of continuously enhancing EU SST in order to maintain reliable space traffic coordination among stakeholders and safeguard EU space assets.

At the same time, efforts are underway to **strengthen the resilience, performance and operational capacity of EU SST** through joint investments and cooperation among EU Member States, while further developing cooperation with international partners. The growing number of space actors and increasing operational complexity of the orbital environment require **enhanced coordination to ensure space safety and sustainability**. These developments are further supported by policy initiatives, notably the **EU approach to Space Traffic Management (STM), which recognises EU SST as a key operational capability** for space traffic coordination, and aims to reinforce Europe's strategic autonomy in this domain.

To address current and future needs, the evolution of EU SST builds on several complementary frameworks aimed at exploring improvements and innovative solutions. From a strategic perspective, a **Research & Development (R&D) plan** has been established to support the sustained evolution and enhancement of EU SST sensors, processing capabilities and services. The plan includes hardware and software development activities to improve sensor performance, data processing and service provision, while also supporting studies on future system architectures and advanced SST capabilities. The implementation of the R&D plan involves close cooperation with European industry, research organisations and start-ups, contributing to innovation and strengthening the European SSA ecosystem. Complementary initiatives, such as discussions within the EU Industry and Start-ups Forum and feedback collected through the Front Desk user uptake activities, contribute to identifying technological priorities and capability gaps and support the continuous evolution of EU SST services. As an example, a recent consultation has been launched for registered collision avoidance users to gather feedback on how expanded SST information sharing could enhance coordination and overall space safety.

Finally, rising user demand is fostering the **emergence of a European ecosystem for advanced and commercial SST services**. This ecosystem connects industry and operators and supports the development of new services addressing evolving needs in the space domain.

SSA: SWE and NEO

SWE – monitoring space weather

Solar activity – primarily flares or mass ejections – **along with galactic cosmic rays, creates a complex radiation environment that threatens our increasingly vital space and ground-based infrastructure**. These effects can be experienced both in space (degraded communications and navigation signals, degradation of orbital prediction and the loss of altitude due to increased drag, damaged spacecraft electronics, and astronauts and high-altitude aviation exposure to elevated radiation levels) and on Earth (impacted systems and critical infrastructure such as power grids or pipelines). As this dependency grows, the ability to monitor, forecast and mitigate space weather impacts has become a strategic necessity.

The **SWE sub-component focuses on the development of observational parameters related to space weather events**, mainly through monitoring and analysis of solar and space phenomena such as solar flares and coronal mass ejections. In addition, **special attention is given to continuous modelling and prediction capability improvements**, as explained in ARCAFF on state-of-the-art flare forecasting and EUHFORIA 2.0 on how space weather travels from the sun to the Earth.

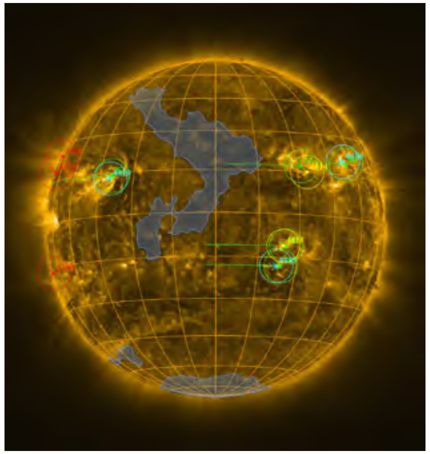
In this context, **the EU has initiated the procurement of SWE service provision for the space domain** as reflected in the Implementing Decision (EU) 2025/469, due to technical maturity and budgetary constraints.

© EC

Supports the mitigation of risks to human life on Earth

Supports the mitigation of risks to assets on Earth and in space

Supports the development of a European space weather service



ESA Space Weather Service Network

NEO – observing space rocks

Near-Earth Objects, asteroids and comets, whose orbits bring them into proximity with the Earth, represent a natural space hazard with potentially severe consequences. Currently tens of thousands of objects are known, and new space missions enabling an increasing rate of detection underscores the need for monitoring, analysis and response capabilities.

The NEO sub-component focuses on monitoring the risk of natural objects, such as space rocks in the solar system, **which are approaching the Earth**, supporting in particular the characterisation of detected objects. These aspects are essential to understand the real risk that an object poses in case of an imminent approach.

Furthermore, the EU supports these efforts – primarily through funded projects – aimed to improve and develop the service. These activities include mapping Member States' capabilities to detect and monitor NEOs and increasing the knowledge sharing of these objects through yearly thematic workshops to increase the monitoring of fireballs and lunar impacts, and the identification of potential NEOs for future deflection missions.

The activities rely on close cooperation among Member States' facilities and research centres. Due to the global nature of these activities, they are linked to international observation and warning efforts, in coordination with mechanisms established under COPUOS, including the International Asteroid Warning Network for global NEO warning and the Space Mission Planning Advisory Group for international mitigation planning processes.

© EC

Supports the physical characterisation of space rocks

Supports the monitoring of space rocks

Supports potential deflection procedures if needed

Near-Earth Objects Coordination Centre © ESA

Cross-cutting analyses – GNSS market for timing and synchronisation and drone service revenues

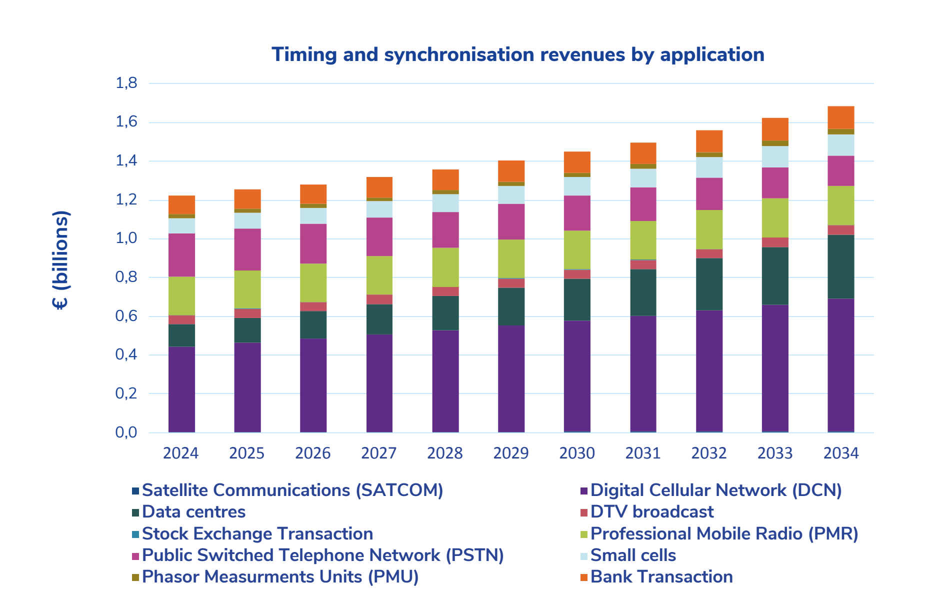
GNSS for timing and synchronisation

GNSS-based timing has become a **core pillar of business continuity**, making it a strategic asset in the digital economy. Precise timing and synchronisation enabled by GNSS underpins critical operations across energy, infrastructure, and financial services, supporting system integrity, automation, and regulatory compliance in highly interconnected environments.

In **energy**, GNSS-synchronised systems are essential for monitoring and protecting electric grids. Utilities rely on GNSS-enabled Phasor Measurement Units to detect faults in real time, balance power across wide areas, and manage increasingly automated grids integrating renewable energy sources. **Telecom infrastructure** operators similarly depend on GNSS timing to synchronise mobile networks, data centres and smart city systems, ensuring resilient and reliable connectivity.

In **insurance and finance**, GNSS timing enables precise event timestamping and high-speed transaction traceability. Financial institutions use GNSS-synchronised clocks to guarantee transaction ordering, detect fraud and comply with regulations such as MiFID II, strengthening transparency and trust in digital financial markets.

Timing and synchronisation generated above **€1.2 billion in revenue in 2024** and is projected to exceed **€1.6 billion by 2034**, reflecting a CAGR of 3.69%. This growth rate signals a mature and well-established market that is still expanding. Revenue is primarily driven by telecom network applications, notably data communication networks, where precise timing remains critical to performance and reliability.



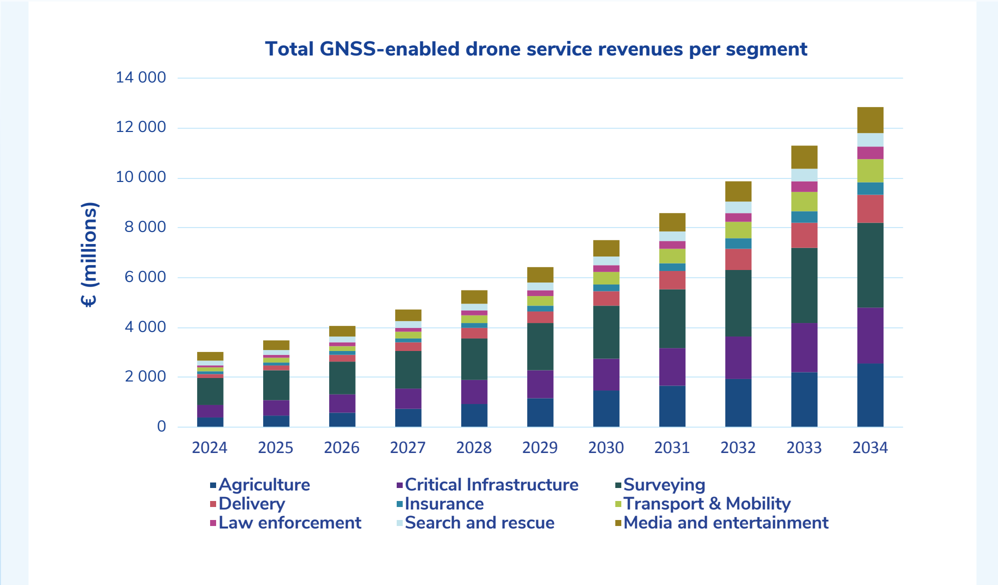
The role of GNSS in drones across different sectors

GNSS is widely recognised as a **key technology** for the **stable and safe operation of drone services** in both professional and commercial applications. It enables core functions such as navigation, positioning, timing, route planning and automation, and therefore underpins the reliable execution of drone missions. Beyond its role in flight control, GNSS also contributes directly to the generation of **added value in drone services** when combined with complementary technologies such as advanced sensors, communication links, data processing capabilities and artificial intelligence. Together, these technologies allow drones to deliver actionable insights and operational efficiencies across a growing range of applications.

As regulatory frameworks evolve and operational concepts mature, drone services are increasingly being deployed at scale and in more complex operational environments. By **2035**, the global drone services market is expected to generate **around €12.8 billion in annual revenues**. This market is growing rapidly, with an estimated compound annual growth rate of almost 14% between 2024 and 2034.

Drone service revenues have been quantified **across nine distinct sectors**, from critical infrastructure and surveying to law enforcement and search & rescue. At present, the largest GNSS-enabled drone service revenues are concentrated in surveying, followed by critical infrastructure, agriculture, and media and entertainment.

These sectors are particularly dependent on accurate and repeatable positioning, georeferencing and precise data acquisition, which makes GNSS a critical enabling technology. Looking ahead to 2035, the strongest growth is expected in agriculture, delivery and transport and mobility, driven by legal framework evolution, the expansion of beyond visual line-of-sight operations, increasing automation and rising demand for efficient, scalable and cost-effective services.



The dual use of downstream space solutions and the role of GNSS for IoT

The dual use of GNSS and EO

Dual-use refers to capabilities that, although deployed widely in commercial and civil domains, can also be directly exploited for defence, security and crisis-management purposes. The boundary between civil and military use is not always clear-cut, with shared infrastructure, data and services supporting both societal resilience and national security objectives. **GNSS and EO are prime examples of dual-use** technologies, underpinning both civilian and security/defence applications across all major market segments.

From the supply side perspective, security and defence act as "anchor customer" for expensive EO capabilities. Once satellites, sensors, ground systems and analytics pipelines are developed for defence and security purposes, civilian markets can reuse part of that capacity at lower marginal cost.

In civil markets, GNSS enables precise positioning and timing for transport, aviation, maritime, agriculture and everyday consumer solutions such as smartphones, wearables and connected vehicles. EO data supports land, marine and atmosphere monitoring, resource and infrastructure management, disaster risk reduction, climate services and urban planning, providing consistent, high-resolution information for public authorities and private operators. For example, application specific benefits in agriculture include GNSS enabling precision farming (e.g. automated guidance and variable-rate inputs), while EO data is now critical for large-scale crop assessment, yield forecasting, soil moisture tracking, and resource optimisation.

From a **security and defence perspective**, GNSS is essential for military navigation, precision-guided operations, blue-force tracking and robust, encrypted timing for secure communications and critical infrastructure. EO assets are central to intelligence, surveillance and reconnaissance, border and maritime security and operational planning, as well as situational awareness in hybrid and high-intensity scenarios.

Within **applications for authorities**, the dual-use nature of these systems becomes particularly evident. Services such as emergency management, search and rescue, civil protection, critical infrastructure monitoring and climate-adaptation planning draw on the same GNSS and EO capabilities that defence and security actors use for mission planning, logistics support, threat detection and crisis response.

Macro area	Civil use cases		Security / defence use cases	
	GNSS	EO	GNSS	EO
Transport (road, maritime, aviation, drones)	Navigation and routing, fleet management, road user char ing, rail signalling, drone traffic management	Traffic monitoring, port/airport monitoring, emissions and congestion mapping	Blue-force tracking, navigation for military vehicles, aircraft, vessels and UAS, geofencing of restricted areas	Maritime domain awareness, route reconnaissance, target area mapping, surveillance of ports and airfields
Emergency management and Humanitarian Aid / EU Border and Internal Security	Search-and-rescue localisation, emergency vehicle dispatch, logistics for relief supplies	Rapid damage mapping (floods, fires, earthquakes), evacuation planning, humanitarian needs assessment	Secure for first responders in contested environments, coordination of civil-military crisis response	Intelligence, Surveillance and Reconnaissance (ISR) support to crisis management, monitoring of conflict-affected areas, planning of safe corridors and evacuations
Critical infrastructure & smart cities	Timing for power grids, telecoms and finance; asset tracking; guidance for construction machines	Monitoring of pipelines, power lines, urban expansion, land subsidence and structural deformation	Encrypted timing and positioning for strategic infrastructure, secure communications, and protection of critical assets	Surveillance of strategic sites, detection of threats to infrastructure, mapping vulnerabilities in urban environments

GNSS positioning is a key enabler for IoT

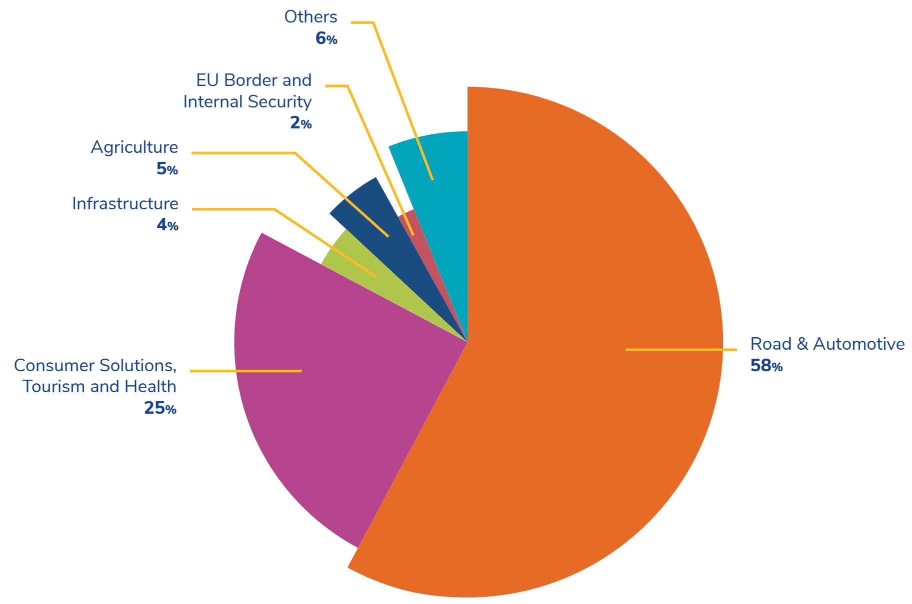
By enabling the reliable collection, transmission and analysis of large volumes of sensor data, **IoT technologies** support more efficient logistics, enhanced precision agriculture, smarter infrastructure management, and faster, more effective emergency response operations.

GNSS is a key enabler of the Internet of Things (IoT), providing real-time positioning information, supporting global asset tracking, and environmental monitoring capabilities, in particular for applications where objects are moving, including in remote and underserved areas.

Within IoT, GNSS plays a central role by delivering precise positioning and timing information to a wide range of IoT applications. It underpins **asset tracking** and **fleet management** in logistics, supports **monitoring and maintenance of smart infrastructure**, and is essential for **connected and autonomous vehicles**. GNSS is also embedded in consumer IoT solutions such as **smart wearables** and **smart city systems**, enabling accurate location awareness for navigation, safety and real-time operational management.

Overall, in 2025, the GNSS-enabled IoT market (quantified across the different market segments in this report) accounted for around €115 billion. This market is primarily driven by road and automotive applications, which generate about 58% of GNSS IoT revenues, followed by consumer solutions, tourism and health representing roughly 25%.

GNSS IoT share of revenues per market segment in 2025



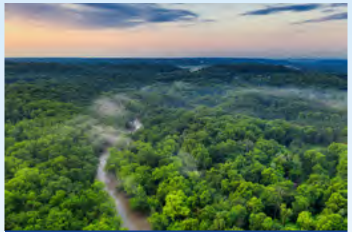
What you should not miss in this report...

AGRICULTURE

CAP simplification continuing to push reliance on space data. CHIME to enhance agricultural monitoring (p. 52, 54 and 55)

AVIATION AND DRONES

GNSS and EO resilience: a challenge for securing safe and sustainable market evolution (p. 60, 63 and 64)

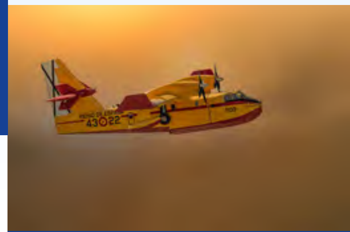


CLIMATE, ENVIRONMENT AND BIODIVERSITY

EO use is rapidly growing to support climate resilience, environmental monitoring, biodiversity protection and emissions transparency (p. 69-71 and 73-76)

CONSUMER SOLUTIONS, TOURISM AND HEALTH

With smartphones nearing saturation, satellite-powered apps will fuel the next wave of growth (p. 82-83 and 86-88)



EMERGENCY MANAGEMENT AND HUMANITARIAN AID

As needs grow and resources remain constrained, EO and GNSS offer cost-effective solutions. p. 94 and 96-98)

ENERGY AND RAW MATERIALS

GNSS and EO support the energy transition and responsible mining through monitoring and risk assessment (p. 103-104 and 107-110)

EU BORDER AND INTERNAL SECURITY

Digitalisation in customs and exploitation in forensics increase the potential of GNSS and EO services (p. 116, 119 and 120)

FISHERIES AND AQUACULTURE

EO and GNSS enable sustainable fisheries and aquaculture via environmental monitoring, fleet transparency, farm management and precise positioning (p. 134, 136 and 137)

FORESTRY

EU forests losing carbon sink capacity and EO improving post-wildfire forest recovery (p. 126, 128 and 129)

What you should not miss in this report...

INFRASTRUCTURE

—

GNSS and EO help to increase safety of operations, optimise maintenance and improve resilience (p. 142 and 145-147)

RAIL

—

GNSS growth accelerates as asset management solutions enhance efficiency and safety (p. 170, 173 and 174)

INSURANCE AND FINANCE

—

Transforming global markets with data-driven risk and compliance solutions, powered by EO and GNSS (p. 153, 156 and 157)

URBAN DEVELOPMENT AND CULTURAL HERITAGE

—

Precision spatial data transform urban planning, climate adaptation and cultural heritage management (p. 194-195 and 197-200)

ROAD AND AUTOMOTIVE

—

GNSS underpins advanced vehicle navigation, safety, fleet management and smart mobility (p. 178, 181 and 182)

MARITIME AND INLAND WATERWAYS

—

GNSS and EO are key enablers in sustainability and automation transformation (p. 162, 164 and 165)

SPACE

—

GNSS continues its evolution as the space navigation backbone for the full satellite mission lifecycle (p. 187, 189 and 190)

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AGRICULTURE

Environmental monitoring
- Carbon capture & content assessment
- Environmental impact monitoring

Natural resources monitoring
- Vegetation biomass and health monitoring
- Crop yield forecasting
- Soil condition monitoring

Operations management
- Asset monitoring
- Automatic steering
- Subsidy and policy control
- Farm machinery guidance
- Livestock wearables
- Farm Operations Management[1]

Weather services for agriculture
- Weather and climate services for agriculture

Application descriptions can be found in Annex 3.

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

1: "Farm Operations Management" is a grouped application consisting of the following sub applications:

- **Field delineation**
- **Farm management systems (FMS)**
- **Pastureland management**
- **Precision irrigation**
- **Variable rate application**

Note: Other applications are also used within Farm Operations Management (e.g. crop yield forecasting and soil condition monitoring), however, these applications serve a broader range of users beyond farmers, including food security stakeholders, economists, insurance companies, and other decision-makers. Therefore, within this taxonomy they remain as standalone applications.

AGRICULTURE

Digital technologies in farm management – and across the wider agricultural sector – are helping to tackle major challenges faced by farmers, cooperatives, policymakers and governments. By improving decision-making and operational efficiency, these tools enhance farm profitability, support more efficient use of resources and advance broader sustainability goals.

At the farm level, EO enables growers to remotely monitor crop performance and optimise input use, including reducing reliance on fertilisers. At the broader scale, EO delivers extensive, high-quality data that public authorities and economists can use to strengthen analysis, guide policy and support more informed decision-making.

GNSS provides significant value to agriculture by enabling precise machinery guidance and accurate livestock tracking, helping farmers maintain highly efficient and well-coordinated operations.

Together, EO and GNSS link what is happening on the ground with exactly where it is happening, providing stakeholders with precise, scalable insight into agriculture and enabling more effective, sustainability-driven decision-making.

What you will find in this chapter

- **Key trends:** CAP simplification, the role of agroforestry in sustainable farming systems, and affordable GNSS solutions are reshaping precision agriculture to be more flexible, sustainable and accessible.
- **Industry:** Agriculture value chains.
- **Recent developments:** The EU Carbon Farming Regulation is driving sustainable farming, while GNSS and Secure SATCOM is further enabling autonomous machinery capabilities.
- **Future market evolution:** CHIME will enhance agricultural sustainability with global hyperspectral imaging, while GNSS-enabled devices give farmers affordable precision tools for mapping and management.
- **Focus on European systems:** The EU Space Programme supports R&I activities in agriculture.
- **Reference charts:** Annual evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

CAP simplification, the role of agroforestry in sustainable farming systems, and affordable GNSS solutions are reshaping precision agriculture to be more flexible, sustainable, and accessible

Key market trends

- The 2025 CAP Simplification Package aims to cut bureaucracy and give Member States more flexibility, while continuing to promote the use of EO and GNSS technologies in compliance checking.
- The expansion of agroforestry as a resilience and income strategy is being supported by EO, which enables scalable monitoring and evaluation of these mixed land-use systems.
- Affordable GNSS with RTK and sensors can deliver precision farming accuracy, widening access for smaller farms and agri-robotics while the Galileo High Accuracy Service (HAS) provides open and free access to high-accuracy corrections.
- The agricultural services market is large and growing, driven by expanding satellite infrastructure that improves data resolution, accessibility, and rural connectivity, alongside rising food demand and resource constraints increasing demand for EO and GNSS-based services.

The CAP Simplification Package reduces field inspections and relaxes some GAEC rules, increasing reliance on remote sensing to monitor land use and environmental compliance

The CAP Simplification Package was proposed in 2025 to reduce bureaucracy for farmers and national administrations while making the Common Agricultural Policy more flexible and easier to implement. A central aim is to cut administrative burdens, streamline inspections and allow Member States greater discretion in applying rules, particularly around environmental standards and conditionality. The European Commission estimates that these measures could save farmers up to €1.58 billion annually and national administrations another €210m. The simplification has direct implications for the use of EO in agricultural monitoring. Although EO is already extensively used in CAP monitoring, the simplification package is likely to change how it is used. By reducing administrative burdens and limiting the number of on-farm inspections, the EU will increasingly rely on satellite and aerial monitoring to verify compliance, track land use and measure environmental impacts. Changes to "good agricultural and environmental conditions" standards – such as more flexibility in permanent grassland thresholds, peatland/wetland protection and buffer strip management – also affect what needs to be monitored. These elements, along with crop health and other agricultural practices, can all be monitored through remote sensing, but the loosening of rules may shift emphasis from strict enforcement to broader landscape-scale monitoring.

Agroforestry: cultivating harvests, restoring nature

Agroforestry integrates trees and shrubs into agricultural landscapes, combining crop and livestock production with woody perennials. This approach enhances biodiversity, improves soil fertility, regulates water cycles and increases resilience to climate change, while also diversifying farmers' income sources. Although it is a practice that has existed for quite a while, it's gaining more traction globally because it sits at the intersection of climate action, sustainable agriculture and rural development. In recent years, the EU has promoted agroforestry through the CAP, offering incentives for farmers who adopt tree-based systems. Agroforestry is also closely linked to the Carbon Removals and Carbon Farming Certification (CRCF) Regulation because it is recognised as a key carbon farming practice. By integrating trees with crops and livestock, agroforestry systems remove carbon dioxide from the atmosphere and store it both in tree biomass and in soils.

EO supports agroforestry by enabling large-scale mapping and monitoring of tree cover, crop-tree interactions and land-use dynamics. Satellite and drone imagery can track canopy growth, carbon sequestration and soil moisture, providing valuable insights into both productivity and ecological benefits. This can help evaluate the performance of agroforestry systems and guides sustainable land management decisions.

Affordable GNSS solutions allowing for increased uptake in agriculture

Different farming operations demand different levels of accuracy. For resource monitoring or yield mapping, errors of more than a metre may be acceptable. Semi-automated guidance systems usually need accuracy within 10cm to 20cm, while fully automated systems and precision operations require accuracy down to a few centimetres.

A study compared the performance of premium commercial automatic guidance systems versus lower cost GNSS receivers and concluded that moderately priced GNSS receivers (with RTK corrections) are viable for many precision agriculture tasks. This approach allows for wider adoption of GNSS technologies in agriculture by providing sufficient precise positioning for fieldwork operations. Integrating GNSS with advanced technologies like visual odometry is also being investigated to enhance positioning accuracy further, making GNSS-based precision localisation a feasible option under various field conditions. From a practical standpoint, this means smaller farms or robotic/agro-mechanical developers can consider lower-cost solutions, especially when augmented with auxiliary sensors, and still attain an acceptable level of precision for many operations. It should also be noted that small, medium and industrial farms adopt at different speeds and for varied reasons, driven by constraints such as rural connectivity, platform integration and the cost sensitivities to the pricing of services.

The Galileo High Accuracy Service (HAS) provides open and free access to high-accuracy corrections.Traditionally, precise positioning services required paid subscriptions or specialised regional networks. By contrast, HAS democratises access to precision navigation, opening up even more opportunities for innovation and technological adoption in agriculture. It also provides global coverage by distributing corrections through two complementary channels. Where internet connectivity is available, corrections can be accessed via standard IP-based services. To ensure availability in Internet white-spot areas, HAS also broadcasts corrections directly via the Galileo Signal-in-Space (SiS) on the E6 band. This requires no ground connectivity, allowing users to receive corrections anywhere Galileo satellites are visible, including remote and infrastructure-poor regions.

GNSS and EO Agriculture Value Chain[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- GEOSAT*
- E-GEOS*
- EARTH-I*
- EOS DATA ANALYTICS*
- ICEYE*
- ORORATECH*
- PLANET
- SATELLOGIC*
- UMBRA
- VAISALA*
- VANTOR

- COPERNICUS SENTINELS*
- NISAR (NASA/ISRO)
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)-
- RELEVANT EUROPEAN NATIONAL MISSIONS
- RELEVANT IN-SITU NETWORKS

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- ADAM*
- CREODIAS*
- EDS CEODE
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- SENTINEL-HUB* (PLANET)-
- TERRADUE*
- UP42*

- COPERNICUS DATASPACE ECOSYSTEM*
- FOOD TEP*
- WEKEO*

EO PRODUCTS AND SERVICES PROVIDERS

- AGRICOLUS*
- AGROBIT**
- BASF*
- CAIUS**
- DESCARTES LABS
- DIGIFARM*
- E-GEOS*
- EARTH DAILY
- ESRI
- EOS DATA ANALYTICS
- FARMON**
- FIELDSENSE*
- GAF*
- GEOVILLE*
- GMV*
- KAPPAZETA*
- KERMAP**
- NEO B.V.*
- ONESOIL*
- PESSL INSTRUMENTS*
- PLANETEK*
- SATAGRO*
- SATELLIGENCE*
- SENCROP*
- SEQANA**
- SPACE4GOOD*
- SYLVA*
- TALKINGFIELDS*
- TERRA METALLUM**
- TRIMBLE
- VISTA*
- VITO*

- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*

INFORMATION PROVIDERS

- FARM MANAGEMENT SERVICES:
- 365FARMNET*
- AGRIVI*
- AGWORLD
- CLEVERFARM*
- CROPWISE
- FARMERP
- GRANULAR
- SECTOR SPECIFIC SERVICES: GAMAYA* (SOY, SUGAR CANE)
- GEO4A* (POTATO)

END USERS

- AGRI-INSURERS
- AGRICULTURAL CONSULTANTS
- AGROCHEMICAL MANUFACTURERS
- AGRONOMISTS
- CARBON FARMING STAKEHOLDERS (PROJECT DEVELOPERS, VERIFIERS ETC.)
- COOPERATIVES
- ENVIRONMENTAL AGENCIES
- FARMERS
- FOOD PROCESSORS
- INTERNATIONAL AGENCIES (e.g. FAO, WFP...)
- PAYING AGENCIES
- WINE PRODUCERS

LEGEND

- Commercial offering
- Public offering / entities
- User segments

GNSS

AUGMENTATION SERVICE PROVIDERS

- CNH INDUSTRIAL* (INCLUDING HEMISPHERE)
- DEERE
- FUGRO*
- HEMISPHERE (ATLAS)
- HEXAGON*
- SAPCORDA*
- SWIFT
- TERIA*
- TOPCON
- TRIMBLE

- GALILEO HIGH ACCURACY SERVICE
- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS

COMPONENT AND RECEIVER MANUFACTURERS

- AG LEADER TECHNOLOGY
- AGJUNCTION
- ANALOG DEVICES
- ANTCOM
- ARAG*
- AVMAP*
- BEIJING BDSTAR NAVIGATION
- BEIJING UNISTRONG SCIENCE & TECHNOLOGY COMPANY
- CAMPBELL SCIENTIFIC
- CHCNAV
- CNH INDUSTRIAL*
- COMNAV TECHNOLOGY
- DEERE
- HARXON
- HEXAGON*
- RAVEN INDUSTRIES*
- TOPCON CORPORATION
- TRIMBLE NAVIGATION
- UNISTRONG GNSS
- YAGEO

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

- AG LEADER TECHNOLOGY
- AGCO CORP
- AGC TECHNOLOGIES*
- AMAZONEN-WERKE*
- ARAG*
- AVMAP*
- CLAAS KGAA*
- CHCNAV
- CNH INDUSTRIAL*
- DAEDONG INDUSTRIAL
- DEERE
- HEXAGON*
- ISEKI & CO
- JCB*
- KRONE*
- KUBOTA CORPORATION
- MAHINDRA
- MILLAT TRACTORS
- SDF GROUP*
- TONGYANG MOOLSAN
- YANMAR

USERS OF POSITIONING INFORMATION

- FISHING COMPANIES
- PORT AUTHORITIES
- SURVEILLANCE AUTHORITIES
- DATA-ANALYTICS COMPANIES:
- MARINETRAFFIC, MYSHIPTRACKING, VESSELTRACKER

The European[2] EO and GNSS industry in the global arena

Topcon, Trimble and Beijing Unistrong Science & Technology Company hold a combined revenue share of almost 70% of the global GNSS component and receiver manufacturing market. Hexagon AB is the largest European company in this market.

Although North American and Asian companies lead the EO data processing market, European companies such as Vaisala, Airbus and Leonardo (e-GEOS) capture almost one third of the global market. European companies make up more than 40% of the analysis, insights, and decision-support services market within the agricultural sector.

NOTES

1 The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

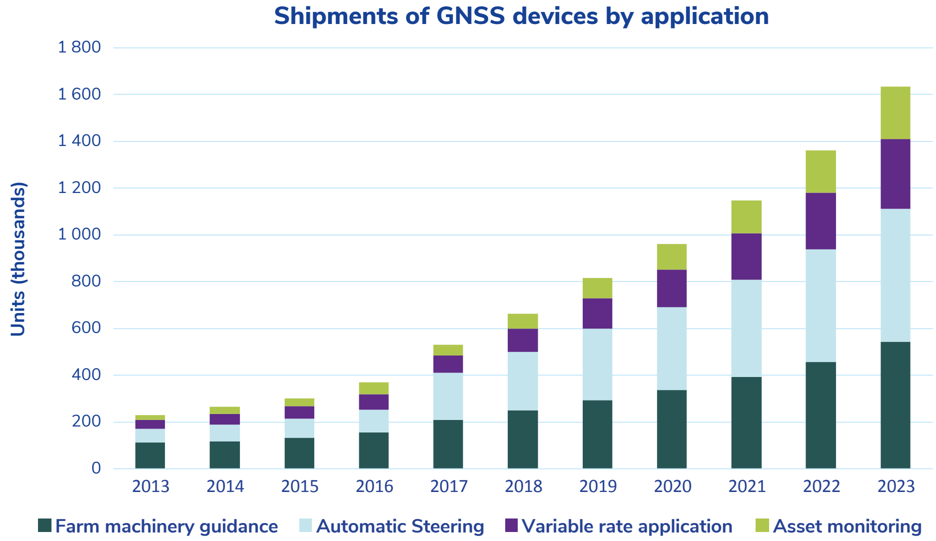
2 In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

The EU Carbon Farming Regulation is driving sustainable farming, while GNSS and Secure SATCOM are further enabling autonomous machinery capabilities



Shipment numbers of GNSS receivers continued to grow steadily over the past decade, gaining traction from 230,000 units shipped across all applications to 1,634,000 units shipped annually.

The growth in farm machinery guidance units was modest, with the market opting more for automatic steering solutions over the period. This resulted in the market domination of automated steering thanks to its utility in boosting machinery precision and optimising the use of inputs such as fertilisers and pesticides.

Both variable rate application and asset monitoring applications grew steadily, resulting in just under 300,000 and 225,000 units being shipped by 2023 respectively.

This upward trend reflects continued and increasing demand for precision agriculture tools that enhance input efficiency and support better operational decision-making.

The EU Carbon Farming Regulation: Policy for more sustainable farming and potential for new revenue streams

The EU has established a framework to certify high-quality carbon removals and promote carbon farming practices. The Carbon Removals and Carbon Farming (CRCF) Regulation aims to create the first EU-wide voluntary framework for certifying carbon removals, carbon farming and carbon storage in products across Europe. The CRCF places EO and Copernicus at the core of how carbon removals and carbon farming activities are monitored and certified. EO is explicitly promoted to enable robust, scalable, and cost-effective monitoring, reporting, and verification (MRV), particularly for activities where reliance on on-site measurements is costly, infrequent, or difficult to harmonise across regions. This EO-based approach is complemented by mandatory third-party verification, with certification-related information published in an EU-wide registry to ensure transparency and comparability.

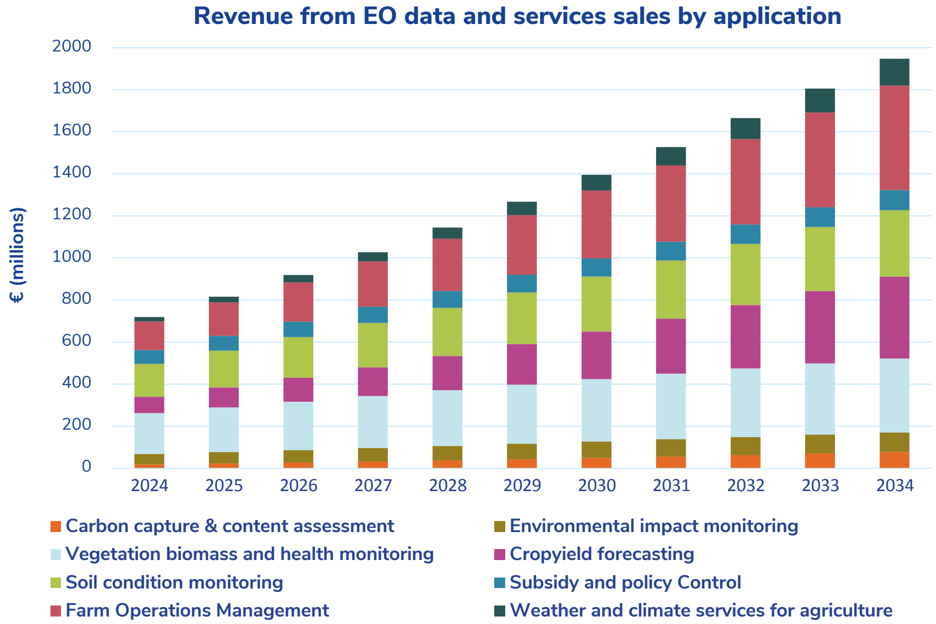
The CRCF has the potential to generate carbon credits that could be integrated into the EU Emissions Trading System (EU ETS) or the Voluntary Carbon Market (VCM), although the precise mechanisms and scope of any such integration remain under development. The EU ETS is a mandatory carbon market currently covering sectors including power, manufacturing and aviation, while the VCM is a non-mandatory market where businesses, individuals or governments voluntarily purchase carbon credits from carbon removal projects. Moreover, historically, there has been no unified framework for using EO in carbon removal certification, leading to global fragmentation where acceptable monitoring methods vary between the EU and UN frameworks and voluntary schemes.

GNSS and Secure SATCOM enabling precision agriculture autonomous machinery, helping agriculture tackle labour shortages through accurate, real-time navigation

GNSS is continuing to play a central role in the development and operation of autonomous machinery. By providing continuous position, velocity and timing information, GNSS enables machines to navigate in real time without relying solely on human control. One of the key advantages of GNSS in autonomous machinery is the level of accuracy and reliability it can achieve when paired with correction services. While standard GNSS signals typically provide positioning within a few metres, techniques such as Real-Time Kinematic and Precise Point Positioning allow machines to operate at centimetre-level precision.

In early 2025, John Deere introduced the second generation of its autonomy kit, which integrates advanced computer vision, AI, and camera technology to enhance machine navigation in various environments. This development comes in response to widespread labour shortages across multiple industries. The agricultural sector faces a significant challenge, with the American Farm Bureau Federation estimating that around 2.4 million farm jobs must be filled annually. Secure SATCOM also plays a role in this context. One of the biggest advantages of Secure SATCOM in autonomous farming is real-time fleet coordination and monitoring. For instance, autonomous tractors can share location, operating status and task progress via satellite links, allowing farmers or operators to oversee multiple machines simultaneously from a central hub. Crucially, Secure SATCOM also enables these capabilities in remote and rural areas with limited or unreliable terrestrial connectivity, ensuring continuous operations across large, geographically dispersed fields without reliance on local internet infrastructure.

CHIME will enhance agricultural sustainability with global hyperspectral imaging, while GNSS-enabled devices give farmers affordable precision tools for mapping and management



CHIME – Upcoming mission delivering global hyperspectral imaging to boost agricultural sustainability

The Copernicus Hyperspectral Imaging Mission (CHIME) is one of the six new missions aimed at broadening the current range of Sentinel missions. CHIME-A is scheduled to be launched in 2028 and CHIME-B in 2030. The satellites have an expected operational lifespan of seven years but will be launched with sufficient consumables to allow them to remain operational for up to 12 years. For agriculture, CHIME will provide insights into crop health, nutrients and stress, supporting sustainable farming, food security, and precision agriculture. It will help optimise inputs, improve yield forecasts and enable quicker responses to drought or disease. For soils, CHIME can detect organic matter, texture, and moisture, while monitoring degradation and erosion for better land management.

CHIME comprises two satellites, CHIME-A and CHIME-B, which are designed to provide systematic hyperspectral images that can be used to map changes in land cover and support sustainable agricultural practices. Especially in the context of agriculture, CHIME is expected to facilitate routine, global hyperspectral observations (with revisit times of ~11 days with both satellites) that will allow much more detailed monitoring of vegetation biochemistry (e.g. nitrogen, pigments), crop stress (from water, pests, disease), soil properties (texture, organic matter, moisture), land cover change, crop type classification, and yield prediction. The CHIME mission's primary objective is to support the development of new and improved operational applications and services that are related to food security, sustainable agriculture, and raw materials.

Revenues from **EO data and service sales** across all agricultural applications are expected to increase from almost €720 million in 2024 to over €1.9 billion in 2034.

The strong market growth in agriculture is a reflection of multiple drivers. While nearly half of the habitable land on Earth is agricultural land, rising global food demand is currently facing challenges related to land and water constraints, increasing input costs, and labour shortages.

All of this is accelerating the adoption of EO-enabled data and services in agriculture. Satellite remote sensing is particularly suitable for the agricultural sector compared to others because many agricultural variables are readily monitorable from space. Monitoring these lands from the ground is also slow and expensive, while satellites provide wide-area coverage, frequent revisits thanks to the evolution of LEO constellations, and consistent observations over time. Moreover, EO services are highly scalable and have a clear quantifiable return-on-investment in agriculture. This makes remote sensing uniquely suited to agriculture compared to sectors that are smaller-scale or less spatially distributed.

Currently, the three largest applications by market share are **vegetation biomass and health monitoring**, **soil condition monitoring**, and **farm operations management**. They generate a combined revenue of around €490m in 2024, which is forecasted to reach over €1.1bn by 2034. This reflects the continued focus and push for soil health and biomass health monitoring from climate friendly policies. Moreover, soil and vegetation health monitoring brings value to not only farmers, but also governmental bodies and economists concerned with the maintenance and monitoring of food supply chains.

The substantial market share of **crop yield forecasting** is evidence of the growing user base of EO data and service, with commodity traders paying higher prices for market insights, boasting almost €80m in revenues in 2024, reaching close to €390m by 2034.

Farm in Your Pocket – Access real-time field data, weather updates and crop conditions anytime, anywhere

Tablets and mobile phones are becoming increasingly important tools for farmers, particularly when their functionalities are combined with technologies such as GNSS, EO and the Internet of Things (IoT), enabling more precise, data-driven and connected farm management. One of the most common applications is field mapping and boundary marking. With a GNSS-enabled smartphone or tablet, farmers can walk around their fields to accurately record boundaries and calculate acreage. This improves land management, ensures accurate input planning and helps avoid disputes over land use. When paired with correction services such as RTK, and a dedicated GNSS receiver, accuracy can reach the centimetre level, making it possible to map soil zones or crop variability with high precision. In addition, GNSS in mobile devices supports field monitoring and crop scouting. Farmers can use rugged tablets to take geo-tagged photos, log pest or disease outbreaks, and record soil sampling points. Over time, this builds a spatial history of field conditions, facilitating early problem detection and better decision-making. Farmers also rely on GNSS for basic measurements, such as calculating field size, distances and slopes, which are useful for irrigation planning and infrastructure layout. What makes mobile phones and tablets especially attractive is their flexibility and affordability. Many systems allow farmers to start with just a phone app, using built-in GNSS for rough guidance, and then upgrade by adding an external RTK receiver for high-precision work. Rugged tablets designed for agriculture add durability, and have dustproof, waterproof, and sunlight-readable displays for use in harsh field conditions. This scalability lowers the entry barrier for precision agriculture, making GNSS-based tools accessible to farms of all sizes.

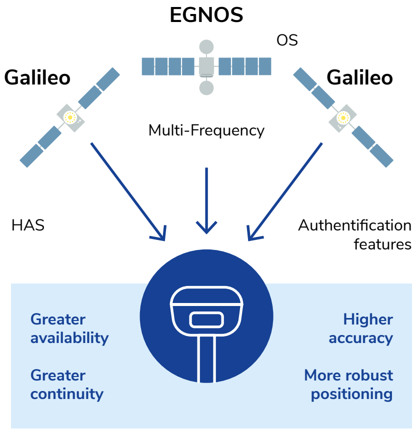
The EU Space Programme supports R&I activities in agriculture

Current and future use of EGNSS

Galileo High Accuracy Service (HAS) delivers horizontal accuracy down to 20 cm and vertical accuracy of 40 cm, which is crucial for precise positioning and guidance in agricultural practices such as planting seeds, applying fertilisers and pesticides, and harvesting crops. **Farmers can leverage this accuracy to minimise overlaps, reduce costs and maximise productivity.**

The **Open Service Navigation Message Authentication (OSNMA)** is a security feature that allows users to verify that GNSS navigation messages are genuine and have not been tampered with. This ensures that farmers can rely on the GNSS signals for accurate navigation and positioning, enhancing safety and preventing disruptions in operations.

These Galileo-specific differentiators make the system suitable for various agricultural activities, empowering farmers with **accurate positioning, reliable signals and enhanced capabilities for optimal decision-making and efficiency.**



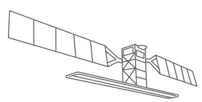
Current and future use of Copernicus

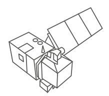
Copernicus Sentinel-1 and Sentinel-2 have changed the agricultural sector, **providing world-class data in a free and open manner for multiple agricultural applications.**

A host of innovative companies are **making use of Sentinel data** to provide variable rate application, CAP monitoring and carbon content assessment services.

Additional products from the Copernicus Land Monitoring Service (CLMS) (e.g. land use/land cover and various indices) as well as products from the Copernicus Climate Change Service (C3S) (e.g. temperature and precipitation) also contribute to agricultural activities. The Copernicus Emergency Management Service (CEMS) provides early-warning information for climate-related risks affecting agriculture such as droughts or floods.

Land (CLMS) | **Climate Change** (C3S) | **Emergency** (CEMS)


Sentinel-1


Sentinel-2

Horizon Europe, a programme of the European Union

HASHTAG

The HASHTAG Project (High Accuracy Service Harnessed Trusted Application and Governance) aims to make satellite-based data from Galileo and Copernicus more trustworthy, accurate and standardised for use in precision agriculture.

The project focuses on three pillars: verifying machine operation data, standardising the processing of EO imagery into reliable farm maps, and using Galileo's High Accuracy Service (HAS) with navigation authentication (OS-NMA) to ensure precise, secure positioning. Together, these create a transparent and verifiable chain of data, from satellite observation to on-field action.

Horizon Europe, a programme of the European Union

KijaniSpace

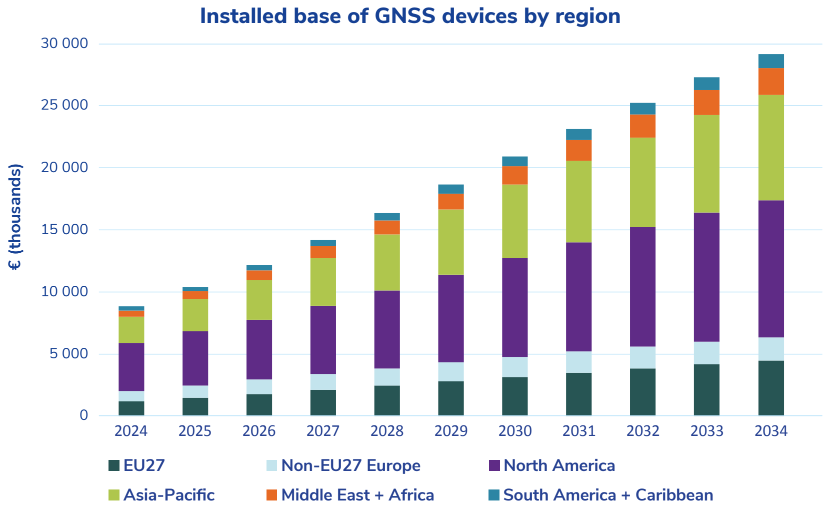
KijaniSpace (named from the Swahili word for 'green') connects African and European partners to promote climate-smart agriculture and aquaculture around the Lake Victoria Basin. It integrates Copernicus EO data with IoT sensors to help smallholder farmers and fishers make data-driven decisions on irrigation, soil health and water quality.

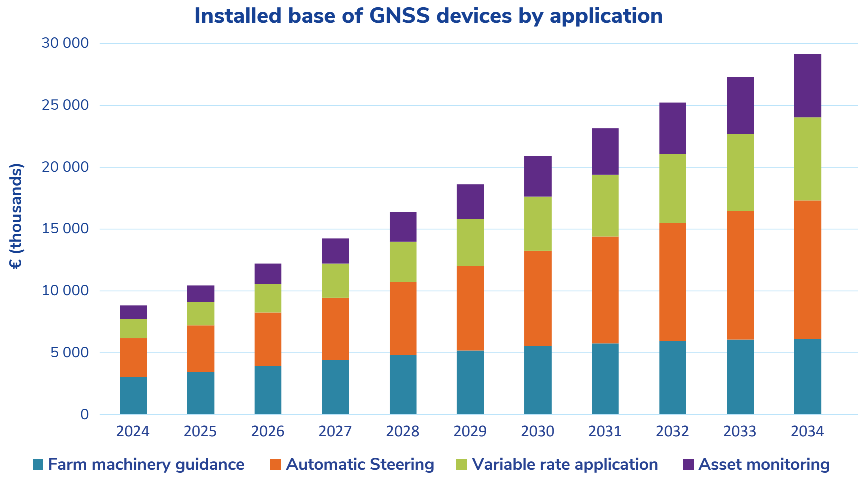
At the heart of the project is the "KijaniBox", a Space-IoT solution that combines satellite and local sensor data to deliver real-time insights. The project also runs training and innovation programmes to build technical capacity and support startups developing agricultural IoT tools.

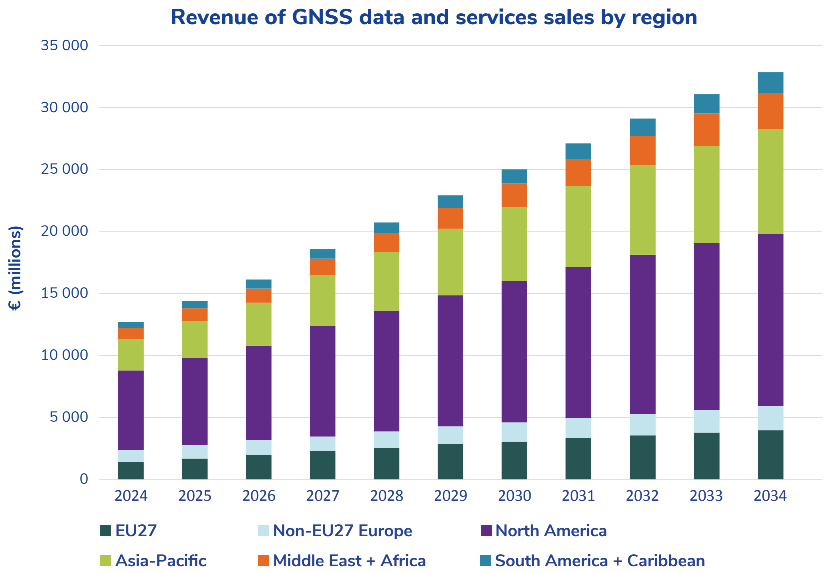
Horizon Europe, a programme of the European Union

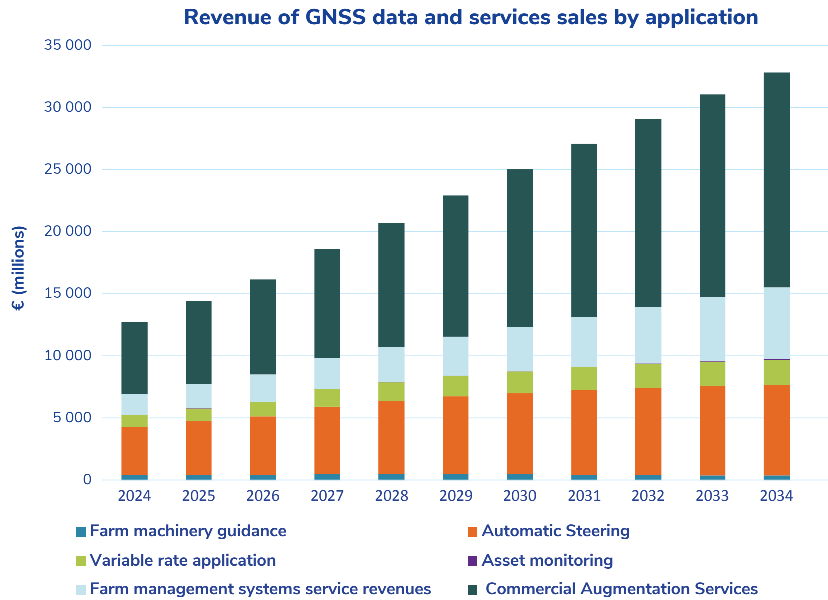
SQAT

SQAT improves access to high-quality soil data to make farming more efficient, productive and profitable. By combining advanced technologies – including Copernicus and Galileo satellite data – it ensures accurate, cost-effective and high-resolution soil insights. The project uses this novel data to power new precision agriculture applications and bring innovative solutions to market.

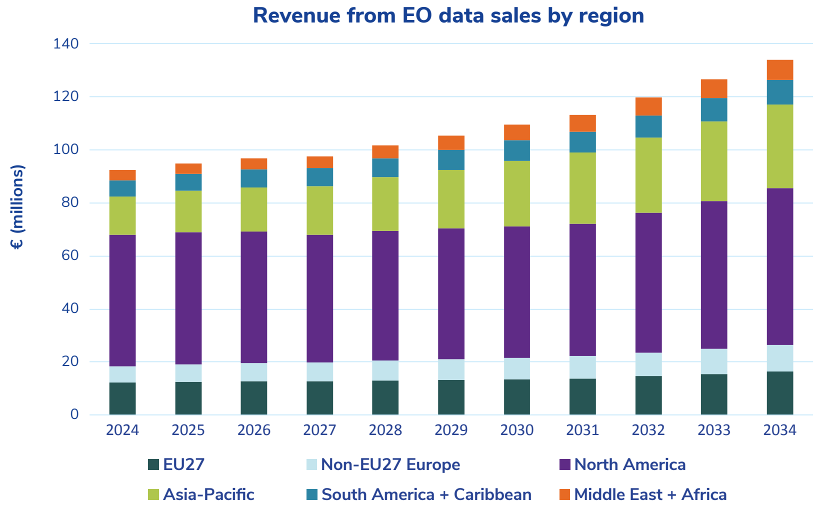


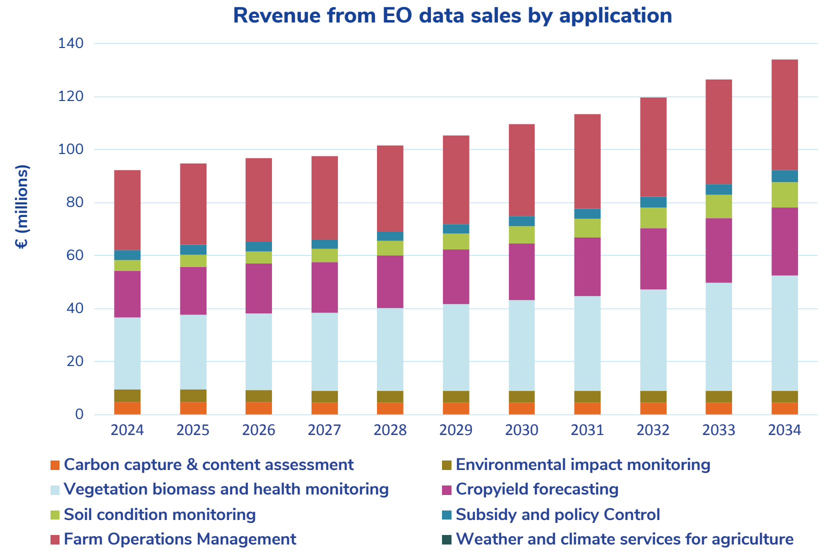


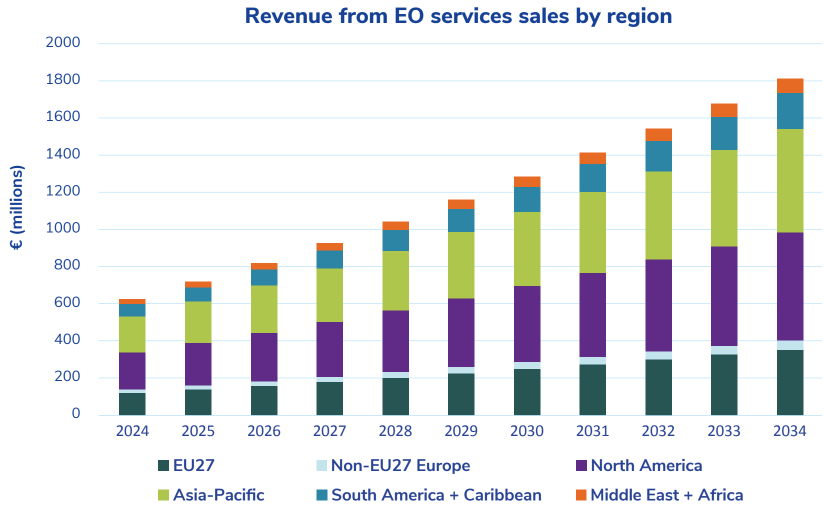


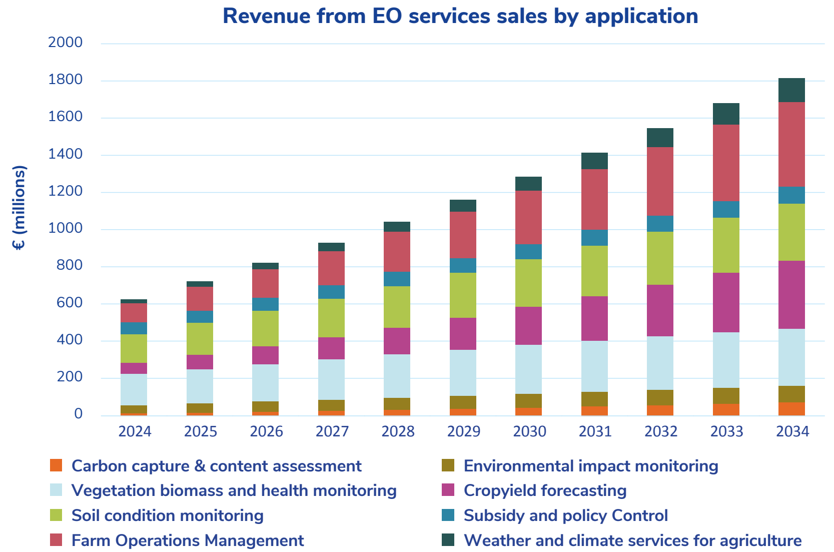


Commercial Augmentation Services only include revenue from applications in Agriculture. Commercial Augmentation Services from applications in Infrastructure, Energy and Raw Materials and Urban Development and Cultural Heritage segments are captured in the chart for Urban Development and Cultural Heritage.
Farm management systems service revenues and variable rate application are quantified together under the bundled application, Farm Operations Management, in EO charts. Under GNSS, they are quantified separately.


Revenue from EO data sales by region
140
120
100
80
60
40
20
0
€ (millions)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
140
120
100
80
60
40
20
0
€ (millions)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Carbon capture & content assessment
Environmental impact monitoring
Vegetation biomass and health monitoring
Cropyield forecasting
Soil condition monitoring
Subsidy and policy Control
Farm Operations Management
Weather and climate services for agriculture


Revenue from EO services sales by region
2000
1800
1600
1400
1200
1000
800
600
400
200
0
€ (millions)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa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€ (millions)
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2033
2034
Carbon capture & content assessment
Environmental impact monitoring
Vegetation biomass and health monitoring
Cropyield forecasting
Soil condition monitoring
Subsidy and policy Control
Farm Operations Management
Weather and climate services for agriculture

© unsplash

AVIATION AND DRONES

Communication
- ATM system timing

Climate change mitigation, environmental impact and hazards
- Aircraft emission measurement and monitoring
- Particulate matter monitoring
- Hazardous weather identification

Navigation
- Drone navigation (uncertified)*
- Performance Based Navigation (PBN)
- Performance Based Navigation (PBN) for drones*
- VFR[1] complement

Operations management
- Aircraft maintenance and operations optimisation
- Airport capacity and safety
- Drone operations planning*
- Monitoring terrain obstacles
- U-space services*

Surveillance
- Electronic conspicuity (certified)*
- Electronic conspicuity (uncertified)*
- GADSS[2]
- Infrastructure timing

- **GNSS application**
- **EO application**
- **Synergetic application** (combined use of EO and GNSS)

* Applies also (or exclusively) to drones

Application descriptions can be found in Annex 3.

1: Visual Flight Rules
2: Global Aeronautical Distress & Safety System

AVIATION AND DRONES

Aviation has long been a mature and pioneering user of GNSS technologies, which have enabled sustained growth in air traffic and enhanced connectivity across all regions of the world. As the sector continues to evolve, the reliance on GNSS has deepened, prompting ongoing evaluations and upgrades to ensure that performance standards meet the needs of both traditional users and emerging segments such as drones, Innovative Air Mobility (IAM) and Higher Airspace Operations (HAO).

Today, GNSS is indispensable within aviation, underpinning all facets of the industry – from Performance Based Navigation and flight planning to operations, airspace design, and the provision of services to airlines, pilots, airports, and Air Navigation Service Providers (ANSPs). However, the recent sharp increase of radio-frequency interference (RFI) of malicious origin presents a significant challenge to the safe and reliable use of GNSS. Addressing these threats is essential to maintaining the safety and integrity of aviation operations.

To enhance system resilience, at European level, solutions such as the operationalisation of Galileo OSNMA and the standardisation of Dual Frequency Multi Constellation (DFMC) receivers are being implemented. International bodies including ICAO, in coordination with industry groups, such as EUROCAE and RTCA, are leading the development and harmonisation of new standards, with a particular focus on DFMC, Galileo OSNMA and SBAS authentication technologies to further strengthen GNSS robustness given its critical role in aviation.

Satellite EO data is supporting both manned and unmanned aviation. Global terrain models and volcanic ash warnings have operational uses in manned aviation. Very high-resolution imagery elevation models help with airport and obstacle mapping, Flight Procedure and U-space services. EO helps understand and mitigate the impact of aviation on climate change (contrails), the environment (air quality and noise), and the impact of natural hazards on aviation.

Satellite EO helps transform census data into a fine-scale population density grid. The pan-European Copernicus GHSL-POP population map is now the recommended source for ground risk assessment in Specific Operations Risk Assessment (SORA) 2.5 for unmanned operations.

Note: the sub-segment aviation is showcased with a **plane icon**, while the sub-segment drones is showcased with a **drone icon**.

What you will find in this chapter

- **Key trends:** GNSS resilience and U-space development, key pillars for enhancing safety, performance and innovation.
- **Industry:** Aviation and drones value GNSS and EO chains.
- **Recent developments:** The growing role of EGNSS and EO in aviation
- **Future market evolution:** Copernicus and SATCOM bridging the gap in search for reliable and cost-effective tools.
- **European systems:** EGNSS and Copernicus enhancing operational effectiveness.
- **European projects:** Research and innovation projects in the aviation and drones segment.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues by application and region.

GNSS resilience and U-space deployment - key pillars for enhancing safety, performance, and innovation

Key market trends

- Improving GNSS resilience has become a key priority in response to increasing Radio-Frequency Interference (RFI).
- Push for Dual Frequency and Multi-Constellation (DFMC), a mean to increase robustness and resilience
- U-space: key stakeholders, Common Information Service Providers (CISPs) and U-space Service Providers (USSPs) are entering the scene.

Mitigating Radio-Frequency Interference: Safeguarding GNSS Resilience in Aviation

The **Radio-Frequency Interference (RFI)** has been on the rise in recent years, leading to **a 220% increase** of GNSS signal loss events due to spoofing or jamming between 2021 and 2024, according to IATA's data. While RFI negatively influences both manned and unmanned aviation, the manned aviation currently faces higher **safety risks** caused by these effects **across all communication, navigation and surveillance (CNS)** elements – Performance-based navigation (PBN), Automatic Dependent Surveillance – Broadcast (ADS-B) or Controller-Pilot Data Link Communication (CPDLC).

According to Eurocontrol, the GNSS disruptions cause cascading effects leading **to inaccurate positioning, loss of communication and potentially dangerous situations**. These effects are further compounded by system reliance on GNSS for essential functions, such as Flight Management System (FMS) navigation, guidance and terrain avoidance provided by Terrain Awareness Warning System/European Ground Proximity Warning System (TAWS/EGPWS), forcing pilots to fly less efficient routes or divert to other airports, or even causing uncoordinated high rates of climb in response to false terrain warnings generated by disrupted data. The increasing frequency of RFI events might delay the transition to PBN. The aviation industry is addressing RFI through coordinated actions at operational, regulatory, and technical levels. In the short-term mitigation, efforts focus on detection, reporting, and operational resilience. Eurocontrol provides RFI monitoring through the GNSS RFI Monitoring Tool.

In the medium to long-term mitigation, the most promising measures aim to reduce dependence on GNSS-only navigation and improve the system robustness. This includes the introduction of SBAS authentication, the accelerated adoption of Galileo Open Service Navigation Message Authentication (OSNMA), the introduction of Dual-Frequency Multi-Constellation (DFMC), the development of interference-resistant receivers and antennas, as well as the utilisation of signals of opportunity and other Positioning, Navigation, and Timing (PNT) means. ICAO has already adopted the amendment of Annex 10 to include SBAS authentication, and OSNMA will be complementary to the solution.

U-space Implementation in Europe: Progress, Challenges, and the Road Ahead

U-space is a European framework of digital services and rules enabling safe and coordinated drone operations in shared airspace, especially over cities and densely populated areas.

The **U-space EU regulation (EU) 2021/664**, which has been in force for several years, is starting to be implemented by Member States, including **designating and certifying** Common Information Service Providers (**CISPs**) and U-space Service Providers (**USSPs**). In 2025, several providers received certifications from their national authorities. The Innov'ATM (France), d-Flight (Italy) and ANRA (certified by EASA) were certified as USSPs, while Poland, Portugal, Romania, Spain and the Netherlands designated their ANSPs to become CISPs.

Naturally, the U-space roll-out builds on existing service providers and therefore the only **U-space** in accordance with Regulation (EU) 2021/664 was **designated** in **Italian FIR** by AIRAC Amendment as Restricted area LI R700 San Salvo U-space.

SESAR JU has invested heavily in U-space development by co-funding demonstrator and R&D projects such as **U-ELCOME**, **BURDI** and **ÉALÚ-AER**. These initiatives have advanced U-space deployment and interoperability across Europe, including initial operational implementation in several countries, cross-border reference design, and Ireland's first Digital Sky Demonstrator integrating drones with traditional air traffic control. **Standardisation** activities are also progressing; **Eurocae WG 105 SG 3 UTM** published a draft of ED-339 NID Data Exchange ICD for indirect exchanges between USSPs, and between USSPs and Authorised Users.

Despite these efforts, the U-space **progress has been slower** than expected. This is because **regulators** have **limited capacity** and often choose between processing BVLOS approvals or advancing U-space implementation, as they cannot address both simultaneously. Member States still **disagree** on **how data should be shared** between CISPs and USSPs, and although EUROCAE is addressing this issue, **finding a consensus is slow**.

Push for Dual Frequency and Multi-Constellation (DFMC)

The implementation of EGNOS V3 is making significant progress, with Airbus conducting highly promising tests that demonstrated excellent vertical positioning performance. Beyond these achievements, the introduction of Dual-Frequency Multi-Constellation (DFMC) capabilities will greatly enhance the reliability, robustness and resilience of GNSS-based navigation. This improvement is being driven by several key developments, all of which are advancing well in terms of standardisation. The deployment of the ARAIM (Advanced Receiver Autonomous Integrity Monitoring) concept, increases robustness and redundancy by enabling multi-constellation integrity monitoring supported by integrity support data that can be enhanced by the provision of a constellation specific Integrity Support Message (ISM). Standardisation efforts are on track, and horizontal ARAIM (H-ARAIM) is expected to meet the requirements for RNP0.3 and non-precision approaches. ICAO Amendment 94 to Annex 10, Volume I, which incorporates ARAIM Standards and Recommended Practices (SARPs) for horizontal navigation is applicable since November 2025. Vertical ARAIM (V-ARAIM) is the subsequent step to be standardised, and is expected to be incorporated in Annex 10, Volume I by 2032 targeting support of the requirements for ILS CAT I and LPV-200 precision approaches. The Minimum Operational Performance Standards (MOPS) for DFMC SBAS airborne equipment (ED-259A/DO-401) are currently being updated to include features such as OSNMA and H-ARAIM (Horizontal-ARAIM), with publication targeted for June 2027. Lastly, DFMC GBAS standards are also under development, with readiness of validated standards by ICAO expected by 2030. The new DFMC GBAS-based service, known as GAST E, will specifically increase service availability even under severe ionospheric conditions.

Aviation and drones GNSS value chain[1]

European[2] GNSS industry in the global arena

European and North American organisations dominated the manufacturing of aviation GNSS receivers in 2025 with North American receiver suppliers accounting for more than three quarters of the market and European suppliers around a sixth of the market.[3]

LEGEND

Drones

Manned Aviation

COMPONENT AND RECEIVER MANUFACTURERS

Drones:

- ADVANTECH
- ANTCOM CORP
- AUTERION
- BEIJING UNISTRONG SCIENCE &
- TECHNOLOGY
- COMNAV TECHNOLOGY
- CUBEPILOT
- DJI
- FLIR
- GMV*
- GREMSY
- HERE TECHNOLOGIES*
- HEXAGON AB*
- INFINEON*
- INVOLI* **
- MICROCHIP TECHNOLOGY
- MICROPILOT
- NOVATEL
- PIXHAWK
- QIANXUN SPATIAL INTELLIGENCE
- XEXAGON*
- SHANGHAI HUACE NAVIGATION
- TECHNOLOGY
- T-MOTOR
- TRIMBLE NAVIGATION
- U-BLOX*
- VECTORNAV TECHNOLOGIES

Manned Aviation:

- AEROANTENNA TECHNOLOGY
- AVIDYNE
- BEIJING BDSTAR NAVIGATION
- CADENCE DESIGN SYSTEMS
- CHCNAV
- COBHAM*
- COLLINS AEROSPACE
- GARMIN
- HONEYWELL
- LEONARDO*
- MERCURY SYSTEMS
- NORTHROP GRUMMAN
- NUVOTON
- RTX
- SABCA
- SAFRAN*
- SBG SYSTEMS*
- SENSOR SYSTEMS
- STMICROELECTRONICS
- THALES AVIONICS*
- TRANSDIGM GROUP
- TRIG AVIONICS*
- UAVIONIX
- UNIVERSAL AVIONICS SYSTEMS

AIRCRAFT & DRONE MANUFACTURERS & SYSTEM INTEGRATORS

Drones:

FIXED WING
- AEROVIRONMENT, AGEAGLE AEROSPACE COMMUNICATIONS*, ATMOS*, AUTEL ROBOTICS, AVIATION INDUSTRY CORP. OF CHINA, AVY*, BAYKAR TECHNOLOGIES, CHINA AEROSPACE SCIENCE & TECH CORP., DELAIR*, DJI, ELBIT SYSTEMS, ETRA AIR*, GENERAL ATOMICS AERONAUTICAL SYSTEMS, ISRAEL AEROSPACE INDUSTRIES, NORTHROP GRUMMAN, WINGTRA, ZIPLINE;

MULTI-ROTOR
- AGEAGLE AEROSPACE COMMUNICATIONS*, AMUSE ONESELF, AUTEL ROBOTICS, DJI, EHANG, ETRA AIR*, FLYING BASKET*, HITACHI, HOLY STONE, HUBSAN, PRECISIONHAWK, SKYDIO, SYMA, WALKERA, YUNEEC;

SINGLE ROTOR
- AEROSCOUT*, ALPHA UNMANNED SYTEMS*, BABCOCK*, DRAGONFLY PICTURES, SCHIEBEL*, STEADICOPTER, SWISSDRONES*, UMS SKELDAR*, YAMAHA MOTOR;

VTOL FIXED WING
- AEROVIRONMENT, ALTI UAS, HI-TARGET SURVEZING INSTRUMENT, ISRAEL AEROSPACE INDUSTRIES, MANNA*, NORTHROP GRUMMAN, QUANTUM SYSTEMS*, RIGITECH, SCHIEBEL, UKREPECSYSTEMS, UMS SKELDAR*, WING, WINGTRA*;

IAM
- ARCHER AVIATION, AUTOFLIGHT, BETA TECHNOLOGIES, EHANG, EVE AIR MOBILITY, HYUNDAI, JOBY AVIATION, SKYDRIVE, VERTICAL AEROSPACE, VOLOCOPTER*, WISK

Manned Aviation:

COMMERCIAL AIRCRAFT MANUFACTURERS
- AIRBUS*
- BOEING
- BOMBARDIER
- COMAC
- EMBRAER
- MITSUBISHI HEAVY INDUSTRIES
- SAAB AB*
- TEXTRON
- VULCANAIR*

BUSINESS, ROTORCRAFT AND GENERAL AVIATION MANUFACTURERS
- BEECHCRAFT
- CESSNA
- COBHAM*
- DAHER AEROSPACE*
- DASSAULT*
- DIAMOND AIRCRAFT INDUSTRIES*
- GULFSTREAM AEROSPACE
- KAWASAKI HEAVY INDUSTRIES
- LEONARDO*
- PILATUS AIRCRAFT*
- PIAGGIO AEROSPACE*
- RTX
- UNITED AIRCRAFT CORPORATION
- VULCANAIR*

DRONE OPERATORS & AIRLINES / AIRCRAFT OWNERS AND OPERATORS

Drones:

- AERODYNE GROUP
- AMAZON PRIME AIR
- CYBERHAWK
- DELAIR*
- DJI AGRICULTURE
- DRONEUP
- EHANG
- FLYTREX
- HEMAV*
- MANNA*
- NASA
- SKYDIO
- SKYFUTURES*
- SKYPORTS*
- SWIFT NAVIGATION
- TERRA DRONE
- VOLOCOPTER*
- WING
- ZIPLINE

Manned Aviation:

MAIN AIRLINES ALLIANCES
- ONEWORLD
- SKYTEAM
- STAR ALLIANCE

USER GROUP ASSOCIATIONS
- AIRLINES FOR EUROPE (A4E)
- EUROPE AIR SPORTS
- EUROPEAN BUSINESS AVIATION ASSOCIATION (EBAA)
- EUROPEAN HELICOPTER ASSOCIATION (EHA)
- EUROPEAN REGIONS AIRLINE ASSOCIATION (ERA)
- INTERNATIONAL AIRCRAFT OWNERS AND PILOTS ASSOCIATION (IAOPA)
- INTERNATIONAL AIR CARRIER ASSOCIATION (IACA)
- INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

UTM SERVICE PROVIDERS & ATM DATA SERVICE PROVIDERS & AIR NAVIGATION SERVICE PROVIDERS & REGULATORS AND MAIN ORGANISATIONS

Drones:

- DRONE ALLIANCE EUROPE (DAE)*
- DRONEUP
- EUROCAE*
- EUROCONTROL*
- EUROPEAN UNION AVIATION SAFETY AGENCY (EASA)*
- GLOBAL UTM ASSOCIATION
- HAPS ALLIANCE
- INTERNATIONAL CIVIL AVIATION
- ORGANISATION (ICAO)
- JOINT AUTHORITIES FOR RULEMAKING ON UAS (JARUS)
- RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)
- SKYPUZZLER* **
- TERRA DRONE
- USSPS (D-FLIGHT, DRONIQ, SKYEDRONE)

Manned Aviation:

- CIVIL AIR NAVIGATION SERVICES ORGANISATION (CANSO)
- EUROPEAN UNION AVIATION SAFETY AGENCY (EASA)*
- EUROCAE*
- EUROCONTROL*
- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO)
- RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)

AERODROMES & INFRASTRUCTURE OPERATORS

Drones:

- 3L ROBOTICS* **
- AIRBUS*
- SKYPORTS*
- URBANV*
- URBAN-AIR PORT*

Manned Aviation:

- AIRPORTS COUNCIL INTERNATIONAL (ACI)
- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO)
- INTERNATIONAL AIRPORTS
- REGIONAL AIRPORTS ASSOCIATIONS

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative

3: Please refer to page 30 for a comprehensive description of value chain and how to interpret them at segment level.

Aviation and Drones EO Value Chain[1]

EO

DATA PROVIDERS → INFRASTRUCTURE PROVIDERS → PLATFORM PROVIDERS → EO PRODUCTS AND SERVICE AND INFORMATION PROVIDERS → END USERS

DATA PROVIDERS

Commercial offering:
- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- ICEYE*
- LEONARDO (E-GEOS)*
- NISAR
- JEPPESEN
- NAVBLUE
- PLANET
- SPIRE GLOBAL
- VANTOR
- XRTECH GROUP

Public offering:
- EOS-4 (ISRO)
- NISAR (NASA/ISRO)
- LANDSAT (USGS/NASA)
- NOAA and GOES (NOAA)
- RELEVANT IN-SITU NETWORKS
- RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

Commercial offering:
- AWS
- ALIBABA CLOUD
- ARUBA CLOUD*
- CLOUDFERRO*
- GOOGLE CLOUD
- IBM CLOUD
- OVH CLOUD*
- HETZNER ONLINE*
- MICROSOFT AZURE
- T-SYSTEMS*

Public offering:
- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*

PLATFORM PROVIDERS

Commercial offering:
- CREODIAS*
- GOOGLE EARTH ENGINE
- SATELLITE EARTHSTAR GEOGRAPHICS
- SENTINEL-HUB (PLANET)

Public offering:
- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- OPENEO*
- WEKEO*

EO PRODUCTS AND SERVICE AND INFORMATION PROVIDERS

Commercial offering:
- ASCENDXYZ
- BOHANNAN HUSTON
- CREOTECH INSTRUMENTS*
- DARES TECHNOLOGY*
- E-GEOS*
- EISAT IMAGENS DE SATELITE*
- FLYCOM HOLDINGS*
- LUFTHANSA SYSTEMS*
- METEOBLUE AG
- RHEA SYSTEM*
- SATAVIA
- SATELLITE IMAGING
- SATSURE
- SIGNALVOID* **
- SKYMAP GLOBAL
- VANTAGE*
- DRONEDEPLOY
- UAV NAVIGATION
- PIX4D

Public offering:
- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- NATIONAL GEOSPATIAL DATA PROVIDERS

END USERS

User segments:
- AIR NAVIGATION SERVICE PROVIDERS
- AIRLINES-AIR OPERATORS
- AIRPORT PLANNERS
- AIRPORTS
- CIVIL AVIATION AUTHORITIES
- DRONE OPERATORS
- FLIGHT PLANNERS
- INSTRUMENT FLIGHT PROCEDURE DESIGNERS
- USSPs and CISPs

LEGEND

- Commercial offering
- Public offering
- User segments

European[2] EO industry in the global arena

The value of EO for aviation and drones continues to rise, with more than 100 companies globally now active in this specialized segment (2025). Europe maintains its leadership, controlling over 70% of the market share for commercial EO offerings in the aviation and drone sectors (as of 2025). Key regional players like Leonardo (E-GEOS) and RHEA System remain dominant, collectively securing nearly half of the total global market.

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers' step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

The growing role of EGNSS and EO in aviation

GNSS authentication becomes operational

The adoption of Galileo's Open Service Navigation Message Authentication (OSNMA) for navigation data authentication due to RFI occurrences is progressing. On July 24, 2025, Galileo OSNMA transitioned from testing to operational status. ICAO recognises OSNMA as an authentication solution to strengthen GNSS system resilience and has endorsed Standards and Recommended Practices (SARPs) for GNSS navigation data authentication, with Galileo OSNMA SARPs expected to be applicable by 2029.

OSNMA is also being explored for other uses, such as in the SESAR Anysky project, which aims to enhance ADS-B data security by using OSNMA principles to mask or encrypt sensitive information. Only authorized users with proper keys could access the full data, improving confidentiality and integrity of ADS-B communications, leveraging Galileo's robust infrastructure and advanced authentication services.

Safety, climate and environment needs open opportunities for EO

Terrain, obstacles and visual navigation

A regulatory proposal is increasing the demand for country-wide, high-fidelity terrain and obstacle data to support both manned and unmanned aviation applications, including Localizer Performance with Vertical guidance (LPV) and UAS geographical-zone boundary protection. EASA Opinion N° 02/2025 proposes the provision of country-wide, terrain and obstacle data corresponding to ICAO Area2 data quality requirements. This will address concerns of rotorcraft and drone communities. EUSPA explores how free and open Copernicus DEM GLO-30 could help Member States comply. A recent EUSPA/ESSP guidance draws attention of global Flight Procedure community to Copernicus GLO-30.

Recent advances in visual relative and map matching-based positioning are seen in commercial off-the shelf drones and maturing in general aviation. These systems use onboard cameras to match real-time imagery with preloaded maps, terrain models or landmark databases, enabling reliable positioning and navigation when GNSS is degraded, denied or unavailable.

Nowcasting weather, climate resilience, mitigation and environmental impact

Recently launched MTG-I geostationary satellite can observe weather every 10 minutes at 1km resolution, while seeing lightning near real time. This improves weather nowcasting at very fine spatial scales. Short-term forecasts of events such as thunderstorms, tornadoes and flash floods enhance safety.

EUROCONTROL's FlyingGreen platform helps aviation stakeholders adopt sustainable practices. The Net-Zero pillar features emissions and comprehensive fuel burn tracking. ClimAdapt supports assessment of risks stemming from the changing climate.

While aviation greenhouse gas emissions and impact are well understood, impact and optimal mitigation of non-CO2 effects of aviation (mainly contrails) are less known. Earth observation already supports R&D on understanding of the effects, while it can support mitigation and monitoring, reporting and verification schemas.

Aviation faces a wide range of climate-related hazards, including extreme weather, heavy precipitation and coastal flooding, acute and chronic heat that can disrupt operations, reduce network capacity, and damage ground infrastructure. Earth observation enables the monitoring, understanding, modelling and forecasting of Earth system processes at global, regional and local scales. These data-driven representations – effectively digital twins of the environment – support the aviation sector in assessing risks, planning adaptation measures and improving its ability to prepare for, respond to and recover from adverse events.

PBN harmonisation and expansion across Europe

The implementation of EGNOS-based procedures is steadily expanding across Europe, especially at regional airports. As of January 2026, there were 1,163 EGNOS-based procedures available at 565 airports and helipads; including 1,053 LPV and 105 APV/Baro. Additionally, there are 5 RNP0.3 routes for rotorcraft (source: AIRAC Cycle 2602).

Recent initiatives have extended LPV procedures to general aviation aerodromes with non-instrument runways and no ATC services, enhancing accessibility and safety while minimizing infrastructure costs for smaller airports. EFLA aerodrome published the first LPV procedure to a Non-Instrument Runway End (NIRE) in Class G airspace. (source.: EFLA Aerodrome)

EGNOS continue to provide benefits in HEMS (Helicopter Emergency Medical Services) operations by facilitating the implementation of LLR (low-level routes) between hospitals, allowing operations in all weather conditions, as well as PinS (Point in Space) procedures that provide guided approaches with lower minima, granting access to isolated or urban sites (like hospital helipad) even in low cloud base conditions.

Performance-Based Navigation (PBN) development now includes the **RNP Visual Flight Procedures with Prescribed Track (RNP VPT)** concept, allowing pilots to follow highly precise trajectories even during visual approaches as defined in ICAO Circular 359, "Development of Visual Flight Procedures with Prescribed Track Based on Required Navigation Performance (RNP)". In May 2025, EASA released a Safety Information Bulletin (SIB 2025-05) with best practices, recommendations and potential risks for these procedures. Operational trials by airlines such as EasyJet, Lufthansa, Austrian Airlines, and Iberia have shown benefits like improved safety, reduced environmental impact, and economic advantages due to less training requirements. To further deploy RNP-VPT, existing RNAV and RNP visual procedures should be converted to RNP (VPT) and published by national authorities; alternatively, operators may develop their own procedures. Initial RNP VPT charts have been published in France and Spain.

Europe has prompted EASA to launch rulemaking task EASA RMT-0761 to amend Regulation (EU) 2018/1048, where the EC Decision with the final amended text of Regulation is expected by 2028.

Electronic Conspicuity: enabling airspace modernisation and enhancing safety

The Electronic Conspicuity concept allows aircraft to broadcast their position making them visible to other airspace users. It is considered one of the **key enablers of airspace modernisation** and drone integration. The Electronic Conspicuity is a prerequisite for manned aviation to operate within U-space, while drones are expected to be equipped with remote/network identification (as a minimum). EASA also recognises Electronic Conspicuity's added value to safety and is considering options for increasing equipage rate, including Automatic Dependent Surveillance – Broadcast (ADS-B) Out (1090MHz), **ADS-L (Light) SRD-860** and **ADS-L 4 MOBILE** (telephony). Furthermore, EASA launched an **ADS-L Coalition** that puts together most of major device and software manufacturers. The coalition committed to supporting future ADS-L development. **National initiatives** are also moving towards increased situational awareness. One of these initiatives includes **FOCA**, the Swiss CAA, building a fully connected airspace by 2035 through **FASST-CH [1]** project where aircraft are electronically conspicuous.

In the UK, the CAA is advancing its **Electronic Conspicuity Interoperability Test Programme** (ECITP). Stage 3 is currently ongoing and builds on outcomes of the previous stages. It focuses on four key workstreams: improving system resilience to **GNSS interference**, developing tools and processes to assess ADS-B performance, enhancing situational awareness through Traffic Information Service – Broadcast (**TIS-B**) and introducing an **Air Traffic Density Analysis Tool** to support future surveillance and airspace modernisation efforts. More information about FASST-CH.

Copernicus and SATCOM bridging the gap in search for reliable and cost-effective tools

Higher Airspace Operations: Regulatory Framework and Integration Challenges Above Commercial Flight Levels

Higher Airspace Operations (HAO) refer to a new form of air transport conducted by various aircraft and vehicle systems in the airspace above current commercial flight levels (above FL 550/FL600) and below the Kármán line (100 km above sea level).

As these operations expand, they introduce safety, security, and environmental challenges that must be managed to ensure safe, secure, and sustainable air transport within the EU. To address these concerns, the European Commission mandated EASA in November 2024 to develop a comprehensive regulatory framework for HAO. This framework will support the integration of emerging aviation activities in higher airspace, considering ongoing initiatives such as JARUS for regulation, SESAR ECHO2 (European Concept for Higher Altitude Operations Phase 2) for the concept of operations, and the European Defence Agency's study on military impacts and civil-military coordination.

Prior to finalising this framework, further research is needed to understand operator needs regarding traffic management, communications, navigation, surveillance (CNS), meteorological (MET) and space weather services in the targeted altitude range. EASA and SESAR have launched complementary projects to address these issues (respectively "Initial study on CNS civil needs and capacities in HAO, incl. spectrum needs" and SCAN). Given the limitations of ground-based systems at high altitudes, satellite services offer a solution to bridge existing and future capability gaps across atmospheric layers, including the troposphere, stratosphere, and mesosphere.

The SORA 2.5 emerging, GRC guidance builds on Copernicus

Specific Operations Risk Assessment (SORA) is a standardised risk assessment methodology used in drone operations to evaluate safety risks and define mitigation measures for specific missions.

In September 2025, EASA published ED Decision 2025/018/R, updating the AMC and GM to Commission Implementing Regulation (EU) 2019/947 for Unmanned Aircraft Systems (UAS). The decision introduces the latest SORA 2.5 package, which replaces the previous SORA 2.0 framework. The updated version is intended to simplify the risk assessment process and increase harmonisation in regulatory implementation, while still allowing operators the flexibility to use either SORA 2.0 or 2.5 for their risk assessments.

SORA 2.5 introduces specific updates for drones operating in EASA specific category, including revised ground risk mitigations, updated Operational Safety Objectives (OSOs), and modified criteria for ground risk adjacent areas.

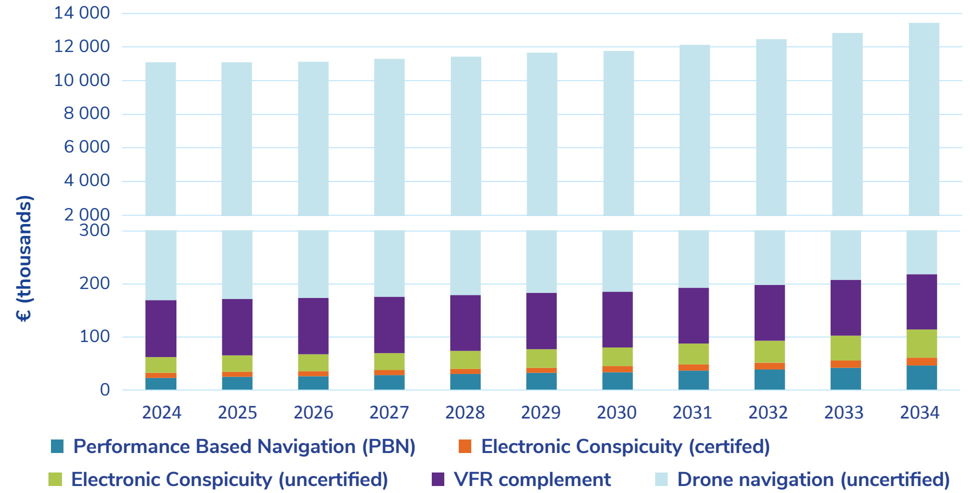
In addition, Copernicus GHSL datasets have been integrated into SORA 2.5 following cooperation between EASA and EUSPA, and these datasets have been available in EASA's Innovative Air Mobility Hub since late 2024. EASA Guidelines for Static population density [1] were published based on these datasets. EUSPA continues supporting UAS standardisation through EUROCAE WG-105 SG6. Recent work has concentrated on the Guidelines for multi-GNSS solutions for UAS – Medium Risk, with publication planned for the first quarter of 2026. These guidelines currently address airspace risk for drone operations. More information about static population density guidelines is available at: **Population density in EASA Member States - Exploring population density in your country | EASA**

The market share remains consistent with previous market studies as shipments of **uncertified** GNSS devices supporting **drone navigation** continue to **dominate** sales within the aviation and drone sector. Overall, GNSS devices are projected to reach **higher annual sales growth** than previously forecast. The market continues to be driven by uncertified solutions as the regulatory compliance is more achievable, while manned aviation continues to grow at a slower pace than unmanned industry due to high regulatory demands.

In the following years, further growth depends heavily on **regulatory enablers** which have **not** advanced **as quickly as the technology enablers**. Therefore, the forecasts remain conservative, especially for the 2026-2028 period.

The market for **uncertified electronic conspicuity** devices is expected to grow rapidly after 2030, mainly due to the implementation of **U-space**, although the timeline is longer than initially foreseen. Furthermore, the adoption of EASA's **ADS-L concept** is expected to support the widespread use of electronic conspicuity devices.

Shipments of GNSS devices by application



SATCOM services: Enabling Safe and Scalable BVLOS Drone Operations

The outlook for SATCOM services, including Secure SATCOM, in drone operations is driven by the growing need for reliable, long-range communication to support beyond-visual-line-of-sight (BVLOS) missions in sectors like logistics, surveillance and disaster response. Advances in satellite technology, particularly with high-throughput and low-Earth orbit (LEO) satellites, are expanding coverage, increasing bandwidth and reducing latency, making SATCOM increasingly accessible and effective for both commercial and governmental drone applications. As regulatory frameworks evolve and hardware becomes more compact and affordable (e.g. IRIS²), SATCOM is set to become a critical enabler for safe, autonomous and large-scale drone operations worldwide.

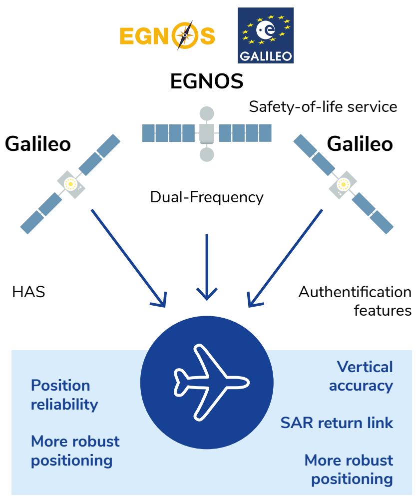
EGNSS and Copernicus enhancing operational effectiveness

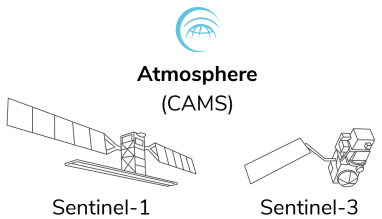
EGNSS for manned aviation

EGNSS with EGNOS enables LPV-200 approach procedures, with minima comparable to traditional Instrument Landing System (ILS) CAT I operations, but without the need for expensive ground-based infrastructure. The coverage and adoption of EGNSS with EGNOS continue to grow across Europe. An increasing number of general aviation aerodromes and helipads – including those located in rural, remote, mountainous and island regions – now benefit from safe, reliable and cost-effective approach procedures enabled by EGNSS with EGNOS. This enhanced accessibility comes with significant reductions in infrastructure costs, as small- and medium-sized airports can now offer precision approach capabilities without the need to install and maintain costly Instrument Landing Systems. The main purpose of EGNOS is to become the main navigation means for CAT I operations by 2030 as per PBN IR. However, it must be noted that there is an on-going EASA rulemaking task (EASA RMT-0761) to amend Regulation (EU) 2018/1048.

Galileo SAR for manned aviation

The SAR/Galileo Return Link Service (RLS) is operational since early 2020 for the initial services, i.e. Acknowledgement Type 1, which provide an automatic acknowledgement message informing the beacon user their request for help has been received and their position computed. Since 2024, the SAR service has reached Full Operational Capability (FOC), With FOC, SAR users benefit from improved response times, reliability and expanded geographic reach, ultimately increasing safety and efficiency in distress situations.





EGNSS for drones

HAS provides free-of-charge, high-accuracy **Precise Point Positioning** corrections up to decimetre level through the Galileo signal (E6-B) and by terrestrial means (Internet). High-performance positioning systems for drones are being tested in the framework of European projects, within the U-space framework focusing on Very Low Level (VLL) and drone operations.

The Galileo High Accuracy Service is evolving from pilot trials into fully operational workflows, supporting advanced drone applications such as BVLOS corridors, precision landing and automated docking – enabling the scale-up of autonomous operations. The Q2 2025 Performance Report can be found via this link.

To address any issues with **spoofing** and ensure the trustworthiness of information received from Galileo satellites, Galileo has developed **OSNMA**, a freely accessible **data authentication function** for Galileo Open Service users worldwide. This provides a level of security that protects against spoofing and ensures that the positioning data is reliable and based on known source data. The OSNMA, in combination with other technologies, can support **U-space services** and IAM operations enabled by EGNSS by providing signal authentication, which is especially useful where the Conformance Monitoring Service is provided.

Terminology used on this page is explained in Annex 2 for both GNSS and EO performance parameters.

Copernicus for manned aviation

Copernicus Atmosphere Monitoring Service (CAMS) provides observations and forecasts of atmospheric composition. These are a key input for Volcanic Ash Advisory Centres (VAAC) centres in delivering warnings and forecasts of volcanic emissions of ash and reactive gases. While high concentrations of volcanic ash present acute danger, long-term exposure to particulate matter and reactive gases affect engines, fuselages and other systems in a more subtle manner.

Airports and surrounding communities are concerned with the **impact of aviation on local air quality**. CAMS, C3S ERA-5, CLMS, Copernicus in-situ data are inputs for urban scale air quality models. The Copernicus global population density map helps track exposure of people to air pollution and noise. EUSPA Copernicus demonstrator by S&T showcased the possibilities of air quality modelling around airports.

Copernicus helps aviation **adapt to climate change** by providing operational Earth observation data to anticipate and manage climate hazards identified in the European platform ClimAdapt. CAMS delivers forecasts of wildfire smoke, dust, volcanic ash and air quality that affect flight safety and capacity. The Climate Change Service (C3S) provides long-term indicators such as trends in extreme temperatures, winds and precipitation to support risk assessment, infrastructure design and performance planning. The Emergency Management Service (EMS) supplies rapid mapping of floods and wildfires affecting airports and navigation sites. In addition, satellite-derived elevation, land cover, snow and coastal data support analysis of flooding, heat exposure, ground stability and sea-level rise, enabling more resilient operations and investment planning.

Copernicus for drones

As a result of EUSPA's efforts, drone operators across Europe have successfully integrated Copernicus GHSL and Copernicus Land Monitoring Service (CLMS) land use and cover data into their drone software for operational management and mission planning. This was achieved through demonstration projects in which operators were actively supported. Local authorities responsible for SORA assessments and mission approvals were also involved.

Up-to-date satellite imagery from the Copernicus Emergency Management Service (CEMS), together with on-demand mapping services, is used by drone operators to support multiple aspects of disaster management, including preparedness, response and recovery.

Historical weather data from the Copernicus Climate Change Service (C3S) supports strategic flight planning, while land use and land cover information from CLMS helps operators assess the ground risk of their operations. A key advantage of Copernicus datasets is their free availability, global or pan-European coverage, supported by open specifications and consistent resolution, enabling trusted and harmonised assessments across Europe.

The Copernicus Digital Elevation Model further supports mission planning by providing terrain information for low-altitude flights, allowing operators to visualise flight elevation profiles and maintain safe separation from terrain.

Research and innovation projects in the aviation and drones segment

CNS DSP 0466 Real Time GNSS Monitoring and Interference

The CNS DSP 'Real Time GNSS Monitoring and Interference is one of the three solutions proposed by the CNS DSP SESAR project. This solution aims to provide GNSS-related added-value navigation services to aviation and non-aviation stakeholders via a dedicated digital platform. These GNSS-related services are designed to monitor satellite-signal performance and position integrity while detecting potential interference, supporting the reliable use of performance-based navigation across different phases of flight. By combining data streams from GNSS signals and sentinel sensors, the system provides real-time and offline status information for specific areas or routes and incorporates an advanced A-RAIM capability to estimate protection levels based on constellation geometry and signal quality. Services are delivered through API and SWIM interfaces connected to a central platform and aligned with ICAO guidance on GNSS monitoring and Receiver Autonomous Integrity Monitoring (RAIM) usage. Building on the foundations of the BLUEGNSS project, the solution extends monitoring and integrity capabilities to a broad range of users – from airlines to drone operators – enhancing situational awareness, improving operational decision-making and supporting the development of a more resilient and efficient navigation service.

Galileo Authentication and GNSS/INS platforms for Secure and Safe services In Air Navigation and mobility (GAUSSIAN)

GAUSSIAN (Galileo Authentication and GNSS/INS platforms for Secure and Safe services In Air Navigation and mobility) is a project focused on enhancing security for Urban Air Mobility (UAM) by developing a compact navigation system powered by authenticated Galileo signals. It combines GNSS and inertial navigation (INS) to protect against spoofing and improve accuracy using Galileo's High Accuracy Service (HAS).

The project, involving leading European companies and experts, plans flight demonstrations in Italy and Austria and aims to introduce innovative features for future air mobility products. GAUSSIAN's goals include improving positioning accuracy, showcasing an integrated avionic prototype, and optimizing system size, weight, power, and cost (SWaP-C) for market readiness. The project envisions a future where urban air transport is efficient, sustainable, and seamlessly integrated, helping reduce congestion and pollution.

E-contrail project (SESAR)

The overall purpose of the E-CONTRAIL project is to develop artificial neural networks for the prediction of the climate impact derived from contrails and aviation-induced cloudiness, contributing to a better understanding of the non-CO2 impact of aviation on global warming and reducing their associated uncertainties. The AI model, trained using historical data, including satellite observations (like existing MSG – SEVIRI, with the plan to move to MTG images), weather, and aerial traffic, offers real-time contrail predictions to help mitigate the environmental impact of aviation. The tool is intended for use by a range of ATM stakeholders – primarily flight dispatchers and airlines, Air Navigation Service Providers and the Network Manager – to support better-informed decisions on flight path and airspace management, with the aim of reducing the environmental footprint of aviation.

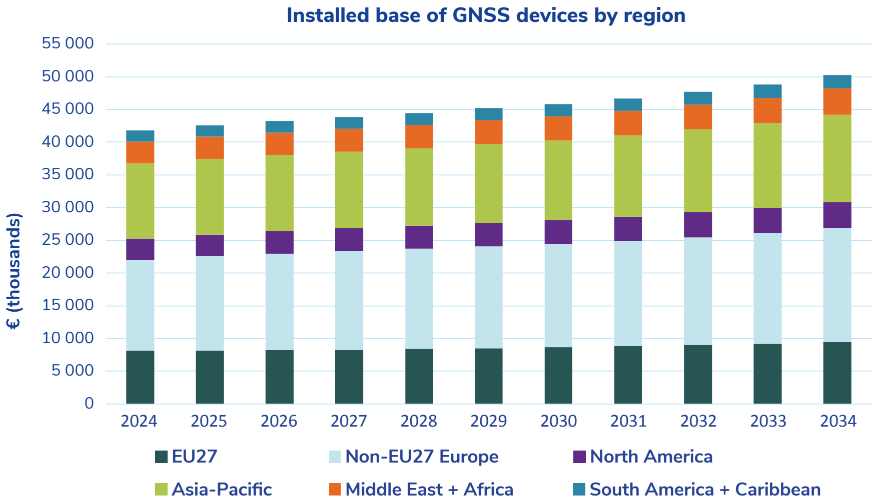
ANCEN (NONCO2): Aviation Non-CO2 Experts Network

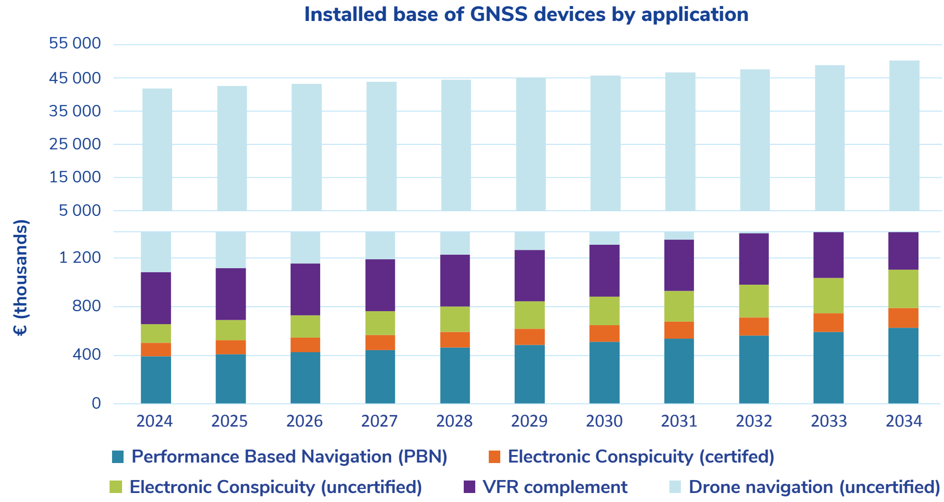
The EASA ANCEN Expert Network is a collaborative group established by the European Union Aviation Safety Agency (EASA) to coordinate and advance research and policy on air-quality impacts and non-CO_2 climate effects of aviation, such as NO_x emissions, particulates, and contrails. This expert network brings together specialists from various fields—including atmospheric science, aviation engineering, environmental policy, and industry stakeholders.

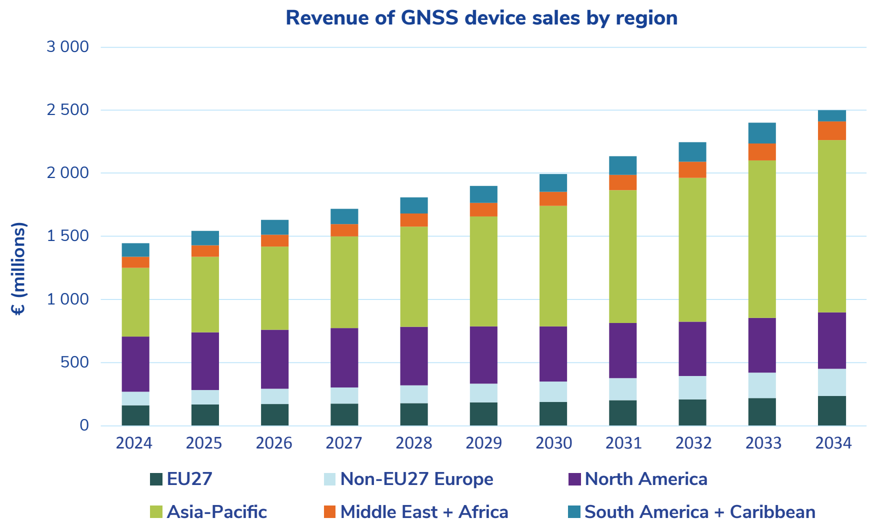
MUSE – Measuring U-space Social and Environmental Impact

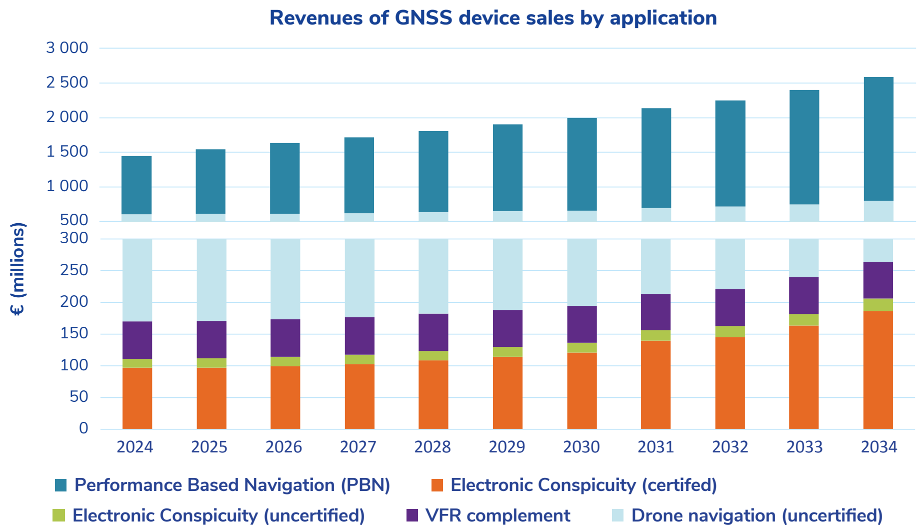
The development of U-space is expected to unlock the full potential of the drone economy and enable large-scale **urban air mobility** (UAM). Its success will depend not only on technological and regulatory progress, but also on societal acceptance. To support environmentally sustainable and socially acceptable UAM operations, the solution provides a dedicated U-space framework enabling **USSPs and operators to quantify and assess the social and environmental externalities of drone operations**. It includes a performance framework with indicators for noise and visual pollution based on population characteristics, a decision-support framework combining advanced noise-modelling, dynamic population mapping and an interactive visualisation tool, and a set of recommendations guiding stakeholders on how to minimise the environmental impact of different UAM operational concepts.

EO data, combined with **mobile phone** data, were used to determine ground-level population density. This information was subsequently applied to assess the societal impacts of drone operations, including noise and visual pollution.









GADSS Aircraft Tracking will either use the GNSS receiver quantified under Performance Based Navigation, or Electronic Conspicuity – certified.
The model does not include any Innovative Air Mobility (IAM) applications (e.g. drone package delivery or Advanced Air Mobility).

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CLIMATE, ENVIRONMENT AND BIODIVERSITY

Biodiversity, ecosystems and natural capital

- Animal tracking for biodiversity purposes
- Ecosystems monitoring

Climate services

- Climate change mitigation and adaptation
- Climate monitoring and forecasting
- EO-based climate modelling
- GNSS-based climate modelling

Environmental monitoring

- Environmental auditing
- Environmental impact assessment and ESG
- Environmental resource management

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

CLIMATE, ENVIRONMENT AND BIODIVERSITY

The accelerating impacts of climate change, environmental degradation and biodiversity loss are fundamentally reshaping the demand for environmental intelligence. Earth Observation (EO) data has evolved from a scientific and public-policy tool into a core enabler of climate resilience, environmental regulation and biodiversity protection. EO has long supported environmental resource management across land, water, oceans, atmosphere and coastal zones. Today, it also underpins environmental impact assessments, environmental auditing and ESG reporting, as regulatory frameworks increasingly require measurable, auditable and repeatable data to assess human pressures on natural systems

Climate services represent one of the fastest-growing areas of EO use. While public authorities and environmental agencies remain key users, demand is rapidly expanding among insurers, financial institutions, corporates, NGOs and infrastructure operators. EO plays a major role in climate monitoring, forecasting and modelling, as well as in climate change mitigation and adaptation. Satellite-based observations provide independent evidence on greenhouse gas emissions, snow and ice dynamics, sea-level rise, soil moisture and extreme weather events, enabling risk modelling and long-term adaptation planning in a context of rising climate-related risks.

At the same time, biodiversity and ecosystem monitoring is gaining strategic importance as nature loss becomes a material risk for economies and societies. While in-situ data remains essential, EO increasingly supports large-scale, consistent monitoring of ecosystem conditions, habitat change, water quality, soil health and coral reefs across terrestrial, freshwater, coastal and marine environments. GNSS further complements EO through the tracking of wildlife movements, supporting conservation planning and the design of effective nature-based solutions.

Note: the sub-segment environmental monitoring is showcased with a **zoom on a plant icon** ,the sub-segment climate services is showcased with a **thermometer icon** and the sub-segment biodiversity, ecosystems and natural capital with a **plant placed on coins icon** .

What you can read in this chapter

- **Key trends:**
  1. Environmental drivers, policy shifts and the escalating water crisis shape the EO market and sustainability landscape.
  2. Empowering climate action: monitoring, mitigation and integrity through EO technologies.
  3. Nature-positive goals and markets are catalyzing global biodiversity protection.
- **Industry:** Climate, environment and biodiversity EO value chain.
- **Recent developments:** EO continues to be of strategic importance in climate resilience, environmental regulation and biodiversity protection.
- **Future market evolution:** European regulatory expansion requires measurable and repeatable EO data, driving market growth.
- **Future market evolution:** EO's expanding role in climate decisions related to adaptation and mitigation.
- **Future market evolution:** From pilots to operational deployment: EO and GNSS enable nature-positive action.
- **EU systems & projects:** Several key projects are developing climate, environment and biodiversity indicators using Copernicus.
- **Reference charts:** Yearly evolution of EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

Environmental drivers, policy shifts, and the escalating water crisis shape the EO market and sustainability landscape

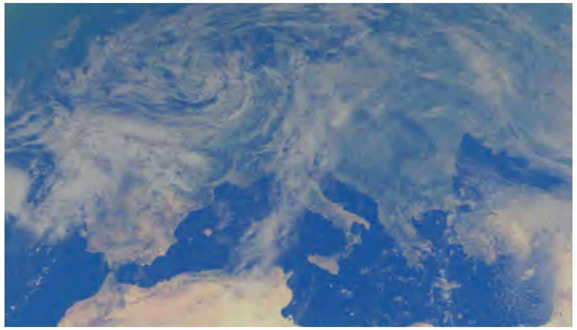
Key market trends

- Environmental, climate and biodiversity market trends are driven by key evolutions in other segments.
- Policy shifts are driving EO demand in the EU, while regulatory uncertainty and budget cuts in North America are slowing growth.
- The global water crisis is intensifying, with rising scarcity and unprepared systems; EO is vital for monitoring and resilience.

Environmental, climate and biodiversity matters are deeply embedded across segments

Biodiversity loss, climate change, and environmental degradation are not isolated challenges—they are deeply interrelated with activities across all segments. While trends within each segment are explored in the other sections of this report, it is important to highlight their interrelations and spillover effects on the climate, environment, and biodiversity sectors. Here are some examples:

- **Sustainable farming:** The growing importance of sustainable farming supports food production while strengthening water regulation, pollinator health and carbon storage. EO enables precision irrigation, customized fertilisation, and monitoring of sustainable practices for eco-scheme verification (e.g. People-4NewCAP) through soil moisture, crop health and land-use monitoring.
- **Urban greening:** As a nature-based solution, urban greening reduces heat stress, improves air quality, prevents flooding and creates habitats for biodiversity. EO maps tree canopies, land surface temperatures and flood risks, with pilots like E-shape Urban Resilience supporting cities such as Helsinki, Bonn and Vienna.
- **Energy and raw materials:** Extraction and processing of raw materials drive land degradation, emissions and biodiversity loss. EO helps assess mining impacts within clean-energy supply chains, monitoring land change and fragmentation, as well as emissions from ore extraction and processing.
- **Infrastructure:** New infrastructure reshapes ecosystems, land use and climate resilience. EO supports the entire lifecycle from construction tracking to InSAR-based ground deformation monitoring and assessment of environmental stressors.
- **Finance and ESG:** Financial risk assessments and ESG frameworks push companies to internalise biodiversity and climate impacts. EO enables insurers and investors to model risks, assess deforestation and emissions, and automate claims, as shown in EO4I Agro-Insurance.



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Policy shifts are shaping the EO market

In the **EU27**, regulatory momentum is an important driver of EO demand. The **Corporate Sustainability Reporting (CSRD)** is potentially transformative, as it directly shapes companies' environmental impact assessment and ESG reporting, as well as the utilization of EO across this application. Other than CSRD, additional EU policies (including the **Fit for 55 Package, the EU Taxonomy, the Nature Restoration Law, the Biodiversity Strategy for 2030 and the Water Resilience Strategy**) may also boost EU demand, should they be implemented as proposed.

In **North America**, the outlook is less consistent. Recent election outcomes are expected to slow environmental and ESG policy momentum between 2025 and 2029, weakening growth prospects for EO applications. A notable example is the restructuring of the **US National Oceanic and Atmospheric Administration (NOAA)**. Policy proposals and budget plans advanced in 2024–2025 have raised concerns about potential restructuring, staff reductions, and budget cuts at NOAA.

The global water crisis is intensifying, triggering the need for water monitoring

Climate change, pollution and population growth are intensifying competition for freshwater resources at a global scale. Water companies face direct pressure from climate change, experiencing both excessive and insufficient water availability. This crisis extends beyond supply challenges: competition over increasingly scarce water resources fuels conflicts among sectors such as agriculture, industry, tourism and households, and can escalate into cross-border disputes and inequalities in access.

The regulatory framework is evolving to respond to these pressures. The Water Resilience Strategy explicitly integrates EO as a key tool for monitoring water quality, scarcity and distribution under climate stress, making it essential for policy implementation and adaptation planning. EO monitoring encompasses aquifers, reservoirs and lakes – tracking water quality, storage, recharge and usage – and supports early warning and response to droughts, floods and seasonal variability, enabling governments and communities to manage water risks more effectively. EO also enables continuous, wide-area monitoring without the costs or logistical challenges of ground surveys, which is especially valuable in conflict zones or remote areas.

However, EO cannot fully replace in situ measurements, as ground data remain essential for calibration, validation and additional insights such as below-surface water quality. Beyond traditional monitoring, new applications are also emerging: EO-based digital twin hydrological models now track snowmelt and river discharge, improving reservoir monitoring (surface area, water level, volume) and enhancing water availability predictions for better allocation and management, as demonstrated by initiatives like the DTE Hydrology NEXT project This project applies a digital twin to predict floods and landslides, as well as monitor droughts and manage water resources.

Empowering climate action monitoring, mitigation and integrity through EO technologies

Key market trends

- The surge in extreme weather is making climate monitoring, forecasting and modelling more essential than ever.
- Carbon market growth, driven by stricter rules and better MRV tools, is pushing climate mitigation to the next level.
- EO is emerging as an independent, science-based source of truth as carbon and climate claims face greenwashing scrutiny.

The rise in extreme weather events drives the need for climate monitoring, forecasting and modelling

In recent years, extreme events have become more frequent, longer-lasting and more severe, and disturbance to the water system is expected to be one of the most significant consequences of the climate crisis. According to the EEA (2024), recent high-cost disasters such as the July 2021 floods in Belgium, Germany and the Netherlands (€44 billion) and the August 2023 floods in Slovenia (around 16% of national GDP) mean climate change is increasingly seen as a major macroeconomic, fiscal and financial threat. Furthermore, economic losses related to climate have increased over the past 30 years, with the average annual loss rising nearly 2% over the past decade. The projected warming will bring more frequent, severe and prolonged droughts and floods, which makes the utilisation of EO even more indispensable.

EO provides independent, real-time data needed to monitor glaciers, sea levels, soil moisture and precipitation patterns. When combined with modelling and forecasting tools, this data underpins early warning systems, disaster response and long-term resilience planning. Moreover, EO strengthens climate finance and insurance by delivering verifiable evidence of risks and impacts, ensuring that both public policy and private markets can better adapt to an era of accelerating climate extremes.

EO is emerging as an independent, science-based source of truth as carbon and climate claims face greenwashing scrutiny

Regulators and frameworks increasingly rely on **EO data** as a trusted foundation for **disclosure and compliance**. EO offers independent, science-based evidence to confirm whether carbon offsets, emission cuts and climate commitments are real and effective. By monitoring forests, emissions and land use from space, EO helps expose **greenwashing** and builds trust in climate action. For example, the Integrity Council for the Voluntary Carbon Market (IC-VCM) requires strong **monitoring, reporting and verification (MRV)** of carbon credits, and explicitly recognises EO as a tool to independently track deforestation, forest growth and methane emissions to ensure credits are trustworthy.

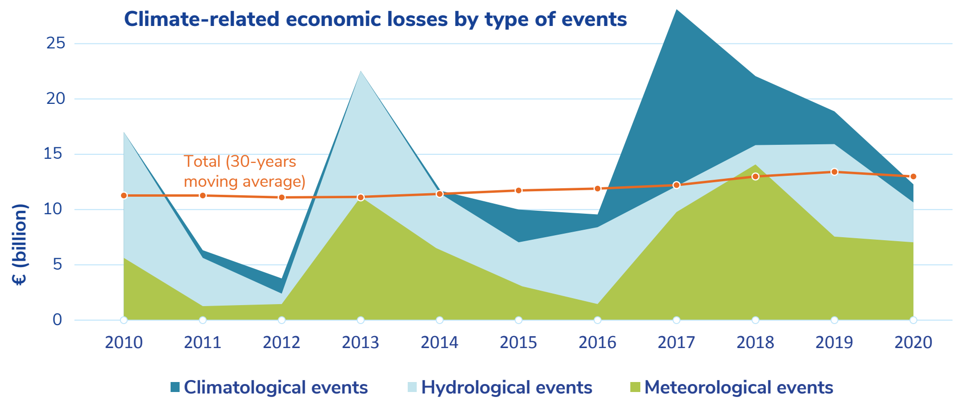
The only operational daily global methane cover remains **Sentinel-5P**, which was launched in 2017 and detects emission hotspots, including wetlands. This is complemented by information from the **ESA Biomass mission**, launched in 2025, that can 'see through' forest canopies to measure not just the leaves but also the trunks and branches, which hold most of the carbon. This capability is essential for accurately **estimating carbon stored in forests**. At the same time, dedicated satellites such as **MethaneSAT** (EDF/NASA) and GHGSat's commercial constellation track and **quantify methane leaks** from oil and gas sites, landfills and agriculture, delivering independent verification of emission reductions and helping prevent greenwashing.

The growth of carbon markets is pushing climate mitigation to its next level

Post-COP29, governments are introducing major reforms to both compliance and voluntary carbon markets, strengthening rules around **measurement, reporting and verification (MRV)**. For example, Singapore has introduced one of the world's first **national carbon services accreditation schemes** and is positioning itself as a global hub for **high-integrity carbon trading**.

In Europe, **the European Climate Law** provides the overarching legal framework to reach **climate neutrality by 2050**, with binding intermediate targets of a **55% reduction of emissions by 2030** and **90% by 2040**. Key measures like **the Fit for 55 Package** and the **EU Emissions Trading System reforms** are part of this trajectory, further increasing demand for robust MRV and independent verification. This stronger regulatory framework is steering corporate behaviour, forcing companies to prove the **integrity** of their carbon credits and **climate change**.

At the same time, commercial solutions are maturing. Companies are shifting from generic sustainability reporting to **precision MRV tools** for emissions and carbon sequestration, making **independent, transparent and verifiable data** a core requirement. Yet carbon markets still face ongoing quality concerns. Issues of non-fungibility (not all credits are equivalent or interchangeable), **double counting** and **uneven governance** continue to raise doubts about their credibility and effectiveness. The markets' growth therefore depends not only on regulatory tightening and **EO-enabled transparency**, but also on stronger integrity standards and international alignment.



Nature-positive goals and markets are catalysing global biodiversity protection

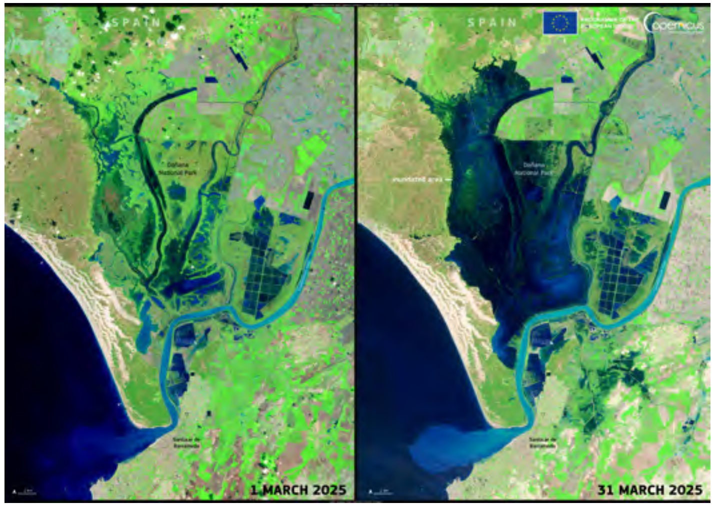
Key market trends

- Nature-positive goals are rising, with initiatives like 30x30 driving action to halt biodiversity loss.
- The emerging market for biodiversity credits is attracting growing interest, although dependent on robust integrity frameworks.
- Nature-based solutions, large-scale restoration and expanding protected areas are driving global ecosystem protection and climate resilience.

Nature-positive goals are on the rise

Following **COP15 in Montreal (2022)** and **COP16 in Cali (2024)**, countries, businesses and other organisations increasingly embrace the nature-positive agenda, aiming to halt biodiversity loss by 2030 and reverse it by 2050. One of the most famous targets set by the **Global Biodiversity Framework (GBF)** from COP15 is the **30x30 Initiative**, under which **over 100 countries have committed to designating 30% of land and ocean as protected areas by 2030**. A follow-up effort, the **Nature Positive Initiative**, seeks to translate this vision into measurable gains in ecosystem health through emerging metrics and pilot programmes.

EO enables the tracking of progress: for instance, **Copernicus Sentinel-2** satellites have proved to be very useful to monitor changes in coral reef health, providing transparent, science-based data to assess whether marine protected areas are effectively conserving biodiversity. EO data also enable systematic monitoring of terrestrial and coastal habitats, including forests, wetlands, grasslands and coastal ecosystems, by revealing changes in vegetation cover, habitat fragmentation and overall ecosystem condition. In addition, EO supports the detection of land degradation, desertification and habitat loss, providing consistent and objective evidence to assess the effectiveness of habitat restoration efforts and biodiversity protection policies over time.



Intense March 2025 rainfall transformed Doñana National Park's wetlands (southern Spain), as shown in false-colour Sentinel-2 images: 1 March (left, dry) vs. 31 March (right, major inundation). This decade's largest recharge restores aquatic ecosystems hit by drought. (Copernicus.eu)

The emerging market for nature credits is attracting increasing interest

Nature credits are gaining traction, especially at important events like COP16, where they were a central topic of debate. The **voluntary biodiversity credit market** is still small but is expected to grow significantly; estimates presented at COP16 suggest that, if integrity frameworks and demand mature, the market could reach **$2 billion (by 2030)** and **$69bn (by 2050)**. However, these credits are strongly criticised by some experts and nature conservation groups, who caution that they could fall into the same pitfalls as carbon credits. A key challenge behind these concerns lies in the inherent difficulty of describing biodiversity, which is complex, multi-dimensional and dependent on context, making it difficult to capture through a single metric. This complexity makes it challenging to define outcomes that are robust, comparable and verifiable, thereby increasing the risk of oversimplification when not adequately considered.
The market's growth also depends on stronger **integrity standards**, and several initiatives are emerging in response. For example, the **EU** is preparing rules for 'nature credits' that would reward farmers and foresters for protecting and restoring ecosystems. **Biodiversity Impact Credits (BIC)** are being developed as scientifically grounded credits that quantify the change in long-term species survival probability, enabling comparisons across species and ecosystems.
EO is indispensable for this market to thrive, serving as the backbone for measuring, monitoring and ensuring integrity in biodiversity finance.

Nature-based solutions, ecosystem restoration and the growth of protected areas are strengthening ecosystem protection worldwide

Nature-based solutions (NbS) rely on ecosystems like mangroves, wetlands and forests to manage climate risks such as floods, heat or carbon. These strategies are increasingly embedded in climate policies, since NbS can provide climate mitigation and adaptation benefits simultaneously while also supporting biodiversity and human well-being. However, to be effective, NbS must be implemented with **high ecological integrity, long-term governance and safeguards for local communities** – otherwise, they risk being ineffective or even harmful.
EO supports this effort by tracking ecosystem health and restoration progress; for example, **Sentinel-2 imagery is used to monitor mangrove restoration in East Africa**, providing data on canopy cover, biomass growth and coastal protection benefits over time. (Sunkur et al., 2024)
Ecosystem restoration under the UN Decade (2021–2030) could provide one-third of needed climate mitigation by 2030, while delivering social and economic benefits that outweigh the costs. From 2000 to 2024, coverage of key biodiversity areas under protection rose substantially: **land** (26.7% > 44.6%), **freshwater** (27.1% > 43.7%), and **marine** (25.8% > 46.0%).

Climate, environment and biodiversity EO Value Chain[1]

EO

DATA PROVIDERS

Commercial offering:
- 21AT
- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- E-GEOS*
- EARTH-I*
- GEOSAT*
- GHGSAT
- HISDESAT
- ICEYE*
- NEC
- PLANET
- SATELLOGIC*
- UMBRA
- VANTOR

Public offering:
- COPERNICUS SENTINELS*
- NISAR (NASA/ISRO)
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- RELEVANT EUROPEAN NATIONAL MISSIONS*

INFRASTRUCTURE PROVIDERS

Commercial offering:
- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- SERCO
- T-SYSTEMS*

Public offering:
- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

Commercial offering:
- CGI
- CREODIAS*
- EDS CEODE
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- IONQ
- NORTH.IO*
- ORBIFY**
- OPEN DATA CUBE
- SENTINEL-HUB* (PLANET)
- UP42*
- WEAVAIR**

Public offering:
- CLIMATE ADAPT*
- COASTAL TEP*
- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- DESTINE*
- FORESTRY TEP*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

Commercial offering:
- 4 EARTH INTELLIGENCE*
- BERRING DATA COLLECTIVE*
- CLIMATESCALE*
- CONSTELLR*
- CYBELE*
- DEWBERRY
- ECOMETRICA*
- E-GEOS*
- EOLAB*
- EOMAP*
- FASHION FOR BIODIVERSITY**
- FUGRO*
- GEOVILLE*
- KANOP**
- KSAT*
- LOBELIA*
- MEEO*
- OHB*
- OVERSTORY*
- PIESAT
- PLANETEK*
- PLENO**
- SATELLIGENCE**
- SUPERMAP
- TELESPAZIO*
- VIRIDIEN*
- WATER INSIGHT*

Public offering:
- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS MARINE SERVICE (CMEMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- DESTINE*
- GLOBAL FOREST WATCH

INFORMATION PROVIDERS

Commercial offering:
- AIRQAST*
- CLIMATE ANALYTICS
- DELTARES*
- DYNAMHEX
- EARTHSENSE*
- FORA FOREST INTELLIGENCE*
- GAF
- JUPITER INTELLIGENCE
- KAYRROS*
- PACHAMA
- SINGLE.EARTH*
- SEQANA**
- VERISK ANALYTICS
- VITO
- WORLD FROM SPACE*

Public offering:
- BGS*
- CLIMATE TRACE

END USERS

User segments:
- CORPORATES
- DUTY HOLDERS
- ENVIRONMENTAL AGENCIES
- ESG AUDITING AND CERTIFICATION PROVIDERS
- FINANCIAL INSTITUTIONS
- GENERAL PUBLIC
- INSURANCE PROVIDERS
- INTERNATIONAL AGENCIES (E.G. UN)
- JUDICIARY
- LEGAL PRACTITIONERS
- NGOS
- POLICY MAKERS

LEGEND

Commercial offering
Public offering
User segments

NOTES

1: The value chain considers the key global and European companies involved in EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 for a comprehensive description of the EO value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

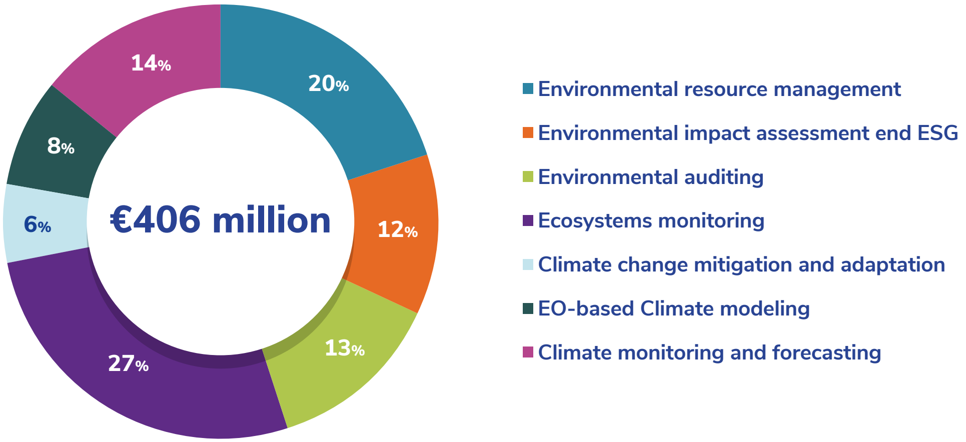
European[2] EO industry in the global arena

In the Climate, Environment & Biodiversity EO market, European companies capture a bit more than one-third of the global market share (approximately 37%).

The top 5 European players include Deltares, Airbus, Serco, Viridien, and Leonardo (e-GEOS). Together they account for 23.10 % of the segment market share.

EO continues to be of strategic importance in climate resilience, environmental regulation and biodiversity protection

Revenue from EO services and data sales by application 2024



Climate, environment and biodiversity EO data and services generated around €406 million in revenues in 2024, **confirming the strategic importance of EO in supporting climate resilience, environmental regulation and biodiversity protection**.

Within the climate segment, climate change mitigation and adaptation currently represents a relatively small share of revenues. However, this application is expected to be the fastest growing over the coming years. Growth is driven by governments, corporates and financial institutions increasingly relying on EO-enabled evidence to support adaptation planning and mitigation.

Ecosystem monitoring remains one of the most important applications and the largest revenue share. Although biodiversity monitoring still relies heavily on in-situ data, EO-based services are increasingly used to assess ecosystem conditions, habitat change, water quality, soil health and coral reef status at scale. Demand is further reinforced by growing commercial interest, as companies face increasing pressure from shareholders and stakeholders to demonstrate credible biodiversity impact mitigation and nature-positive strategies.

Climate change mitigation is now among the high-priority applications according to user needs

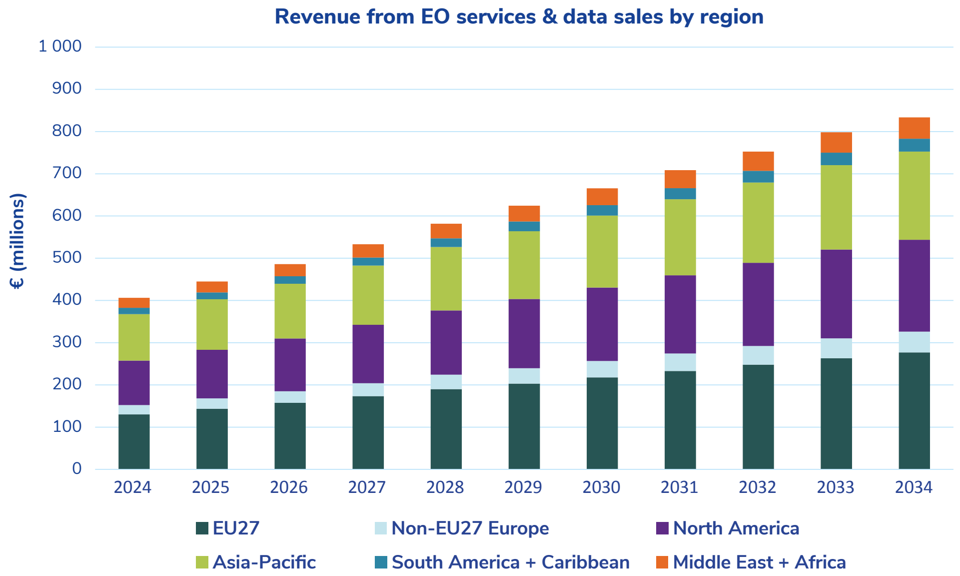
Governments, regulators, financial institutions, insurers, manufacturing and aviation sectors, energy and utility companies, agriculture and forestry operators, and NGOs are increasingly dependent on EO. Users seek accurate monitoring of **GHG emissions** (from energy, industry, agriculture and transport) and **natural carbon sinks** (forests, soils, wetlands) to support net-zero targets, nature-based solutions, carbon markets, and regulatory compliance. EO enables this effort through satellites like **Sentinel-5P** (air quality and GHGs), **MethaneSAT/GHGSat** (methane detection), and **ESA Biomass** (forest carbon accounting). The upcoming **CO2M mission** will provide high-resolution satellite data specifically to monitor anthropogenic CO_2 emissions, supporting transparent and accurate assessment of anthropogenic greenhouse gas sources.

Habitat and ecosystem monitoring are becoming more demanded for environmental impact assessments and ESG reporting

Habitat and ecosystem monitoring is becoming central to **environmental impact assessments (EIA)** and **ESG reporting**, driven by stricter regulations such as the **EU CSRD**, **EU Taxonomy** and **TNFD**. Companies, regulators and investors want regular, spatially explicit updates on habitat health, change and extent to assess risks, dependencies and compliance. Reliable **habitat monitoring** helps companies manage **supply chain risks such as deforestation-free sourcing** and avoid greenwashing, while also unlocking access to nature-linked finance through biodiversity credits and sustainable investment funds.

Missions such as Copernicus Sentinel-1 and Sentinel-2 (for vegetation cover and land use change) are already widely used for EIAs and ESG audits. Hyperspectral imaging, drones and AI further enhance monitoring by enabling detailed, frequent updates. The upcoming Copernicus CHIME mission will provide systematic hyperspectral data to improve land cover mapping, sustainable agriculture and biodiversity management, complementing the Sentinel missions.

European regulatory expansion requires measurable and repeatable EO data, driving market growth



Under a scenario of sustained regulatory expansion and public investment, EO data and services sales could reach €800 million over the next decade, with an **average forecasted annual growth of 6.93%**. Europe currently holds the largest share of the market due to a **unique combination of policy leadership, institutional demand, and sustained public investment in EO infrastructure**.

The segment is forecasted to grow significantly as impacts of climate change, biodiversity loss and environmental degradation are intensifying, creating a structural need for continuous, large-scale monitoring and risk assessment that EO is uniquely positioned to deliver.

Growth is further driven by regulatory expansion, particularly in Europe, where climate, nature, water and ESG policies **increasingly require measurable and repeatable data**. The Corporate Sustainability Reporting Directive (CSRD) is an important example. At the same time, commercial demand is rising as insurers, financial institutions, corporates and asset managers integrate EO into climate risk modelling, environmental impact mitigation and sustainability reporting, turning EO from a primarily public-good tool into a core market service.

Environmental auditing is becoming mainstream

Environmental auditing is evolving as **EO-enabled capabilities** increasingly provide independently **verifiable evidence** for ESG reporting and supply-chain due diligence. Copernicus data provides high-resolution, reliable information on land use, pollution, emissions, water and soil quality, and ecosystem health, allowing companies and regulators to monitor compliance and assess environmental risks. Beyond scientific and public agencies, EO is increasingly used by companies in **agriculture, mining, energy, finance and consumer goods** to measure environmental impacts, evaluate risks and comply with stricter reporting requirements.

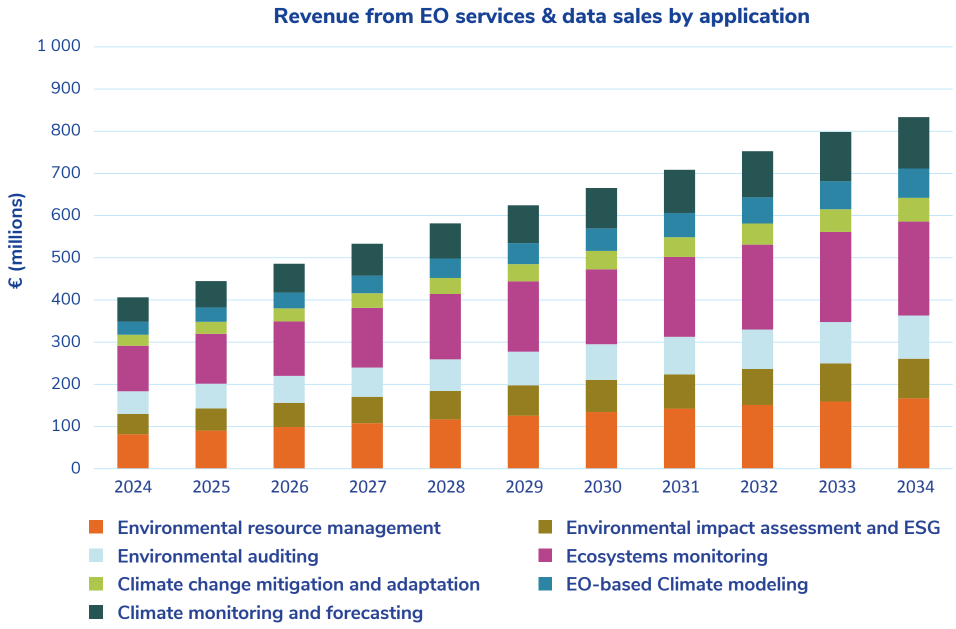
Sentinel-2 optical imagery, for example, is increasingly used to monitor forest loss and land-use change, with high-resolution time-stamped images helping authorities and NGOs detect **illegal logging, mining and other unpermitted activities** while supporting subsequent enforcement actions (Phiri et al.,2020). The Copernicus SESA 'Environmental Compliance' service explicitly offers evidence of infringements of environmental laws and assessments of environmental damage based on Sentinel data, which can be used by inspectors, prosecutors and courts in cases involving illegal waste or unauthorised industrial activities. Recent Copernicus demonstration projects show how **Sentinel-1 and Sentinel-2 time-series** are being used in Italy to detect abrupt forest-cover changes, compare them with authorised logging plans and flag areas where operations may be illegal, thereby helping authorities target on-the-ground inspections and enforcement actions. Regulatory frameworks, such as the EU Corporate Sustainability Reporting Directive, the EU Taxonomy and climate-disclosure rules, further increase demand for auditable environmental data, making **EO integration into environmental auditing** a key factor fuelling market growth and innovation in sustainability-linked finance and supply-chain due diligence.

New market players and private missions are getting on the market

Private satellite/EO data providers are being leveraged for environmental monitoring, often to meet compliance or **ESG demands** (e.g. methane sensors, land cover change tools). These services are often tailored to **corporate reporting, supply-chain due diligence** and **regulatory compliance** needs (e.g. **CSRD**, **EU Deforestation Regulation**).

Private missions tend to move faster than public programmes, deploying **hyperspectral**, **thermal** and **very-high-resolution sensors** to address niche environmental use cases. **GHGSat** has been recognised as a leading data provider in ESG circles and was named **Best Specialist Data Provider** by the ESG Investing Awards. Companies are shifting toward '**analysis-ready data**' and **subscription services**, making EO insights accessible to non-specialist ESG and compliance teams. **Banks, insurers and asset managers** are emerging as key clients, using private EO data for **risk modelling** and **investment screening**.

EO’s expanding role in climate decisions related to adaptation and mitigation



Climate applications are the fastest-growing part of the segment, driven primarily by the rising frequency and cost of extreme weather events. Governments, infrastructure operators, insurers and asset managers increasingly rely on EO-based monitoring and forecasting to assess physical climate risks, support early-warning systems and inform emergency response and long-term resilience planning.

Environmental applications are growing steadily due to **tightening environmental regulation and enforcement**, particularly in Europe. Policies, such as the CSRD, EU Taxonomy, Nature Restoration Law, Water Framework Directive and Water Resilience Strategy, require regular, auditable environmental data – which EO is well suited to provide.

Biodiversity and ecosystem monitoring is growing as biodiversity loss becomes a strategic risk for governments, companies and financial institutions. International commitments, EU nature restoration requirements and emerging biodiversity finance mechanisms are **increasing demand for consistent, repeatable ecosystem indicators**.

Albeit global revenues in the segment are foreseen to increase, growth pace, in particular for value-added services, will differ at regional level. In North America, for example, recent election outcomes are likely to slow the environmental and ESG policy momentum in the near term vis-à-vis regions such as Europe, and consequently slow growth in EO applications.

Records droughts and heat reported by ECMWF

The **2024 European State of the Climate report** confirms 2024 as Europe’s warmest year - with **extreme heatwaves, severe floods** and severe environmental impacts (ECMWF, 2025). Copernicus bulletins show August 2025 as the third warmest globally, Europe’s fourth-warmest summer, widespread droughts across the west and south raising **wildfire risks**, and below-average Arctic sea ice, all monitored using EO data.

European Climate Risk Assessment identifies major climate risks for Europe that will soon reach critical or catastrophic levels

European Climate Risk Assessment (EUCRA) identifies major climate risks for Europe that will soon reach critical or catastrophic levels. EUCRA identifies 36 major climate risks, with many already at critical or urgent levels – notably water scarcity in southern Europe, rising coastal flooding, wildfires and health impacts from extreme heat. Without stronger adaptation, almost all risks could reach critical or catastrophic levels this century under high warming scenarios.

In its report, EUCRA highlights **systemic cascades**, such as ecosystem collapse threatening food and water security, infrastructure failures spreading across sectors, and financial instability from unpriced risks. Despite policy frameworks including the Floods Directive, the Biodiversity Strategy and the Nature Restoration Law, gaps remain in enforcement, integration and resources, and **monitoring is a critical weakness**. EO, combined with other technologies, helps close this monitoring gap by providing standardised, cross-border data to track key hazards (from sea-level rise and glacier retreat to droughts, wildfires and urban heat), enabling earlier forecasts and responses to floods and other extremes, and providing the monitoring information on which EU water, flood and nature legislation relies.

Climate adaptation will increasingly factor into economic decision-making

Policy frameworks and **national adaptation strategies** now require investment decisions to consider future climate risks rather than relying only on historical norms, pushing cities and local governments to integrate long-horizon planning into their budgets. The water framework directive **illustrates this shift** by requiring economic analyses, cost recovery and pricing that reflect water scarcity and environmental pressures. An example at city level is of Prague's post-2002 flood protection upgrades- designed now for a 500-year event with an extra safety margin instead of 100-year. Indeed, the cost-benefit analysis justifies higher upfront spending when avoiding damages to infrastructure and heritage outweigh costs.

This shift is driving demand for risk mapping, early warning systems, and long-term climate modelling, and reshaping urban planning. Indeed, EO and digital twins are increasingly sought after to monitor infrastructure performance, water management, heat islands, and air quality. The European Commission’s Destination Earth (DestinE) complements these efforts with two key digital twins: the **Weather Induced Extremes Digital Twin**, and the **Climate Change Adaptation Digital Twin**.

From pilots to operational deployment: EO and GNSS enable nature-positive action

Wildlife monitoring using both GNSS and EO is being scaled up

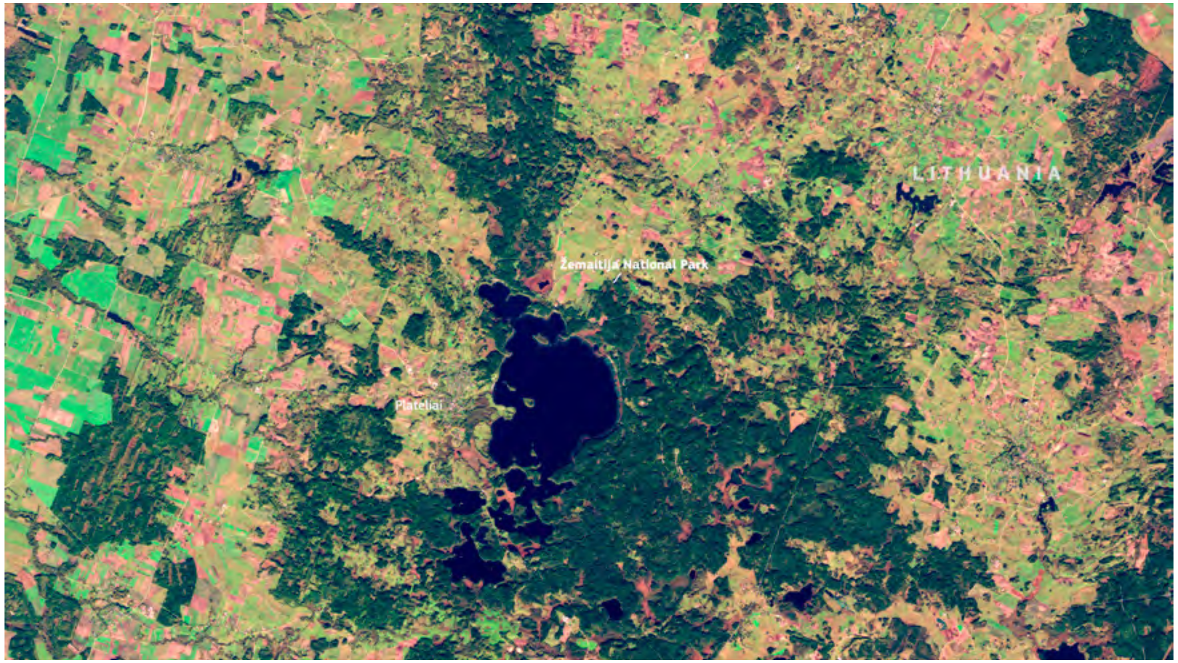
Wildlife monitoring using both GNSS and EO is being scaled up. Advances in **GNSS** and **EO** are enabling more comprehensive tracking of species at both the individual and population levels. Emerging **digital twin technologies** combine GNSS tracking and EO to create dynamic models of wildlife populations, enhancing real-time monitoring and conservation strategies through integration of environmental and movement data. Species distribution monitoring will increasingly benefit from the emerging biodiversity data method based on '**occurrence cubes**', which aggregate occurrence data spatially, temporally and taxonomically to provide analysis-ready datasets that support scalable and standardised monitoring. **Smaller and lighter tags** now allow scientists to track a wider range of species, including birds, marine animals and smaller mammals, without disrupting their behavior.

High-resolution satellite imagery, combined with AI, can detect and count large animal groups (e.g. wildebeests, penguins and elephants) across vast and remote landscapes. EO supports continuous observation of **habitat changes**, such as deforestation, water scarcity or land conversion, that directly affect wildlife populations. Combining **GNSS animal movement data** with **EO habitat data** helps map migration routes, identify critical habitats and design more effective conservation strategies.

Nature-Based Solutions (NbS) will move beyond local pilot projects

Nature-Based Solutions (protecting, restoring or managing ecosystems) are now recognised for tackling multiple challenges: **climate mitigation and adaptation, disaster risks, water and food security, human health, and biodiversity loss**. Researchers highlight that while climate- and biodiversity-oriented NbS have received attention, gaps remain for **water security, food security, socio-economic development and human health**. Scaling NbS is a priority: the **European Environment Agency** stresses that for NbS to deliver across Europe, they must move beyond local pilot projects, which requires **standardised assessment and monitoring frameworks, consistent governance and financial incentives**. According to the **European Investment Bank**, nature-based solutions, whether traditional or innovative, provide almost a quarter of the most cost-effective climate actions and help biodiversity to thrive, yet they remain on the margins of global finance, and scaling them up cannot be accomplished without the active support of the **private sector in partnership with the public sector**.

Because NbS demand **robust monitoring** of ecosystems, carbon stocks, baselines, restoration progress and species outcomes, **EO is becoming indispensable**. EO's **high-resolution imagery, frequent revisit times**, and **multispectral, hyperspectral and radar elements** allow the health and status of ecosystems to be tacked over time.



Space data driving environmental decisions: GNSS and Copernicus for a changing planet

Current and future use of Copernicus for environmental monitoring

The Copernicus programme is the EU's flagship EO initiative for environmental monitoring as a whole. Copernicus data and services are used extensively to inform environmental regulation and support reporting under EU directives. In this context, the **Copernicus Emergency Management Service (CEMS)** is critical, providing real-time early warning and monitoring for floods, droughts and wildfires across Europe and wider afield, thereby supporting disaster risk management. Alongside CEMS early warnings, dedicated services track risks via key indices: EDO/GDO (drought severity and combined indicators), EFAS/GloFAS (flood forecasting and probability), and EFFIS (fire danger and vegetation moisture indices). Future Sentinel expansion missions – LSTM (land surface temperature), ROSE-L (radar for hydrology and forests), CIMR (cryosphere microwave), CRISTAL (ice altimetry) – will further strengthen long-term environmental monitoring capabilities and policy implementation.

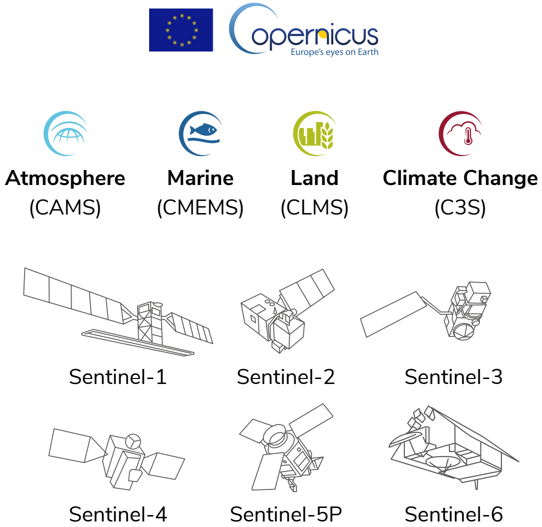
Current and future use of Copernicus for climate services

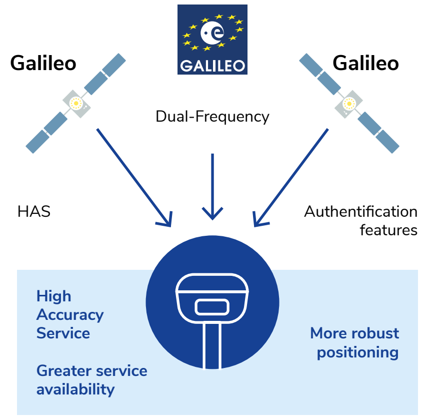
Climate-ADAPT, the European Climate Adaptation **Platform**, is a collaboration between the European Commission and the **European Environment Agency (EEA)**. The EEA oversees its maintenance, assisted by the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA), while leveraging **Copernicus Climate Change Service (C3S)** data through features like the European Climate Data Explorer and direct dataset feeds to enable adaptation strategies and climate services throughout Europe.

Building on this platform, **DestinE** develops advanced climate and weather digital twins that simulate and predict extreme weather events and climate change impacts at high resolution. The upcoming CO2M (Copernicus Anthropogenic CO2 Monitoring) satellites will enhance C3S with direct CO2 emission measurements from space, enabling precise carbon budget tracking for advanced climate services and mitigation planning.

Current and future use of Copernicus for biodiversity monitoring

The **Copernicus Climate Change Service (C3S)** provides biodiversity-focused Sectoral Information System products, offering bioclimatic indicators and climate projections to support ecosystem and species assessments and efforts to curb biodiversity loss. The Copernicus Land Monitoring Service Natura 2000 Land Cover product offers high-resolution land cover maps of protected sites across Europe, supporting habitat conservation and compliance with EU nature directives. The **Copernicus Marine Service** supplies key environmental data such as salinity, temperature, currents, chlorophyll and turbidity to monitor marine biodiversity and **Marine Protected Areas**. Use cases include monitoring harbour porpoises in Baltic Natura 2000 regions and managing invasive species in the Mediterranean. The **Copernicus Atmosphere Monitoring Service** contributes atmospheric composition data vital for understanding air quality and pollutant effects on biodiversity. The upcoming CHIME hyperspectral Sentinel mission will provide detailed information on vegetation composition and health. Looking ahead, Copernicus partners are exploring a dedicated **biodiversity hub** to better integrate and provide access to biodiversity-relevant products and services.





Current and future use of EGNSS for climate services

Although there is limited use of GNSS and thus EGNSS within the climate domain, several techniques such as GNSS radio occultation sounding and GNSS Reflectometry (GNSS-R) support climate modelling. Both techniques can benefit from improved performances offered by Galileo and its services. More specifically, Galileo provides enhanced signal availability and accuracy at high latitudes compared with other GNSS systems, which is particularly important for **climate modelling** in polar regions where scientists monitor and predict climate changes. Additionally, Galileo offers faster and more **frequent updates of positioning information**, enabling more rapid updates of meteorological measurements crucial for real-time monitoring, forecasting and early warning systems.

HydroGNSS, an ESA Scout mission, illustrates **how GNSS reflectometry** is being turned into a dedicated climate service. By measuring GNSS signals from GPS and Galileo after they are reflected by the Earth's surface, HydroGNSS retrieves **key hydrological Essential Climate Variables**, including soil moisture, inundation and wetland extent, freeze/thaw state over permafrost and above-ground forest biomass, and as secondary products wind speed over the ocean and sea-ice extent. These measurements feed applications such as weather and flood forecasting, agricultural monitoring, permafrost and wetland assessment, and climate modelling, thereby demonstrating the growing role of EGNSS in operational climate services.

Current and future use of EGNSS for biodiversity monitoring

Biologists, scientific researchers and conservation agencies are interested in remotely monitoring the relatively fine-scale migratory patterns of free-range animals. **EGNSS** represents an ideal technology to track their location. By attaching an EGNSS-enabled tracker to a collar, harness or directly to the animal, data on its location can be continuously collected and analysed. This helps us better understand what (potentially endangered) animals need to be healthy and thrive in their environment.

Several European funded projects utilise EO to propose solutions in support of environment and biodiversity

CASSINI #EUSpace Challenges

CASSINI challenges

The 2024 CASSINI Challenges supported innovative entrepreneurs developing solutions that harness EU Space data to address real-world issues. Among the winners, several projects stood out for their environmental impact:

Sequana: Focuses on carbon removal by providing verification and monitoring tools for carbon sequestration projects using remote sensing data, supporting climate mitigation efforts.

WeavAir: Provides a 'sustainability-as-a-service' platform for measuring, reporting and verifying greenhouse gas emissions, supporting investors, companies and insurers in implementing ESG and energy-transition strategies.

PeaceEye: Uses a combination of EO data, conflict incident reports and public news to anticipate risks related to natural resource scarcity and environmental stress, aiding humanitarian intervention planning.

Tropicalism: Offers a platform integrating multispectral satellite data and local observations to monitor tropical ecosystems, deforestation and habitat restoration.

iAgro: An AI-powered decision support system utilising Copernicus data to optimise sustainable agricultural practices, reducing environmental footprint while increasing productivity. Each winner received a €100,000 prize and is contributing to the green transformation powered by EU space data.

Horizon Europe,
a programme of the
European Union

COASTS: Coastal Observation Advances Leveraging Space Technology

COASTS is a Horizon Europe project focused on **enhancing the observation, mapping and management of coastal zones using advanced EO data and space technologies**. Coastal areas are vital ecosystems that provide essential services such as biodiversity support, carbon sequestration (blue carbon) and coastal protection, but they face severe threats from climate change and human activities.

The COASTS project aims to **develop innovative, scalable solutions integrating EO data with advanced modelling techniques and morphodynamic process models to monitor coastal dynamics and blue carbon habitats**. It provides downstream services tailored for government stakeholders and coastal planners to develop effective **coastal management strategies and promote nature-based solutions adaptable to various coastal types** and governance frameworks. Pilot sites include Germany, Jersey and the Maldives, serving as learning hubs to establish blueprints for wider application globally. These integrated tools seek to enhance climate resilience, biodiversity protection and sustainable economic development in coastal regions.

Copernicus satellite data for estimating carbon stocks and enabling responsible sourcing across global supply chains

To explore the full potential of Copernicus data for transparency and accountability in sourcing, IKEA, a major furniture company with global footprint, partnered with EUSPA. Through applied EO trials, the company tested how Copernicus data can help quantify carbon stored in forests and soils and improve visibility across sourcing regions. These trials demonstrated that satellite data can offer data-driven, accurate and scalable environmental insights even in remote or under-reported areas — insights that are increasingly critical for supply chain assurance and emissions tracking. More importantly, the project provided the company with a clearer view of the possibilities Copernicus can unlock. It can provide the company with additional tools to benchmark supplier practices, inform procurement decisions and build consistent, verifiable carbon metrics across sourcing regions. The trials also laid the groundwork for more in-depth in-house development and collaboration with EO service providers. This initiative showcases that EO is no longer a mere opportunity for the future — it's a strategic asset in today's climate economy. For companies managing land-intensive supply chains, Copernicus data offers a clear path to responsible sourcing, biogenic removals and emissions transparency, and sustainable growth.

Tracking textile supply chain biodiversity indicators with Copernicus data

As part of its commitment to sustainability and innovation, Danish fashion brand GANNI has launched a pilot project in collaboration with EUSPA to **identify drivers of biodiversity loss across key areas of its textile supply chain**. Featured in GANNI's recently released Responsibility Report, this initiative explores **how Copernicus satellite data can help fashion brands measure and mitigate their environmental impact**.

This pilot marks an important step towards integrating EO insights into biodiversity monitoring within the fashion industry. By assessing current biodiversity status and monitoring changes over time, the project contributed to developing practical science-based indicators. These indicators guide future biodiversity strategies both inside GANNI's operations and potentially serve as a broader industry reference.

The project's results **quantify habitat composition, fragmentation, vegetation condition and human impact across the studied regions, providing a detailed understanding of fashion's environmental footprint** amid growing global sustainability expectations.

Several European funded projects utilise EO to propose solutions in support of environment and biodiversity

Horizon Europe, a programme of the European Union

Enhance: Enabling One Health Coastal Management

Enhance is a **Horizon Europe project** funded under the **EU Space Program** that promotes **sustainable coastal management** through an integrated **One Health** approach. By combining **Copernicus Earth Observation data, EGNSS, citizen science**, and **AI analytics**, the project develops innovative tools to assess how **urban**, **agricultural**, and **climate pressures** affect **water quality**, **biodiversity**, **ecosystem health**, and **public health**.

Enhance delivers **actionable insights** to help **policymakers, coastal authorities, and communities** manage risks such as **pollution**, **habitat loss**, and **climate-related impacts**. The project will produce **three new products** offering dynamic, data-driven support for **coastal resilience and conservation**, aligned with **EU Green Deal objectives**.

Field validation will take place in two pilot areas—**Barcelona's urban beach** and the **Pagasitikos Gulf**—demonstrating how integrated monitoring and management can strengthen the sustainable use of Europe's coastal ecosystems.

Horizon Europe, a programme of the European Union

SNOWCOP: Unlocking Copernicus Potential for Meltwater Insights

SNOWCOP unlocks the full potential of Copernicus data and infrastructure to **enhance meltwater monitoring in the Andes**. This EU-funded Horizon Europe project addresses **gaps in the current Copernicus snow water equivalent (SWE) service**, particularly in **mountains** and the **southern hemisphere**, by employing an innovative re-analysis approach that assimilates Copernicus data into a physically based snow model. It generates high-resolution SWE and ice melt maps covering over 20 years across the extra-tropical Andes at 50m spatial and daily temporal resolution, processed via the **Copernicus DataSpace Ecosystem**, with a commitment to open science by releasing all results and code publicly.

SNOWCOP pursues key objectives to develop and evaluate new SWE and ice melt reanalysis datasets, promote CDSE use for Copernicus innovation, raise awareness of Copernicus and EGNSS among water management stakeholders, and attract investment for advanced tools. By empowering stakeholders with unprecedented detail on meltwater resources, the project supports informed decisions, opens SME opportunities, boosts human well-being in mountainous regions, and advances EGNSS-powered snow stations measuring SWE and liquid water content simultaneously.

Horizon Europe, a programme of the European Union

Birdwatch: Habitat sustainability of farmland birds

Birdwatch is an ongoing Copernicus-based Horizon Europe project (2023-2026) dedicated to improving the habitat suitability of farmland birds across the **EU through satellite-enabled monitoring, evaluation, and optimisation of Common Agricultural Policy (CAP)** eco- and agri-environmental measures. By combining rigorous species distribution modelling with Earth Observation data-derived geospatial features of farmland parcels, Birdwatch produces **detailed maps** that provide stakeholders with insights into bird **habitat suitability and structural deficits or potentials** in agricultural areas.

This service supports evidence-based policymaking and promotes sustainable farming practices by identifying optimal **greening measures** that balance ecological needs with budgetary and operational constraints for farmers. Birdwatch fosters communication and mutual understanding between scientists, farmers, authorities, and other stakeholders by making habitat suitability **monitoring and decision support freely accessible** to support ecological and economic sustainability.

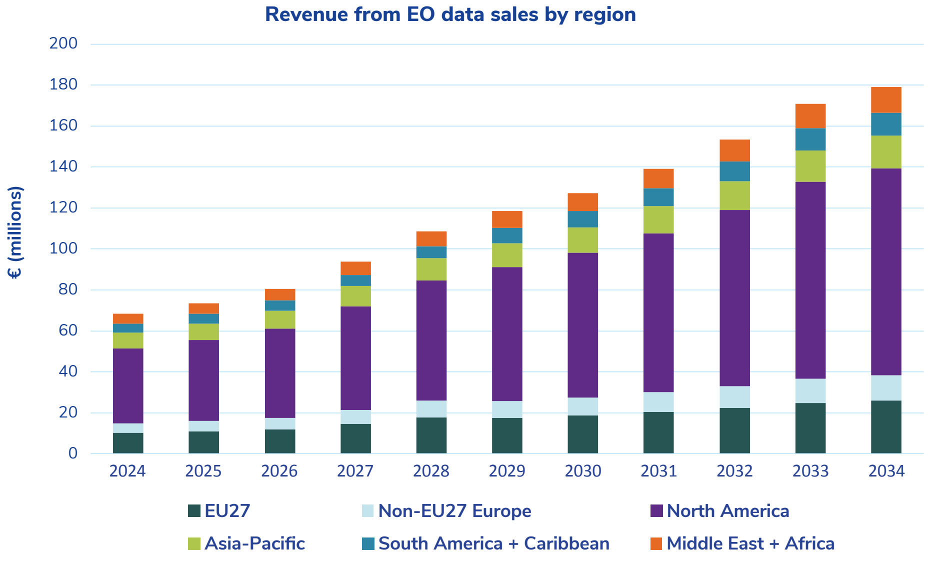
Recent project developments include further development of the **web-based monitoring** and optimisation platform, integration of **additional spatial and socioeconomic data**, and testing in multiple regions to strengthen decision-support capabilities for CAP agri-environmental schemes.

Horizon Europe, a programme of the European Union

SWIM: Surface Water Information Management

SWIM unites SMEs, researchers, and stakeholders from Europe and beyond in a Horizon Europe project to deliver a Copernicus-based application for **comprehensive surface water monitoring**. It fuses EO satellite data with in-situ measurements from the patented **WAMO** (Water Monitoring) **IoT platform** to track water quality, algal blooms, predict water balance, and assess flood/drought risks through AI-driven alerts and visualisations.

The platform combines three main aspects of water management for specific basins: a water quality module for **identification**, **tracking**, **predictive analysis**, and **reporting of indicators**; a water balance module assessing **hydrological balance** of water bodies; and a **natural disaster module identifying and mapping flood/drought risks**. It supports UN SDG 6 and EU Water Framework Directive, enabling reliable decisions for sustainable management.


Revenue from EO data sales by region
€ (millions)
200
180
160
140
120
100
80
60
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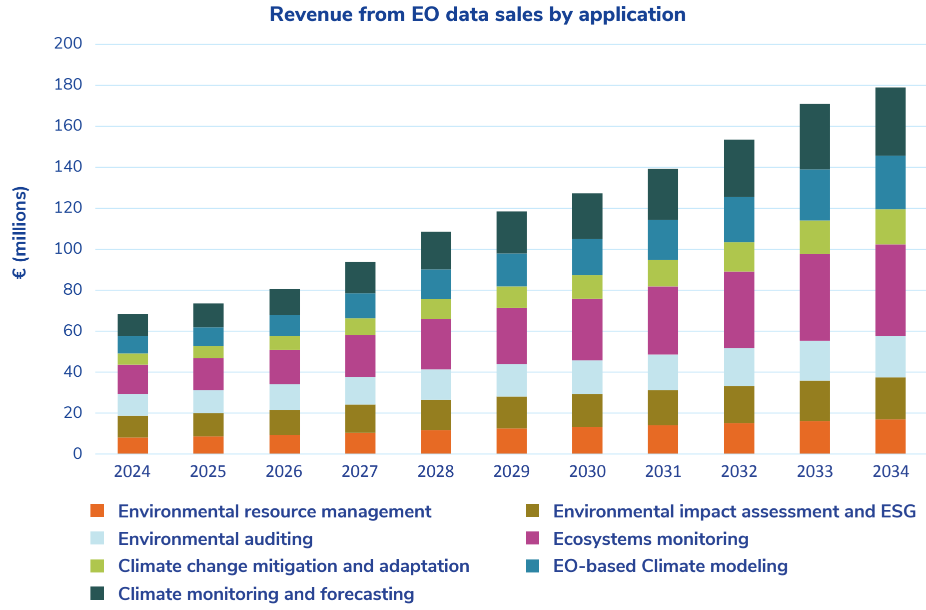
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
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180
160
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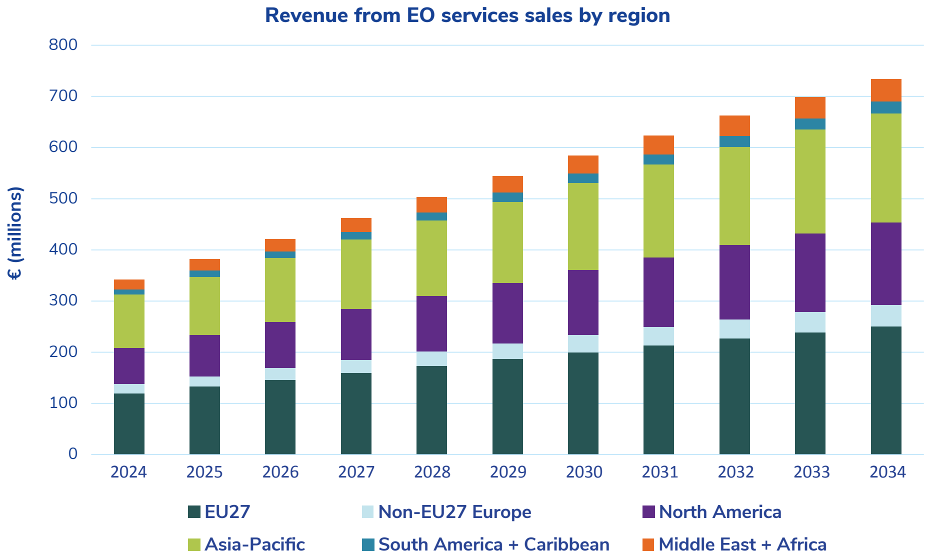
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Environmental resource management
Environmental impact assessment and ESG
Environmental auditing
Ecosystems monitoring
Climate change mitigation and adaptation
EO-based Climate modeling
Climate monitoring and forecasting


Revenue from EO services sales by region
€ (millions)
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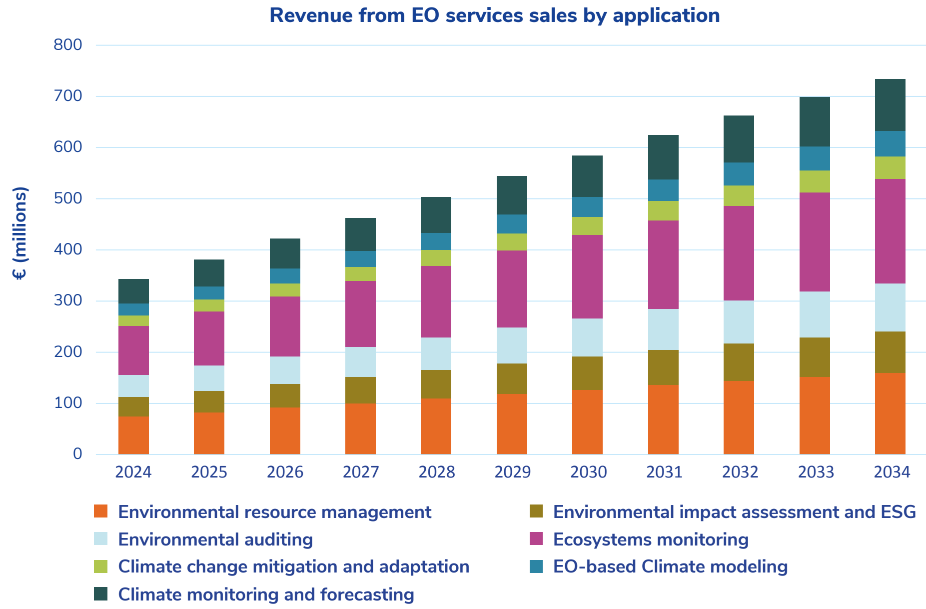
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa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Environmental resource management
Environmental impact assessment and ESG
Environmental auditing
Ecosystems monitoring
Climate change mitigation and adaptation
EO-based Climate modeling
Climate monitoring and forecasting

CONSUMER SOLUTIONS, TOURISM AND HEALTH

Corporate
- Location-based billing
- Geo-advertising
- Mapping and GIS
- Workforce

Health, lifestyle and tourism
- Air quality monitoring
- Games
- Geo-tagging
- mHealth
- Safety and emergency
- Social networks
- Sport, fitness and wellness, incl. specialist
- support tracking
- UV monitoring
- Tourism experience

Navigation and tracking
- Navigation for smartphone users
- Personal & asset tracking
- Visually impaired support

Robotics
- Consumer robotics
- Enhanced human

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

CONSUMER SOLUTIONS, TOURISM AND HEALTH

Consumer solutions are increasingly shaped by the convergence of positioning, connectivity and intelligence embedded directly into everyday devices. EO and GNSS are no longer standalone enablers but integral components of digital consumer ecosystems, supporting a growing range of location-aware, context-sensitive applications across navigation, health and lifestyle, and tourism.

Smartphones and wearables act as primary access points, with positioning and EO data combined with onboard sensors, cloud services and edge processing to deliver personalised, real-time experiences. This shift moves consumer applications from basic tracking and mapping toward adaptive services that respond to user behaviour, environment and conditions.

At the same time, the rapid expansion of connected objects and consumer robotics is extending EO- and GNSS-enabled capabilities beyond personal devices into the physical environment. Improvements in the availability, timeliness and affordability of satellite data are accelerating the integration of EO-derived insights into everyday applications, enabling new services that blend digital convenience with real-world awareness.

Note: the sub-segment consumer solutions is showcased with a **microphone icon** ,the sub-segment health is showcased with a **heart icon** and the sub-segment tourism with a **camera icon** .

What you will find in this chapter

- **Key trends:**
  1. Smartphones and wearables: primary platforms for secure, seamless space-enabled services.
  2. Space-enabled solutions for health and tourism: proactive care and sustainable travel.
- **Industry:** Consumer solutions, tourism and health GNSS and EO value chains.
- **Recent developments:** Global GNSS shipments surge, powering safer and more connected use.
- **GNSS future market evolution:** GNSS-enabled apps fuel growth in navigation, social and location-based services.
- **EO future market evolution:** Earth Observation powers consumer solutions in health, tourism and daily service.
- **European systems:** How Galileo & Copernicus power everyday consumer apps and services.
- **European projects:** EUSPA supports SMEs and start-ups developing GNSS and EO projects for consumer, health and tourism markets.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

Smartphones and wearables: primary platforms for secure, seamless space-enabled services

Key market trends

- Space-enabled data is evolving from episodic measurements to continuous well-being insights, using GNSS and EO to support public-health awareness and more proactive community resilience.
- Eco-scores powered by GNSS and EO are making sustainable tourism measurable, guiding travellers and destinations toward low-impact, environmentally responsible choices.
- Space-enabled connectivity and positioning make medical support possible beyond mobile network reach and ensure reliable emergency communication via smartphones.
- GenAI-powered assistants are reshaping tourism by using GNSS and environmental data to optimise visitor flow, reduce congestion and enhance comfort in real time.

From devices to platforms: smartphones and wearables as the core of space services

Space-enabled data **increasingly underpin everyday digital applications**, even if users are largely unaware of their space origin. Rather than interacting with space services directly, consumers **benefit from them through smartphones and wearables that integrate positioning, timing and connectivity into navigation, health, safety and location-based applications**, with these capabilities operating continuously in the background.

GNSS lies at the core of this evolution, enabling the **georeferencing of users and objects** that supports applications such as mapping, mobility services, fitness tracking, augmented reality and location-aware services. Galileo has strengthened this ecosystem, with **dual-frequency support now available in mid- and high-end consumer devices**, improving positioning accuracy and robustness.

In parallel, **satellite connectivity** is beginning to **complement terrestrial networks by addressing coverage gaps**. Satellite-to-device services are starting to be integrated into consumer electronics, with Apple's Emergency SOS via satellite illustrating how connectivity can be maintained in the absence of cellular networks.

Tracking as utility: peace of mind becomes a built-in feature

Personal, pet and asset tracking is moving from a **visible feature to an invisible default**. Location tags integrated into everyday objects such as purses, bikes, luggage and wearables are **increasingly part of daily routines**, with expectations shifting from **active monitoring to passive reassurance that users are alerted only when something goes wrong**.

This shift is enabled by **space-based positioning technologies** operating quietly in the background. Multi-constellation GNSS, including Galileo, **improves availability and reliability of location information** across a wide range of environments. **Dual-frequency** support, now common in mid- and high-end smartphones, contributes to **more consistent and accurate positioning**, supporting dependable tracking at scale. As of December 2025, nearly 2,400 smartphone models were Galileo-enabled, enabling broad adoption of consumer-tracking services.

As tracking becomes ubiquitous, **trust in location data becomes increasingly important**. Features such as **authenticated navigation signals help protect against spoofing and manipulation**, reinforcing confidence in location information as it becomes embedded into everyday digital ecosystems.

GenAI day-planner: from "show me a map" to "plan and adapt my day"

People increasingly expect **digital assistants** to move beyond **isolated tasks**, such as displaying a map or checking the weather, toward **seamless**, **conversational planning** that adapts throughout the day. To earn trust, these assistants **must be grounded in real-world data**, ensuring that recommendations are reliable, transparent, and explainable.

Space-enabled data provide this foundation. **GNSS** delivers **precise, continuous context on location and movement**, while **EO** and environmental data add **situational awareness such as weather conditions, heat exposure and urban density**.

Building on this foundation, generative AI enables a **shift from static queries to dynamic, context-aware guidance**. Assistants can proactively suggest itineraries, adapt schedules in real time, and justify recommendations based on changing conditions.

© pexels

Spatial computing at the interface: indoor-outdoor positioning that feels seamless

As **augmented reality matures on smartphones and head-worn displays, digital guidance** increasingly shifts **from screens to the physical environment itself**. Rather than showing users where they are, spatial computing uses positioning to anchor directions, cues and information directly onto the surroundings, enabling users to follow visual guidance, receive on-site safety alerts, and access contextual content exactly where it is relevant.

This experience is enabled by the convergence of **multiple positioning technologies**. Multi-constellation **GNSS**, including Galileo, **provides robust outdoor positioning, while complementary technologies such as UWB, Wi-Fi RTT, and inertial sensors** support precise localisation indoors.

When indoor–outdoor handovers become seamless, navigation evolves into on-scene guidance. Visual arrows, turn cues, and contextual overlays can **support safer routes, improved tourism experiences and more effective crowd management** in complex spaces such as transport hubs, campuses and city centres.

Space-enabled solutions for health and tourism: proactive care and sustainable travel

Key market trends

- Space-enabled data is evolving from episodic measurements to continuous well-being insights, using GNSS and EO to support public-health awareness and more proactive community resilience.
- Eco-scores powered by GNSS and EO are making sustainable tourism measurable, guiding travellers and destinations toward low-impact, environmentally responsible choices.
- Space-enabled connectivity and positioning make medical support possible beyond mobile network reach and ensure reliable emergency communication via smartphones.
- GenAI-powered assistants are reshaping tourism by using GNSS and environmental data to optimise visitor flow, reduce congestion and enhance comfort in real time.

Public health in motion: from situational awareness to daily well-being support

Public health is increasingly shifting from **episodic intervention towards continuous monitoring, situational awareness and daily well-being support**. The scale of chronic disease underlines this transition: cardiovascular diseases caused around 19.2 million deaths globally in 2023; chronic respiratory diseases affected hundreds of millions of people worldwide; and asthma alone impacted more than 260 million individuals globally in recent estimates. At the same time, vector-borne diseases such as dengue continue to expand geographically.

EO supports public health primarily at population level by providing **large-scale environmental indicators**, including air pollution, temperature, humidity, and vegetation dynamics. Together, they enable **improved disease risk mapping, early-warning systems and epidemiological forecasting for respiratory and vector-borne diseases**.

GNSS complements EO by enabling **reliable localisation and time-stamping** of health-related data, supporting remote monitoring and physical activity tracking. **Trusted positioning and timing** are expected to become increasingly **important for data integrity and interoperability**. In this context, authenticated GNSS services such as OSNMA could play a role by enabling reliable positioning.

Emergency messaging when networks fail: smartphones connected by satellites

Extreme weather events and outdoor incidents increasingly reveal the limits of terrestrial connectivity, especially in remote or overloaded areas. When mobile networks fail, people rely on **alternative ways to send distress alerts and share their location**. A growing trend in emergency management and humanitarian aid is **the use of consumer smartphones that can connect directly to satellites when no cellular coverage is available**.

Satellite-to-device messaging and GNSS positioning help bridge this gap **by enabling emergency alerts with accurate location information even without a mobile signal**. These capabilities extend the reach of rescue services into areas that would otherwise remain unconnected.

Recent deployments show this becoming available at consumer level. A notable example is the SOS service on iPhone 14 and later models, which uses the Globalstar constellation and is already supported in several EU countries. This complements traditional Personal Locator Beacons used by professionals and experienced outdoor users, covered in the Emergency Management and Humanitarian Aid segment of this report, offering a broader range of life-saving tools for the public.

The eco-score era: sustainable tourism you can see

Globally, tourism keeps growing. According to UN Tourism, 1.4 billion international arrivals are expected in 2024 as the baseline, with a 4% growth projection for 2025. At the same time, **destinations face increasing climate-driven stress**. Heat waves and air-quality episodes affect **visitor comfort and safety, while pressure on ecosystems threatens long-term attractiveness**. In response, travellers and policymakers are demanding **clearer, more transparent sustainability indicators** to guide choices and manage impacts.

EO contributes to meeting this demand by providing **consistent, comparable environmental data**. Copernicus services support **monitoring of land-surface temperature, air quality, vegetation and land use, and coastal water conditions**, which can be combined with other data sources such as mobility, infrastructure and GNSS-derived accessibility indicators. Together, these inputs feed **into sustainability and eco-performance metrics** that help benchmark destinations and steer demand **towards lower-impact options**.

Several destinations are already applying **data-driven approaches to tourism sustainability**. Cities and regions use environmental monitoring, mobility data and planning tools to **manage visitor flows, protect sensitive areas and support long-term destination planning**. At the same time, digital platforms and public dashboards are emerging to make sustainability indicators more visible to both authorities and travellers, enabling more informed decisions and accountability.

No lines, just landmarks: AI reshapes visitor flow and comfort

The tourism sector is embracing a **clear shift toward AI-driven visitor assistance**, with growing interest in **services that adapt to real-time conditions**. Solutions combining **GNSS positioning with Copernicus environmental information are increasingly explored to improve comfort and safety**. Early deployments already show how live spatial data can support better routing decisions, for example by helping visitors choose cooler paths, avoid exposed areas or adjust their itinerary based on local conditions.

AI guide assistants represent one of the fastest-advancing areas in this trend. Powered by GNSS-enabled language models, they are becoming more conversational and context-aware, offering personalised cultural insights and on-site guidance. Queue and flow-management systems that leverage GNSS and EO data are also gaining traction as destinations and theme parks explore smarter ways to distribute crowds and anticipate pressure points. While these solutions range from pilots to early deployments, they reflect a clear market direction: integrating live spatial data into visitor-flow strategies to reduce congestion and enhance overall satisfaction.

Consumer Solutions, Tourism and Health GNSS Value Chain[1]

GNSS

COMPONENT AND RECEIVER MANUFACTURERS

- BEIJING BDSTAR NAVIGATION
- BROADCOM
- INFINEON*
- INTEL
- LEADTEK RESEARCH
- MEDIATEK
- NIHON DEMPA KOGYO
- NXP SEMICONDUCTORS*
- QUALCOMM
- QUECTEL WIRELESS
- SAMSUNG
- SEIKO EPSON
- SIERRA WIRELESS
- SITRONIX TECHNOLOGY
- SONY
- SPREADTRUM COMMUNICATIONS
- STMICROELECTRONICS*
- U-BLOX*
- UNISTRONG GNSS
- YAGEO

OPERATING SYSTEM DEVELOPERS

- APPLE (IOS)
- CANONICAL* (UBUNTU)
- GOOGLE (ANDROID)
- JOLLA* (SAILFISH)
- LINUX FOUNDATION(LINUX)
- MICROSOFT (WINDOWS)

DEVICE INTEGRATORS AND VENDORS

SMARTPHONE/TABLETS:
- ALPHABET
- APPLE
- ASUS
- GOOGLE
- HUAWEI
- LENOVO
- LG
- NOKIA
- NOTHING
- OPPO
- SAMSUNG
- SONY
- VIVO
- XIAOMI
- ZTE

WEARABLES:
- ALPHABET
- APPLE
- AMER SPORTS*
- GARMIN
- LG
- POLAR*
- SAMSUNG
- SUUNTO*
- XIAOMI

- **PEOPLE TRACKING DEVICE MANUFACTURERS**
- **ORIGINAL DESIGN MANUFACTURERS**
- **CAMERA ANUFACTURERS**
- **PC MANUFACTURERS**

SERVICE & CONTENT PROVIDERS

GNSS MOBILE NETWORK OPERATORS AND ASSISTANCE DATA PROVIDERS:
- AT&T MOBILIT
- KDDI
- ORANGE*
- SOFTBANK
- TELEFÓNICA*
- VERIZON WIRELESS
- VODAFONE*

APP DEVELOPERS/ RETAILERS

GENERAL APP DEVELOPERS:
- ALIBABA
- APPLE
- GOOGLE
- META
- MICROSOFT
- SAMSUNG
- SUPERCELL*
- TENCENT
- TRIPADVISOR
- XIAOMI
- Many small app
- developers

mCOMMERCE:
- ALIBABA
- AMAZON
- EBAY
- PAYPAL
- RAKUTEN
- ZALANDO*

mHEALTH:
- CALM
- FITBIT
- FLO HEALTH*
- HEADSPAC
- MYFITNESSPAL

RETAILERS:
AIRLINES, BANKS, GENERAL RETAILERS, MEDIA COMPANIES, MOBILE NETWORK OPERATORS, TRANSPORT PROVIDERS, VEHICLE MANUFACTURERS

APP STORES

- AMAZON APPSTORE
- APPLE APP STORE
- GOOGLE PLAY
- HUAWEI APPGALLERY
- MICROSOFT STORE
- TENCENT APPSTORE

END USERS

- CITIZENS
- ELDERLY AND VULNERABLE GROUPS
- TOURISTS
- SPORT ENTHUSIASTS
- WORKFORCE
- TOURISM BOARDS
- DESTINATION MANAGERS
- HOSPITALITY
- PROVIDERS
- TOUR OPERATORS
- RESORT SERVICES

LEGEND

Commercial offering
Public offering
User segments

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

European[2] GNSS industry in the global arena

As of 2024, the latest available industry data indicate that European players such as STMicroelectronics, Infineon Technologies and u-blox remained among the top 10 global companies in the GNSS components and receivers market. Based on these figures, Europe accounts for around 5% of global market share, still trailing North America (50%) and Asia (45%). At the system integration level, European GNSS integrators, including smartphone and wearable manufacturers, continue to represent around 5% of global segment turnover, compared with Asia's 60% and North America's 35%.

Consumer Solutions, Tourism and Health EO Value Chain[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- CGSTL
- GEOSAT*
- E-GEOS*
- ICEYE*
- PLANET
- UMBRA
- VANTOR

Map Providers:
APPLE, GOOGLE, HERE*, MAPQUEST MICROSOFT, OPENSTREETMAP*, TOMTOM*

- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- NISAR (NASA/ISRO)
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- ADAM*
- PIESAT
- CLEOS*
- CREODIAS*
- GOOGLE EARTH ENGINE
- NOR*
- SENTINEL HUB* (PLANET)
- TERRADUE*
- UP42*
- VANTOR
- VITO*

- COPERNICUS DATA SPACE ECOYSTEM (CDSE)*
- DESTINE*
- WEKEO*

EO PRODUCT AND SERVICE PROVIDERS

- AIRBUS*
- BIKEMAPPS*
- CGI
- DEEPTRACE TECHNOLOGIES*
- DATEL*
- EOMAP*
- MURMURATION*
- PLANETEK*
- SEACRAS*
- VANTOR

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- DESTINE*

INFORMATION PROVIDERS

- ACCUWEATHER
- AIRBUS*
- ARCTUR*
- CAIUS*
- CGI
- DRAXIS*
- RISKMAP*
- SCIDRONES*
- SM GEODIS*
- VANTOR
- WINDY*

END USERS

- SMARTPHONE DEVELOPERS
- APP DEVELOPERS
- CITIZENS
- ELDERLY AND VULNERABLE GROUPS
- TOURISTS
- SPORT ENTHUSIASTS
- WORKFORCE
- TOURISM BOARDS
- DESTINATION MANAGERS
- HOSPITALITY PROVIDERS
- TOUR OPERATORS
- RESORT SERVICES

LEGEND

Commercial offering
Public offering
User segments

NOTES

1: The value chain considers the key global and European companies involved in EO downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

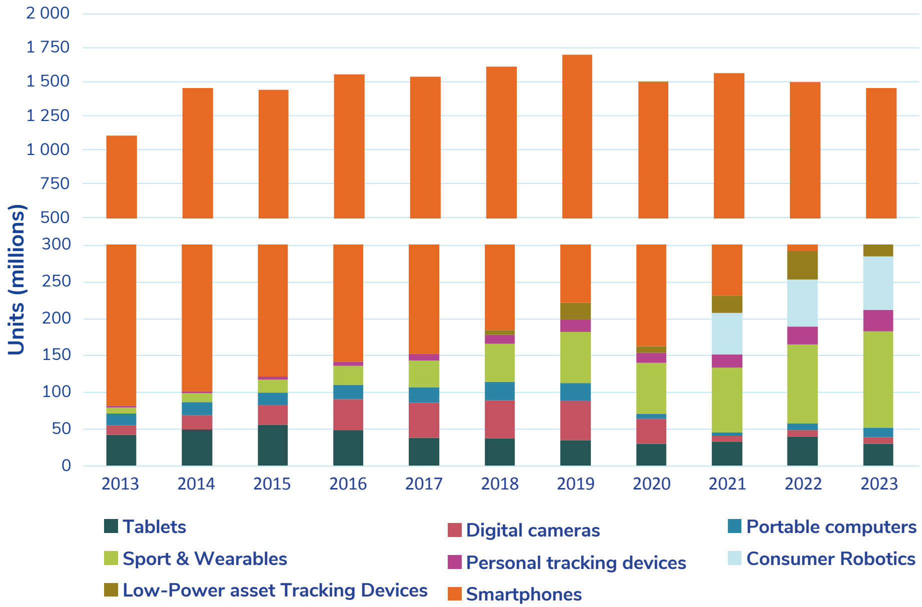
Please refer to page 20 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

European[2] EO industry in the global arena

The latest available market evidence shows that European Earth Observation companies represent nearly one third of global market share, with leading players such as Airbus, Hispasat and ICEYE. Despite this solid European footprint, North American firms continue to dominate the sector, capturing around 60% of worldwide EO revenues.

Global GNSS shipments surge, powering safer and more connected use



GNSS device shipments for consumer applications fluctuated between 2013 and 2018, before reaching a peak of around 1.65 billion units in 2019. After this spike, shipments declined and by 2023 had stabilised at levels below the earlier peak. Smartphones dominate throughout the decade, shaping the overall trend and accounting for most shipments. Their growth slows after 2019 as markets saturate, replacement cycles lengthen, and sustainability initiatives encourage repairability and extended warranties.

Sport and wearables devices has emerged as the second-largest category, driven by health, fitness and safety applications. Their steady rise reflects the integration of advanced sensors and GNSS connectivity, positioning wearables as a key diversification driver. **Personal tracking devices and low-power asset trackers have gained traction**, supported by affordability, family safety awareness and logistics demand. **Consumer robotics entered the market later**, with GNSS-enabled lawn mowers and delivery robots appearing in 2022 and growing in 2023, signalling the start of a new segment.

Shipments of legacy applications decline over the period. Tablets, portable computers and digital cameras decline as multifunctional smartphones and wearables absorb their functions, leaving them marginal by 2023. This shift underscores the consolidation of location services into connected, adaptive devices.

Overall, the chart to the left illustrates a transition from a smartphone-centric ecosystem to a more diversified GNSS landscape, where wearables, trackers and robotics complement phones and broaden adoption across health, safety and automation. Although total shipments have not returned to their earlier peak levels, the changing mix reflects shifting consumer priorities and the emergence of new GNSS-enabled use cases.

Space-enabled health and safety services: resilient, off-grid and disaster-ready

Recent developments in space technologies are **significantly enhancing the resilience of health and safety services**, particularly in **off-grid, disaster-affected, or high-demand situations** where terrestrial networks may be unavailable or unreliable.

Advances in **GNSS are improving the real-time georeferencing of users**, responders, and events, which is essential for **emergency localisation**, coordination, and the reliable logging of response actions. This positioning and timing capability underpins a wide range of safety-critical applications and services used daily by health and emergency actors. Within this evolution, Galileo contributes **increased robustness and performance for applications requiring high reliability**.

In parallel, **satellite communications** are evolving **beyond traditional terminals toward direct satellite-to-device connectivity**. Emerging satellite-to-phone messaging and voice capabilities aim to **provide seamless emergency communication** using standard consumer devices, extending health and safety services beyond the reach of terrestrial networks. Although still under deployment, these developments mark a major step toward **ubiquitous access to emergency communications**.

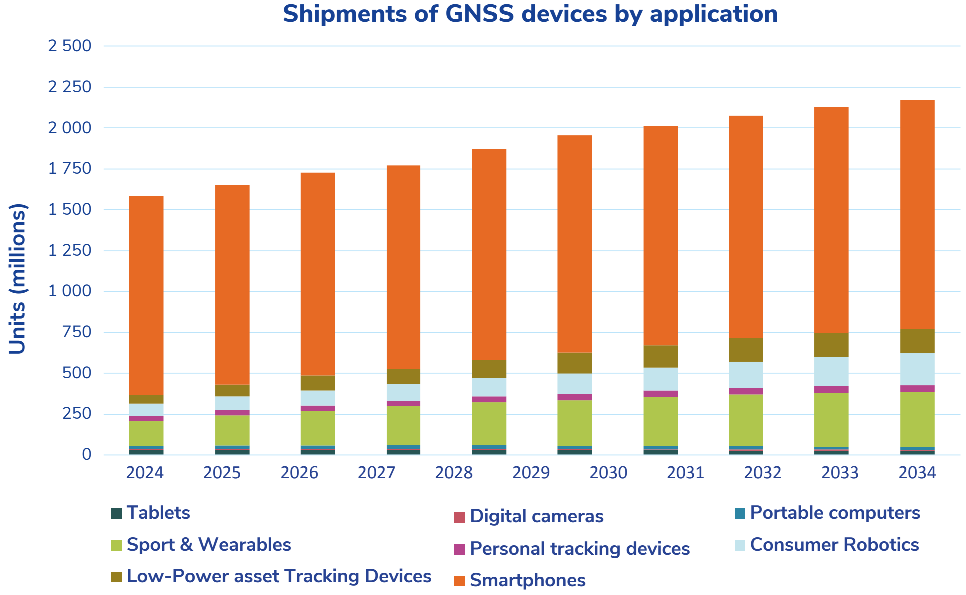
Autonomous home robots: enhancing convenience, safety and daily support

Autonomous home robots are entering a phase of **accelerated deployment as consumer demand shifts from single-purpose devices toward multifunctional systems** combining convenience, safety and outdoor capability.

Recent progress is particularly visible in **outdoor-capable home robots**, where **GNSS** has become **a key enabling technology**. The latest generation of robotic lawn and garden systems is transitioning from **physical boundary installations to RTK-GNSS virtual boundaries**, enabling decimetre-level positioning, precise path planning and safety georeferencing without buried wires. Reliability in residential environments is achieved **through sensor fusion, combining GNSS and RTK corrections with cameras, LiDAR and inertial sensors** to maintain performance near buildings and trees, and during temporary signal obstructions.

Beyond garden automation, similar navigation principles are being adopted by emerging residential delivery and support robots operating in neighbourhood environments. These systems increasingly rely on multi-constellation GNSS integrated with high-definition maps and vision-based perception to achieve accurate localisation, obstacle avoidance, and curb-level navigation. This evolution demonstrates how **GNSS is extending autonomous robotic services beyond the home itself**, enabling new forms of daily support and last-metre autonomy in dynamic, real-world conditions.

GNSS-enabled apps fuel growth in navigation, social and location-based services



GNSS device shipments for consumer applications are projected to grow from about 1.58 billion units in 2024 to around 2.25 billion by 2034, marking a steady upward trend after the earlier plateau. **Smartphones remain the dominant category throughout the period**, but their share is expected to decline gradually as markets mature and replacement cycles lengthen, even though absolute volumes continue to rise.

Sport and wearables devices strengthen their position as the second-largest segment, driven by health, fitness and safety applications, and supported by integration of advanced sensors and GNSS connectivity. **Personal tracking devices and low-power asset trackers are expected to continue growing towards market maturity**, supported by their affordability and ongoing demand for family safety and logistics visibility. **Consumer robotics is expected to accelerate sharply**, led by GNSS-enabled lawn mowers and delivery robots that rely on RTK positioning and sensor fusion for autonomy.

Legacy categories such as tablets, portable computers, and digital cameras remain marginal, continuing their long-term decline as multifunctional smartphones and wearables absorb their functions. By 2034, these segments are projected to account for only a small fraction of total shipments.

Overall, the forecast shows a transition from a smartphone-centric market to a more diversified GNSS ecosystem, where wearables, trackers and robotics drive incremental growth and broaden GNSS adoption across health, safety and automation. This evolution reflects consumer demand for connected, adaptive devices and positions GNSS as a core enabler of next-generation services.

Enhanced flexibility in the workplace through real-time tracking

Future developments will see **real-time workforce tracking evolve from reactive monitoring to predictive and adaptive deployment. GNSS-enabled positioning** integrated into vehicles, tools and mobile devices will increasingly be **combined with analytics and automation** to anticipate needs, dynamically allocate staff, and optimise operations based on live conditions and operational priorities.

EO data will further enhance these systems by providing **anticipatory insights into weather events, traffic congestion and other environmental constraints**. Workforce management platforms will progressively integrate these inputs to automatically adjust routes, schedules and task assignments, improving **safety, efficiency and continuity of operations**.

Together with resilient satellite communications, these developments will enable **adaptive, context-aware workforce networks capable of operating reliably** even in remote or disrupted environments. Over time, this approach is expected to support **more resilient, responsive and sustainable workforce** management across sectors such as construction, utilities, emergency response and humanitarian operations, particularly in high-risk and dynamic conditions.

Seamless indoor-outdoor transition for visually impaired support

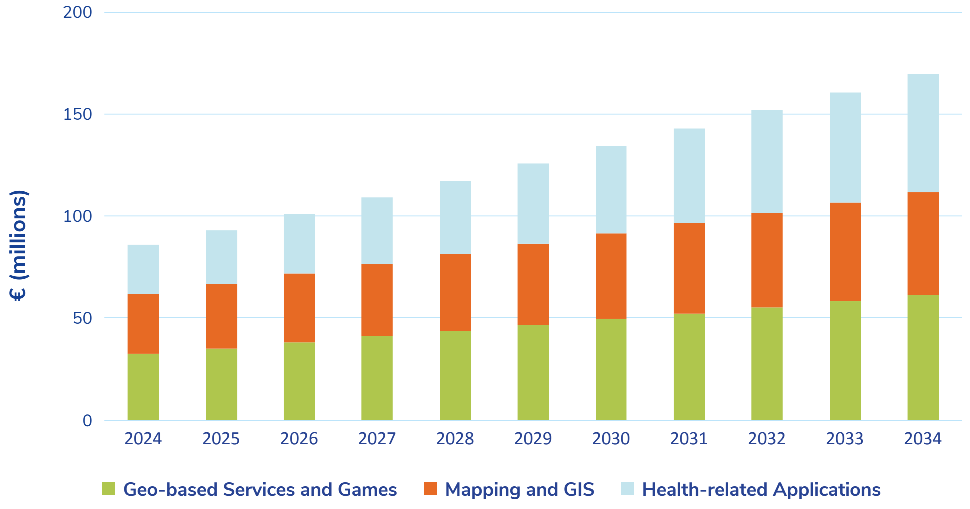
Navigation technologies are evolving toward more **intelligent and adaptive solutions** that aim to enable **seamless indoor–outdoor transitions** for visually impaired users. **GNSS** will continue to provide the foundation for **outdoor positioning**, while **advances in smartphone-based sensor fusion** and on-device processing are expected to **improve continuity of guidance in complex environments such as transport hubs and public buildings**.

Consumer devices are **increasingly positioned to act as integrated navigation platforms**, combining GNSS with inertial sensors, vision-based perception, and connectivity to local infrastructure. This evolution is expected to **support real-time, context-aware instructions that adapt to obstacles, temporary layout changes and crowd conditions**, enhancing **safety and confidence in daily mobility**.

At system level, tighter integration of GNSS with satellite communications and EO data is anticipated to strengthen service resilience by accounting for environmental disruptions such as severe weather or congestion.

EO powers consumer solutions in health, tourism and daily service

Revenue from EO data & services sales by application



Global revenue from EO data and services sales is expected to increase from approximately €85 million in 2024 to nearly €170 million by 2034, corresponding to a CAGR of around 7%.

Revenue growth varies significantly across application areas. Over the entire period, **geo-based services and gaming** remain the **largest revenue drivers**, consistently accounting for roughly 37% of total revenues and growing at a CAGR of close to 7%. Within this category, applications such as geo-based gaming and geo-advertising are expected to deliver particularly strong value creation over the forecast period.

Health-related applications, while representing the smallest revenue share at the beginning of the period, **are projected to grow rapidly**. Their share of total revenues is expected to increase steadily, making health the second-largest application segment by 2034, close behind geo-based service. This segment is forecast to **grow at a CAGR exceeding 9%**, driven by **rising awareness of health issues and increasing recognition of the impact of external environmental factors such as UV exposure and air pollution**.

In contrast, revenues from **mapping and GIS** applications are expected **to grow at a more moderate pace**, with a **CAGR of around 5% over the period**. This slower growth reflects the relative maturity of the segment compared to emerging, high-growth applications such as health and location-based consumer service.

Overall, EO data typically acts as an enabling layer of geospatial information, enhancing audience targeting, supporting advanced mapping functionalities, and providing detailed insights into the surrounding environment or atmospheric conditions.

GNSS-enabled enhanced human technologies

Enhanced Human Technologies (EHT) combine robotics, AI, biotechnology and advanced interfaces to extend human capabilities in mobility, productivity, and safety. These technologies are expected to address healthcare needs, support an aging population, and meet industrial demands for efficiency and resilience.

GNSS will be a key enabler of these developments, providing precise location tracking, real-time connectivity, and adaptive control. This capability will allow **mobility aids and wearable systems to navigate outdoor and urban environments autonomously**, supported by georeferencing, hazard alerts, and context-aware guidance. For individuals with mobility challenges, this means safer movement and greater confidence, while industrial applications will benefit from optimised worker movement, reduced fatigue and improved safety in dynamic, high-risk environments.

As GNSS-integrated EHT evolves, integration with smart city infrastructure will amplify benefits, enabling adaptive urban mobility, responsive emergency services, and location-aware augmented experiences. The convergence of EHT, GNSS, and AI will create a connected ecosystem where human augmentation and operational efficiency become integral to future development.

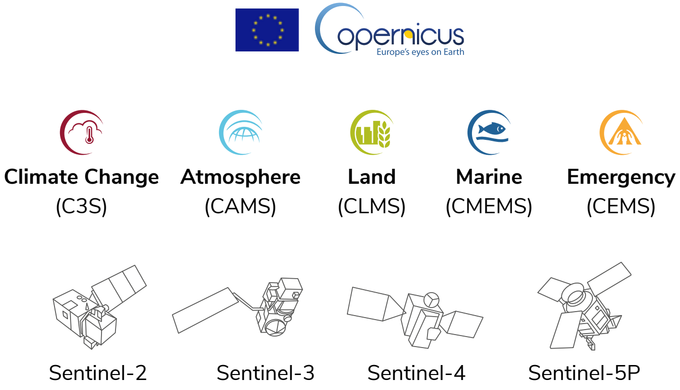
Quantum positioning in everyday devices

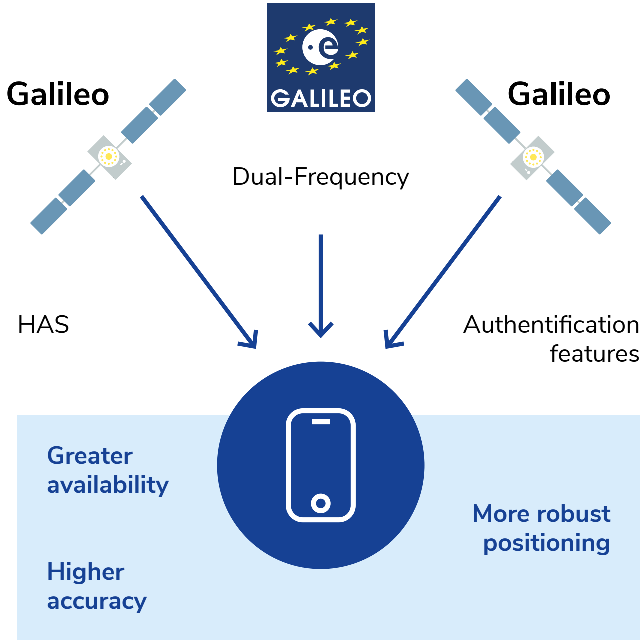
Quantum Positioning Systems (QPS) use quantum sensors such as atom interferometers and quantum gyroscopes to deliver highly accurate motion and location data without relying on satellite signals. This approach is being researched as a solution for environments where GNSS coverage is limited or unavailable, including underground facilities, dense urban areas, and remote regions. Unlike conventional positioning, QPS offers resilience against signal interference and spoofing, making it attractive for critical applications.

Although QPS is still in early development, its potential impact is significant. Initial adoption is expected in sectors where precision and reliability are essential, such as defence, aerospace and autonomous systems operating in GNSS-denied environments. Emergency services and high-value logistics could also benefit from uninterrupted navigation capabilities, ensuring operational continuity under challenging conditions.

Future systems may combine QPS with GNSS and secure authentication layers to create robust positioning solutions. This integration would enhance resilience against interference and improve trustworthiness for navigation in high-risk environments. Technical challenges remain, including miniaturisation, cost reduction and energy efficiency, which will determine the timeline for broader deployment.

How Galileo and Copernicus power everyday consumer apps and services





Copernicus: powering environmental intelligence for land, ocean and climate services

CAMS and C3S deliver essential air quality, weather and climate information that supports tourism and health services. This includes UV and heat stress indicators, pollen forecasts, climate outlooks and other datasets that help public authorities, travellers and health agencies anticipate environmental conditions. Upcoming Sentinel expansion missions, such as LSTM, CO2M and CHIME, will further improve monitoring of land surface temperature, air quality and vegetation health, which are highly relevant for both tourism management and environmental health assessments.

The **Copernicus Land Monitoring Service (CLMS)** provides harmonised land cover, land use and vegetation information derived mainly from Sentinel-2 and Sentinel-3. These datasets support environmental awareness, nature-based recreation and assessments of habitat condition, vegetation stress and wildfire exposure. CLMS products enable downstream services that inform users about changing outdoor conditions and landscape quality.

The **Copernicus Emergency Management Service (CEMS)** complements these capabilities with risk and early warning information. The European and Global Drought Observatories (EDO and GDO) provide drought indices that help assess water scarcity, ecosystem impacts and wildfire risk. The EFAS and GloFAS flood awareness systems deliver flood forecasts and risk information that support civil protection authorities and help safeguard tourism infrastructure. The European Forest Fire Information System (EFFIS) offers fire danger levels, risk indices and damage assessments that are crucial for public safety and environmental protection in fire-prone regions.

The **Copernicus Marine Service (CMEMS)** provides data on sea surface temperature, water colour, currents and water quality. These data underpin services such as bathing water assessments, algal bloom alerts and coastal safety information that are important for coastal tourism and public health. Sentinel-3 observations further enhance the accuracy of marine forecasts and coastal monitoring.

EGNSS is driving accuracy, safety and trusted connectivity for the future

The integration of **Galileo** into consumer solutions continues to grow, driven by the demand for higher positioning accuracy, reliability and resilience. With the progressive adoption of 5G and dual-frequency receivers, smartphones and wearables increasingly benefit from the enhanced precision offered by Galileo. The availability of authenticated and high-accuracy Galileo signals with complementary technologies allow European users to enjoy more reliable navigation in complex urban or indoor environments, improving applications in mobility, tourism and location-based services.

The integration of EGNSS into **Emergency Warning Satellite Services** will allow smartphones to receive authenticated alerts during emergencies, improving reliability and accuracy in critical situations. This development will strengthen Europe's satellite navigation systems as a trusted component of public safety and emergency communication.

The **Open Service Navigation Message Authentication** will deliver advanced data authentication, ensuring that smartphones can offer trusted mobile transactions and precise, secure location-based services. These innovations will establish Europe's satellite navigation systems as critical enablers of next-generation, high-performance consumer experiences.

EUSPA supports SMEs and start-ups developing GNSS and EO applications for consumer, health and tourism markets

niaHealth CASSINI #EUSpace Challenges

ADEN – from satellites to skin health

Nia Health and the University of Augsburg have partnered to launch ADEN, **an innovative platform addressing the growing influence of environmental factors** on chronic skin conditions such as eczema and psoriasis. By integrating **environmental satellite data with patient-reported outcomes**, the system provides personalised and predictive insights that help both patients and clinicians anticipate triggers and develop **tailored treatment strategies with exceptional precision**.

Nia Health offers expertise in certified digital therapeutics and AI-driven dermatology platforms that enable **personalised, data-based care**. The University of Augsburg, through its Institute of Environmental Medicine, adds leading research on the complex interactions between environmental factors and human health.

Supported by EUSPA through the ADEN initiative, this collaboration bridges space technology and healthcare, improving accessibility, precision and sustainability in digital healthcare across Europe.

MURMURATION CASSINI #EUSpace Challenges

Murmuration – environmental monitoring for tourism

Murmuration **leverages EO data to monitor the environmental impact of tourism**, delivering insights across air, water, biodiversity, soil and climate. Its dashboards combine global satellite data with local measurements and statistical sources to **provide actionable information for decision-makers, local authorities and tourism operators**.

A key milestone was achieved through a pilot project with a major hospitality stakeholder of global reach. This initiative engaged hotel managers, sustainability teams and local staff to test Murmuration's capabilities in real operational settings. Participants used the system **to track the environmental footprint of hotel activities, identify areas of high tourism pressure and assess the effectiveness of mitigation measures in near real time**.

The pilot demonstrated the platform's ability to translate complex satellite data into intuitive dashboards and practical insights. Hotels reported **greater awareness of their environmental impact**, improved prioritisation of sustainability actions and enhanced communication of eco-performance to guests and stakeholders. These results confirmed Murmuration's potential as a scalable and user-friendly solution for advancing sustainable tourism practices across multiple sites worldwide.

Resmonics EUSPA

Resmonics – intelligent acoustic monitoring for health

Resmonics is developing an **advanced acoustic intelligence system that continuously detects coughs and monitors hygiene practices** in hospitals and care facilities. This approach enables **early identification of infections** and supports improved management of respiratory diseases.

To provide deeper insights, the system **integrates Copernicus EO data, including humidity, temperature, pollen and air quality**. This allows hospitals to understand how environmental conditions influence respiratory symptoms and adapt care strategies accordingly.

As part of an EUSPA demonstrator project under the EU Space Programme, Resmonics combines **AI-driven monitoring with satellite data to deliver early warnings**, anticipate risks and strengthen preventive healthcare against respiratory and infectious disease outbreaks.

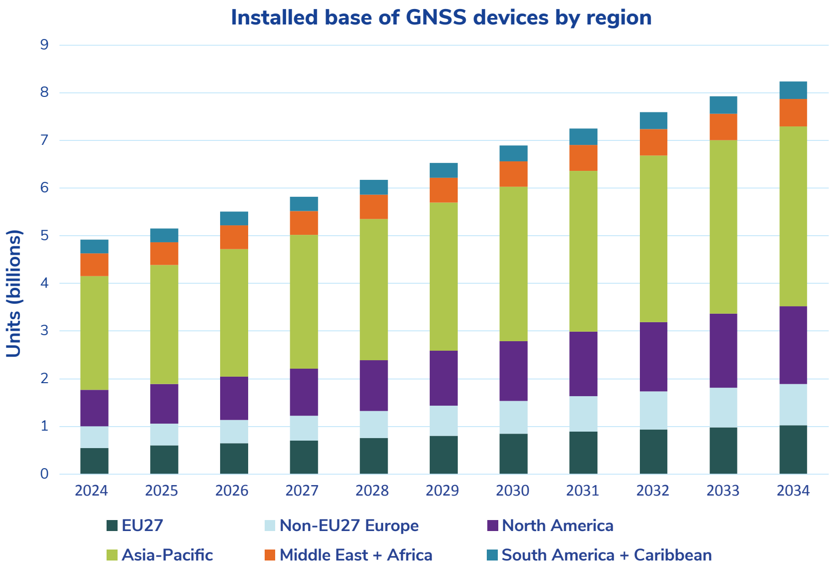
cAius CASSINI #EUSpace Challenges

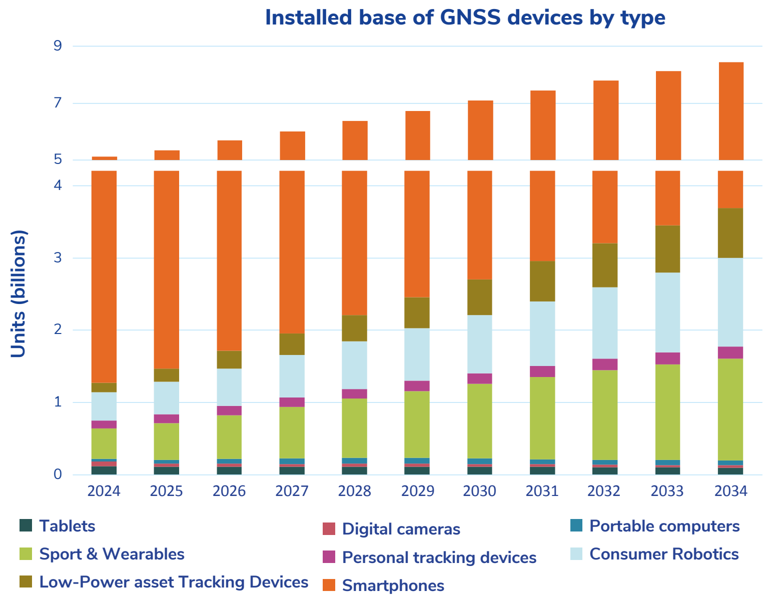
Caius – AI & satellite-driven digitisation

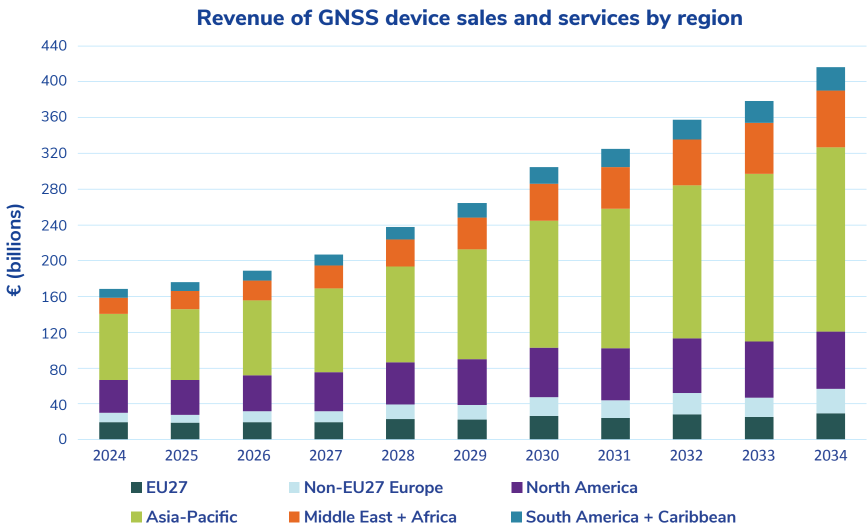
Caius harnesses **Artificial Intelligence and European satellite data from Copernicus and Galileo to automatically digitise rural and natural landscapes**. The platform maps trails, forests and ecosystems, supporting sustainable rural development, environmental protection, and ecotourism.

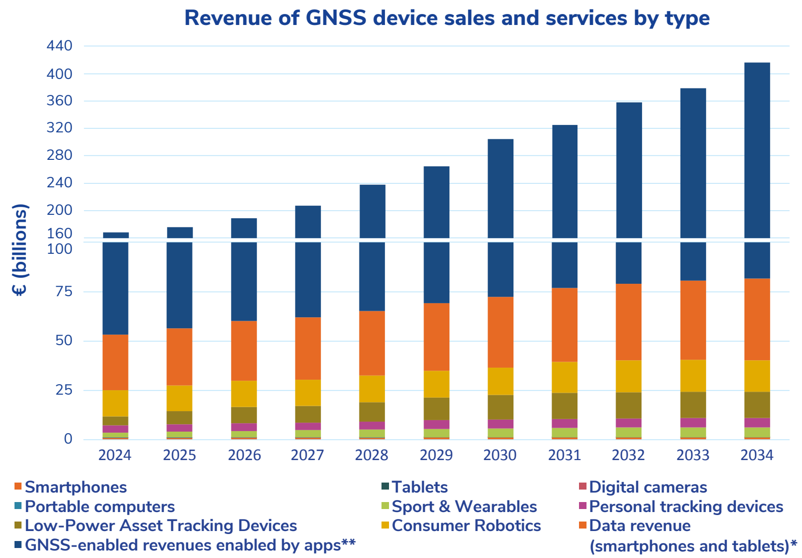
By combining **geomorphological analysis with AI-driven interpretation of satellite imagery, Caius assists local authorities, farmers and tourism providers in environmental monitoring** and land-use planning. Its tools enable informed decisions that balance economic growth with ecological preservation.

Through accessible, data-based solutions, **Caius contributes to biodiversity conservation, disaster prevention** and rural economic development, helping manage Europe's natural heritage in a sustainable and efficient way.

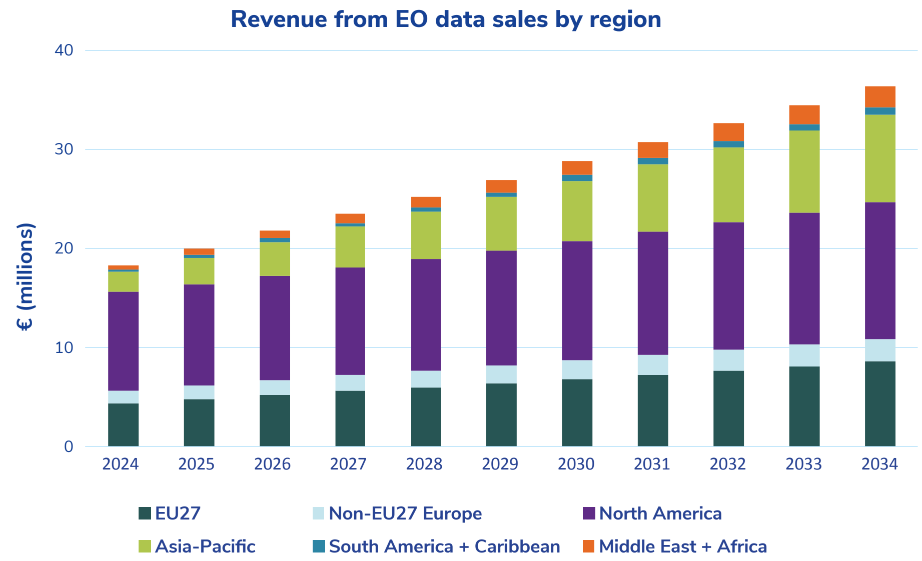








*Only data revenue arising from the use of GNSS-based services considered;
**Pay-to-download, In-app-purchases and ad revenue from health & lifestyle, navigation & trckings, tourism, and corporate apps


Revenue from EO data sales by region
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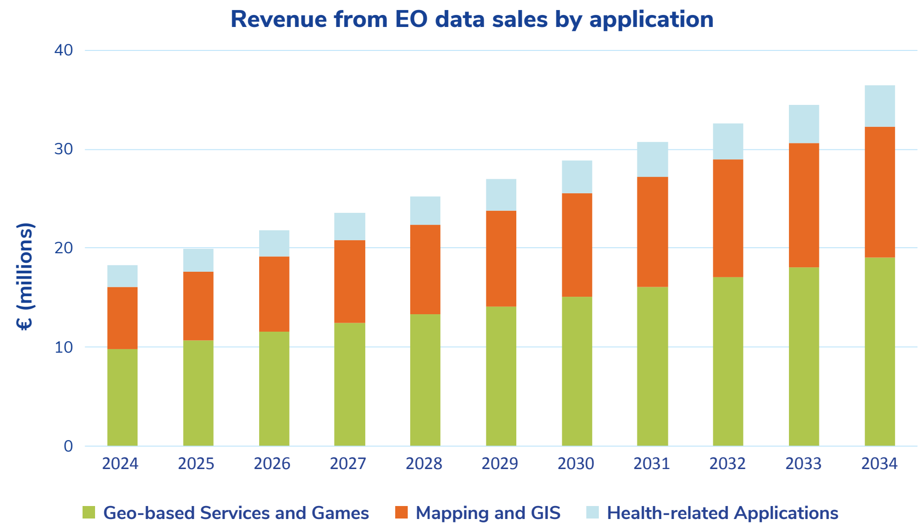
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
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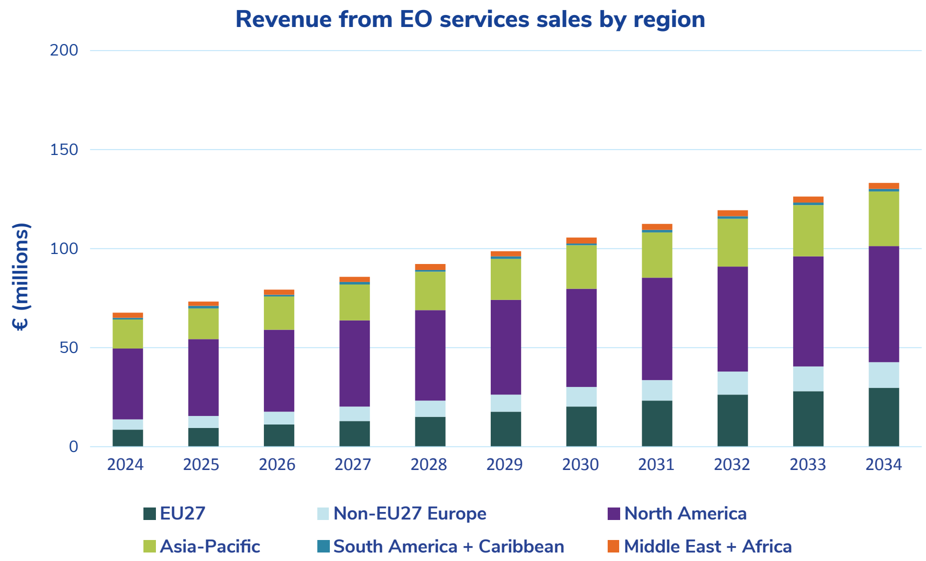
Geo-based Services and Games
Mapping and GIS
Health-related Applications


Revenue from EO services sales by region
€ (millions)
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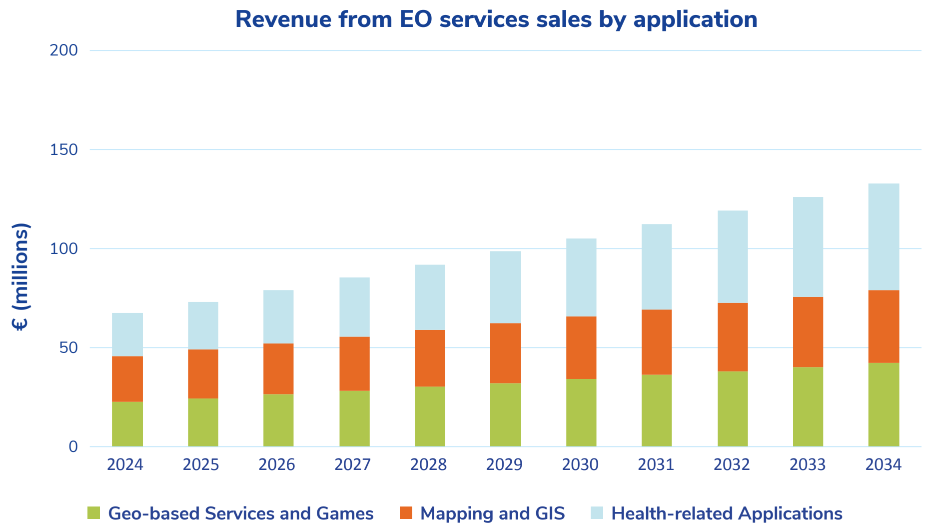
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO services sales by application
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2034
Geo-based Services and Games
Mapping and GIS
Health-related Applications

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EMERGENCY MANAGEMENT AND HUMANITARIAN AID

Prevention and mitigation

- Impact exposure analysis and proactive mitigation measures

Preparedness

- Early warning emergency applications
- Hazard monitoring

Response

- Crisis area assessment
- Operational wildfires modelling

Post-event recovery

- Post-crisis damage assessment and building inspection
- Restoration of supply chains and infrastructure services

Humanitarian aid

- Health and medicine response and coordination (incl. anticipatory humanitarian action)
- Management of refugee camps
- Population displacement monitoring
- NGO asset management[1]
- Welcome applications to people in need of humanitarian aid

Search and Rescue

- SAR operations: at sea[2]
- SAR operations: aviation[3]
- SAR operations: land[4]
- Situational awareness supporting SAR

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

1: Incl. Telematics for vehicles and assets
2: Incl. Emergency Position Indicating Radio Beacon (EPIRB), PLB, Automatic Identification System Search And Rescue Transponder (AIS-SART) and Automatic Identification System Man Overboard Beacon (AIS-MOB)
3: Incl. Emergency locator transmitter (ELT), Emergency locator transmitter Distress Tracking (ELT-DT) and Personal Locator Beacons (PLBs)
4: Incl. PLBs

EMERGENCY MANAGEMENT AND HUMANITARIAN AID

When a cyclone makes landfall, a conflict flares or a wildfire races toward a town, emergency managers and humanitarians are most often the first organised systems to react. The EMAid segment brings together these two worlds: **emergency management**, which focuses on protecting people and infrastructure before, during and after a crisis; and **humanitarian aid**, which delivers life-saving assistance and protection to affected populations, guided by humanitarian principles.

EMAid is powered by a dense network of actors: national civil-protection services, international organisations, the EU and UN systems, NGOs, specialised agencies and an increasingly active private sector. Commercial providers supply EO-based mapping, analytics platforms, GNSS-enabled tracking devices, terminals and apps that support both operations rooms and teams in the field, with the increasing role of AI to speed up decisions and shifting the domain to being more predictive than reactive oriented.

GNSS in EMAid supplies the “where” for almost every decision. Reliable positioning enables convoy routing, last-mile navigation, asset and warehouse tracking, geotagged assessments and proof-of-delivery in challenging environments where road signs, landmarks and even cellular coverage may be absent. Whether coordinating airlifts after an earthquake, trucking vaccines through flood-affected areas or managing refugee camp logistics, GNSS is now a core utility for emergency and humanitarian operations.

Earth Observation satellite imagery supports long-term risk and exposure analysis, preparedness planning and rapid overviews of floods, fires, landslides or conflict damage as events unfold. By comparing new scenes with historical archives, analysts can quantify impacts, guide recovery decisions and provide access and damage maps for search-and-rescue teams, even in remote or insecure areas.

Secure SATCOM provides trusted, available and reliable connectivity for search and rescue, humanitarian aid delivery, real-time emergency response, and coordinated post-event recovery when other networks fail, as covered more in detail in the EUSPA Secure SATCOM Report.

Together, and increasingly in combination with AI and secure satellite communications, EO, GNSS and Secure SATCOM are pushing EMAid from reactive response to intelligence-led operations. Decisions will rely less on fragmented field reports and more on shared, real-time geospatial intelligence and predictive models. This shift will enable earlier warnings, smarter resource prioritisation and more targeted, accountable assistance for those in need of help.

Cross-reference: *GNSS-enabled search and rescue beacons are presented and quantified in this market segment. However, these beacons are used by different users across maritime and inland waterways, fisheries and aquaculture, manned aviation as well as on land (e.g. consumer solutions).*

What you will find in this chapter

- **Key trends:** Navigating crises from above: EO solutions for climate, conflict, and urban development.
- **Industry:** Emergency management and humanitarian aid value chains.
- **Recent developments:** GNSS evolves into a secure, always-on lifeline for emergencies and humanitarian response.
- **Recent developments:** AI as predictive engine for Emergency Management and Humanitarian Aid.
- **Future market evolution:** Next-generation crisis response: secure GNSS, SATCOM and predictive EO.
- **European systems and projects:** EU satellite services power next-generation emergency and humanitarian operations.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region in the EMAid sector.

Navigating crises from above: EO solutions for climate, conflict, and urban development

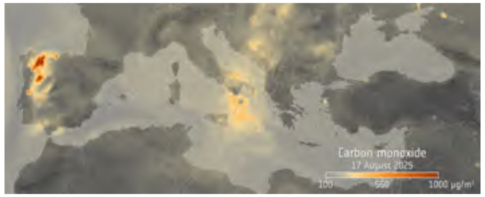
Key market trends

- Climate change, including increasingly frequent incidents of extreme weather, is driving the evolution of EO solutions.
- The escalation of conflicts, instability and displacement, along with funding pressures, have brought space technologies to the humanitarian frontline.
- Vulnerabilities from rapid urbanisation: modernising civil protection thanks to space technologies.

Rising climate risks accelerate the evolution of EO-powered emergency solutions

Climate-driven disasters, such as floods, wildfires, droughts and severe storms, are becoming more frequent and intense, exposing more people and stretching response capacities. Average annual disaster losses rose from around $70–80 billion in 1970–2000 to $180–200bn in 2001–2020. In early **2025 alone, global economic losses reached an estimated $131bn**, slightly below the $155bn in the first half of 2024, but still significantly above historical norms. Insured losses in the same period amounted to $80bn, the second-highest ever recorded for these months.

Satellite applications help preventive actions that aim to reduce risk and losses. **EO services are now essential across the emergency management cycle**, supporting anticipatory risk analysis, early warning, preparedness, real-time response and post-event recovery. EO data enable rapid, continuous mapping of floods, fires, droughts and cyclones, helping authorities understand evolving situations and prioritise interventions. SAR-based missions and open **EO systems such as Copernicus offer all-weather, day-and-night coverage**, feeding climate adaptation and resilience planning, including in regions with data gaps. Emerging AI solutions, such as RSS-Hydro's FloodPin, deliver near-real-time flood maps and damage assessments within minutes, supporting faster and more targeted decisions.



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Modernising civil protection for rapidly growing cities with space solutions

Rapid urbanisation - 98% of which is occurring in the Global South - is pushing more people into hazard-prone areas. By 2050, 1.2 billion additional people will live in cities, many in informal settlements with fragile infrastructure. Urban sprawl is extending into the Wildland-Urban Interface, where housing meets flammable vegetation and wildfire danger rises, further increasing exposure to extreme weather, floods, fires and complex urban emergencies.

Operational space-based technologies underpin the full emergency management cycle. Before disasters, high-resolution imagery and urban digital twins map risks, stress-test infrastructure and guide more resilient planning. During crises, EO data support rapid damage assessments, while GNSS provides precise positioning and timing for rescue teams and logistics, ensuring they can navigate and coordinate effectively even when terrestrial communication networks are disrupted. In recovery, EO data track reconstruction and gauge improvements. **The Copernicus Emergency Management Service and the European Flood Awareness System combine satellite observations with regional models** to deliver actionable local insights. Their performance during disasters, such as those that occurred in Turkey, Nepal and Jakarta, shows how global systems can adapt to local needs.

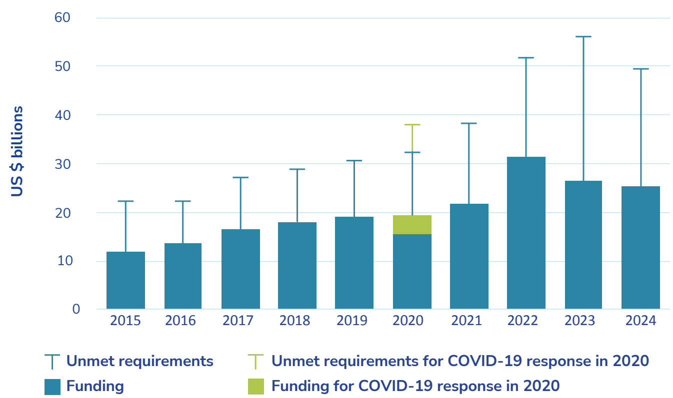
Space technologies at the humanitarian frontline: from reaction to prevention

Humanitarian needs are at record highs, while funding from agencies, NGOs and international institutions is shrinking, with international assistance down **10% in 2024**. Armed **conflicts continue to drive mass displacement**, with forcibly displaced people rising from 65 million in 2015 to about 123 million by the end of 2024. Access constraints make remote monitoring and resilient connectivity essential. As needs outpace resources, the sector must shift **from reactive response to anticipatory action**, using risk analysis and forecasts to reduce losses and costs. Space technologies are key to this effort:

- **EO + GNSS** provide near-real-time mapping of refugee flows, camp expansion and supply routes, strengthening planning and security in volatile contexts.
- **AI-driven analytics** track population movements and infrastructure damage, enabling faster, data-driven decisions and predictive scenarios.
- **LEO SATCOM and portable terminals** restore connectivity for field teams and affected populations when terrestrial networks fail (as piloted in SAT2Rescue project). This trend is driven by handheld and wearable devices, rapidly deployable kits and on-the-move terminals on vehicles and vessels (for more, read EUSPA "GNSS and Secure SATCOM User Technology Report").

The EU Space Programme via Copernicus, Galileo and GOVSATCOM, underpins early warning, vulnerability mapping, logistics and anticipatory planning. **EUSPA's partnership with the Anticipation Hub** is linking space capabilities directly to practitioners to pre-position aid, prioritise vulnerable groups and deliver faster responses. Emerging tools like automated disaster mapping, flexible satellite connectivity services and AI-based risk models further strengthen the ability to act before crises fully unfold. Open geospatial platforms, community mapping and mobile apps empower local responders to act quickly before large deployments occur. UNHCR and UNOSAT are expanding satellite use for camp monitoring, resource planning and post-disaster displacement mapping, demonstrating the operational value of space technologies and their role to sustain impact amid smaller budgets and escalating crises.

Humanitarian funding versus unmet requirements, UN-coordinated appeals, 2015–2024



Source: ALNAP (2025) Global Humanitarian Assistance Report 2025.

Emergency Management and Humanitarian Aid Value Chains[1]

EO

DATA PROVIDERS
- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- GEOSAT*
- E-GEOS*
- ICEYE*
- ORORATECH*
- PLANET
- SPIRE GLOBAL
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- DMC*
- NISAR (NASA/ISRO)
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- RELEVAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS
- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- ORACLE CLOUD INFRASTRUCURE
- OVH CLOUD*
- T-SYSTEMS*

- COPERNICUS COLLABORATIVE GROUND SEGMENT*
- FEDERATED INFRASTRUCTURE (E.G.GAIA-X)*

PLATFORM PROVIDERS
- CREODIAS*
- EDS CEODE
- ESRI ARCGIS
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- OPENEO*
- SENTINEL-HUB (PLANET)
- SKYWATCH
- SPATIAL SERVICES*
- UP42*

- GEOHAZARDS HYDROLOGY TEP*
- COPERNICUS DATASPACE ECOSYSTEM*
- NOAA ONESTOP (NOAA)
- CODE-DE*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS
- 4EARTHINTELLIGENCE*
- CONSTELLR*
- DEIMOS*
- DEWBERRY
- DHI GRAS*
- GAF*
- GEOVILLE*
- GMV*
- HIRIS GUIDER**
- HR WALLINGFORD*
- INDRA SISTEMAS*
- KSAT*
- ORORATECH*
- PIESAT*
- PLANETEK ITALIA*
- RSS HYDRO*
- SERCO*
- SKYGEO
- TRE ALTAMIRA (CLS GROUP)*
- VERISK ANALYTICS

- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*
- COPERNICUS SECURITY SERVICE (CSS)*

INFORMATION PROVIDERS
EMAid CROSS CUTTING:
- E-GEOS*
- EO4GEO*
- SPACE4GOOD*

EMERGENCY MANAGEMENT SERVICES:
- ORBITAL INSIGHTS*

HUMANITARIAN AID SERVICES:
- GEOHUM*

- UNOSAT (UNITAR)
- IMMAP .
- MAPACTION
- HUMANITARIAN tOPENSTREETMAP

END USERS
- CIVIL PROTECTIONS, SMALL PUBLIC SPACE AGENCIES.
- NATIONAL GOVERNMENTS
- NGOS (UNHCR, RED CROSS, MEDICINS SANS FRONTIERES (MSF))
- REGIONAL AUTHORITIES

LEGEND

Commercial offering
Public offering / entities
User segments

GNSS

COMPONENT AND RECEIVER MANUFACTURERS
- ACK TECHNOLOGIES
- ACR ELECTRONICS
- ASTRONICS CORPORATION
- COMNAV TECHNOLOGY*
- CORE CORPORATION
- HEICO CORP
- HEXAGON*
- HR SMITH/TECHTEST LIMITED*
- INTELLIAN TECHNOLOGIES
- NEW SUNRISE CO.
- SAFRAN/OROLIA*
- STANDARD COMMUNICATIONS
- U-BLOX*

SAR BEACON MANUFACTURERS
EPIRB & PLB
ACR ELECTRONICS/OCEAN SIGNAL, COBHAM*, FURUNO ELECTRIC, H R SMITH TECHTEST*, ,JAPAN RADIO CO, JOTRON AS*, SAFRAN/OROLIA*

AIS-SART & AIS-MOB
ACR ELECTRONICS, COBHAM*, FURUNO ELECTRIC, JOTRON AS*, ACR ELECTRONICS/OCEAN SIGNAL*, SAFRAN/OROLIA*

ELT
ACR ELECTRONICS/OCEAN SIGNAL, ASTRONICS CORPORATION, ECA GROUP, GENIEL*, SAFRAN/OROLIA*, H R SMITH/TECHTEST*, SAMYUNG ENC, SYRLINKS*,

SYSTEM INTEGRATORS
- AIRBUS GROUP*
- BOEING COMPANY
- C-ASTRAL*
- FURUNO ELECTRIC
- KONGSBERG MARITIME*
- OCEANEERING INTERNATIONAL
- ST AIRBORNE SYSTEMS AB
- UNITED TECHNOLOGIES CORPORATION
- WÄRTSILÄ*
- HIGHTEK**

END USERS
SEARCH AND RESCUE BEACON USERS
- AIRPLANES AND HELICOPTERS PILOTS
- HIKERS
- FISHING BOAT OPERATORS
- MOUNTAINEERS
- OFF-SHORE OPERATORS
- RECREATIONAL BOATERS
- SHIP OPERATORS
- SOLE MARINERS

SEARCH AND RESCUE RESPONSE
- COAST GUARDS
- COSPAS-SARSAT
- DISASTER MANAGEMENT TEAMS
- JOINT COORDINATION CENTRES

European[2] GNSS and EO industry in the global arena

In EO, the market is often described as being dominated by North America and Asia, which together account for around two-thirds of global demand. European companies capture roughly the remaining one-third, with key players including e-GEOS (Leonardo), Deimos and Indra Sistemas.

In GNSS, European companies held strong positions among GNSS Component and Receiver Manufacturers for EMAid segment in 2024 (Safran/Orolia, U-Blox, HR Smith/Techtest Limited). There are also leading European playears among systems integrators, such as Kongsberg Maritime and Wärtsilä.

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers' step of the value chain often provide platforms as a service. For simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

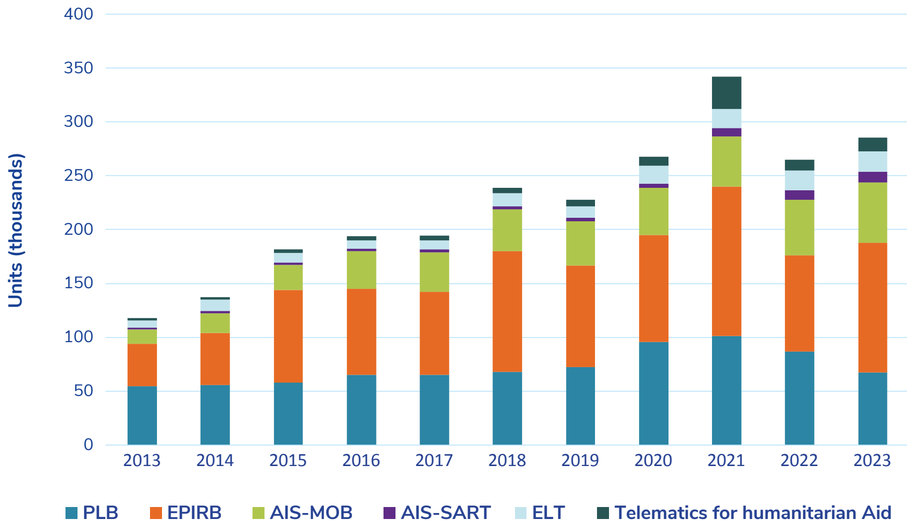
Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

**Company awarded a prize by the EU CASSINI initiative.

GNSS evolves into a secure, always-on lifeline for emergencies and humanitarian response

Shipments of GNSS devices by application



From 2013 to 2023, annual shipments of GNSS emergency devices almost tripled, with a strong upswing from 2018 and a peak in 2023. EPIRBs and PLBs remain the backbone of the market throughout, while AIS-MOB is growing fastest, reflecting tighter crew-safety practices on commercial, offshore and leisure vessels. Another driver is the steady shift from legacy beacons to **GNSS 'location protocol' beacons**, so an increasing share of the total COSPAS-SARSAT fleet now transmits precise GNSS positions. AIS-SART and ELT are increasing at a slower rate from a smaller base but are continuing to modernise the maritime and aviation SAR chains.

A visible shift occurred from 2020 with the appearance of **telematics for humanitarian aid**, NGOs and agencies adopted GNSS-enabled tracking for convoys, warehouses and field teams. Because these operations often take place in contested RF environments, they are particularly exposed to interference, jamming and spoofing, where a falsified GNSS signal can misroute aid or endanger staff.

This is precisely where **Galileo's OSNMA** service becomes strategic: by authenticating the navigation message, it allows humanitarian telematics receivers to detect spoofed signals and increase trust in the reported position. This development trend is laying the foundations for the next phase of growth.

Faster distress detection via satellite-enabled SAR

When a ship, aircraft or hiker triggers a distress beacon today, satellites are among the first 'responders' on the scene. Modern satellite-based search and rescue systems now pick up these signals within minutes and pinpoint their location with remarkable accuracy.

Galileo is fully integrated into the COSPAS-SARSAT MEOSAR framework and has been operational since 2023, with full roll-out completed by 2025. It provides global, near-real-time detection of distress beacons, with positioning typically better than 600 metres and **alerts received within 2–3 minutes** - far faster than the delays of up to an hour seen in earlier generations. **Galileo also introduces the Return Link Service**, which sends a confirmation message to the beacon user once the alert is received and the location determined. For people in distress, the simple message "We've heard you, help is on the way" helps reduce panic and supports better decision-making, while time- window communication enables basic status exchange.

Experience from SAR Meet 2025 exercises and real-world Spanish emergency activations show clearer coordination between agencies, smaller search areas and shorter times to rescue, with Galileo-powered SAR now a critical backbone of modern emergency response.

Smartphones as critical tools during emergencies

In modern emergencies, the first tool many people reach for is not a radio or a siren – it is a smartphone. For professional responders, mobile devices and specialised apps now act as **pocket-sized command centres**, providing real-time situational awareness, GNSS-based team tracking and instant access to mission-critical data. Built-in cameras and automatic geotagging turn photos and videos into **geo-referenced reports**, accelerating assessments and response.

For civilians, smartphones are genuine lifelines. Early warning notifications, **crowdsourced hazard reports and built-in SOS functions** help people receive guidance and share their location when they need help most. Integration with the EU's **Emergency Warning Satellite** Service helps alerts reach communities even when mobile networks are damaged or overloaded. Projects such as AWARE push this further, enabling EWSS messages to reach smartphones and fixed devices in under 60 seconds. Apps like **EU-Alert and Global Disaster Awareness and Coordination System (GDACS) link official warning systems with community action**.

With satellite connectivity via Low Earth Orbit, terminals or hybrid satellite smartphones stay operational during emergencies. Smartphones become a frontline link between satellites, responders and populations.

Satellite IoT and GNSS for emergency logistics and firefighting operations

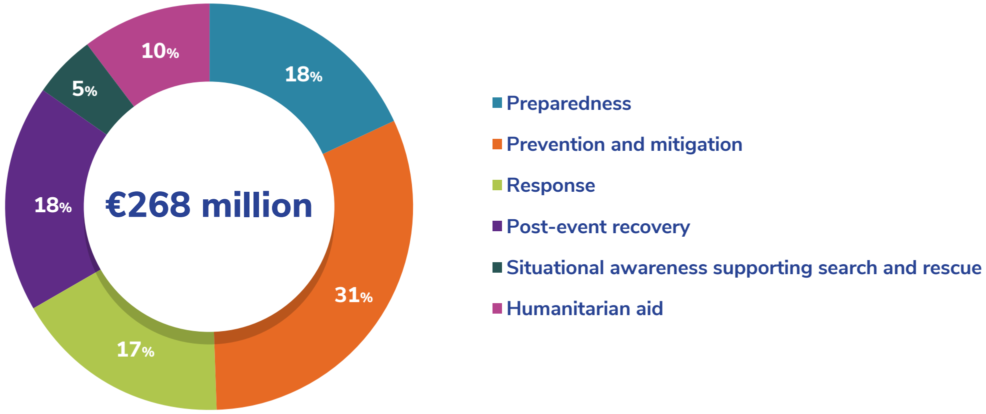
Emergency response is increasingly built on a quiet backbone of **satellite IoT devices combined with GNSS positioning, used to track assets, vehicles and critical supplies in real time**, precisely when terrestrial networks are damaged or down. Nowhere is this more visible than in firefighting logistics, where each minute is critical.

GNSS-enabled IoT trackers allow fire trucks, water tankers and aerial assets to be followed continuously, helping operations centres **optimise routing, avoid blocked roads and safeguard crews** in rapidly evolving fire zones. At the same time, satellite IoT keeps a constant eye on the supply chain for fuel, water and fire retardants, reducing bottlenecks and ensuring that frontline teams receive what they need, where and when they need it.

When cellular networks collapse, Low Earth Orbit (LEO) satellite links and portable terminals preserve communications between commandcentres and field units, keeping the operation coherent under pressure. Recent deployments, such as RoGO Communications' DropBlocks, Globalstar's RM200M modules and Ground Control's satellite asset tracking, show that these capabilities are operational, boosting situational awareness and speeding up wildfire response.

AI as predictive engine for Emergency Management and Humanitarian Aid

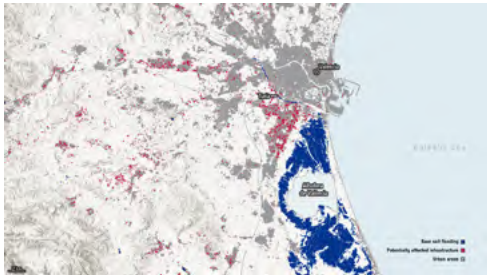
Revenues from EO data & services sales by application in 2024



The EO market for data and services supporting emergency management and humanitarian aid was valued at nearly €268 million in 2024.

Prevention and mitigation represent the largest segment, accounting for 31% of total revenues and showing the strongest growth since 2024. Preparedness follows with an 18% market share, closely trailed by response and post-event recovery. This expansion reflects the growing focus of governments and public institutions on anticipating and managing crises, driven by the increasing frequency and severity of natural and man-made emergencies.

Humanitarian aid applications account for 11% of the market. The smallest share is currently attributed to situational awareness services supporting search and rescue, which have been re-segmented in this year's report. Despite its smaller base, this application is expected to double in size by 2034, building on an already mature service offering and sustained demand growth.



Sentinel-1 derived map of flood affected urban area - Valencia, Spain, 31.10.2024 Credits @ESA

The demand for Communications on the Move

In the area of Secure SATCOM, capacity demand for Communications on the Move (COTM) users is estimated to represent about 25% of the total FSS capacity demand over the 2025 to 2040 period (page 37). The increasing amount of equipment of mobile units (aircraft, vessels, land vehicles and UAVs), together with increasing data transmissions per unit, is expected to support demand.

AI-based services transforming wildfire detection and civil protection

AI-powered satellite services are turning wildfire detection from a reactive task into a proactive, intelligence-led capability for civil protection. What was once experimental is now operational: fires are spotted earlier, false alarms are reduced, and decision-makers see a much clearer picture of what is happening on the ground. The convergence of AI and space technologies brings three main advantages:

- **Speed:** Automated algorithms scan incoming satellite streams for thermal anomalies, smoke patterns and land-use changes, issuing alerts within minutes or hours instead of days. This accelerates the mobilisation of firefighting resources and civil protection teams, especially in fast-moving events.
- **Reach:** Multi-satellite constellations provide continuous coverage of remote forests, mountain regions and expanding Wildland–Urban Interfaces. They capture not only new ignitions but also evolving fire fronts and population movements during crises, giving authorities a real-time view of risk.
- **Integration:** Outputs feed directly into civil protection platforms and command centres, supporting dynamic resource allocation, evacuation planning and anticipatory action. Combining thermal imaging, AI-driven analytics and GNSS geolocation allows responders to pinpoint threats, prioritise assets and communicate clear guidance to the public.

Companies like OroraTech and Constellr are at the forefront of combining satellite images with near-real-time wildfire analytics for detection and risk-assessment. Their systems are an innovative part of climate-resilience strategies and day-to-day emergency response.

High demand for synthetic aperture radar constellations

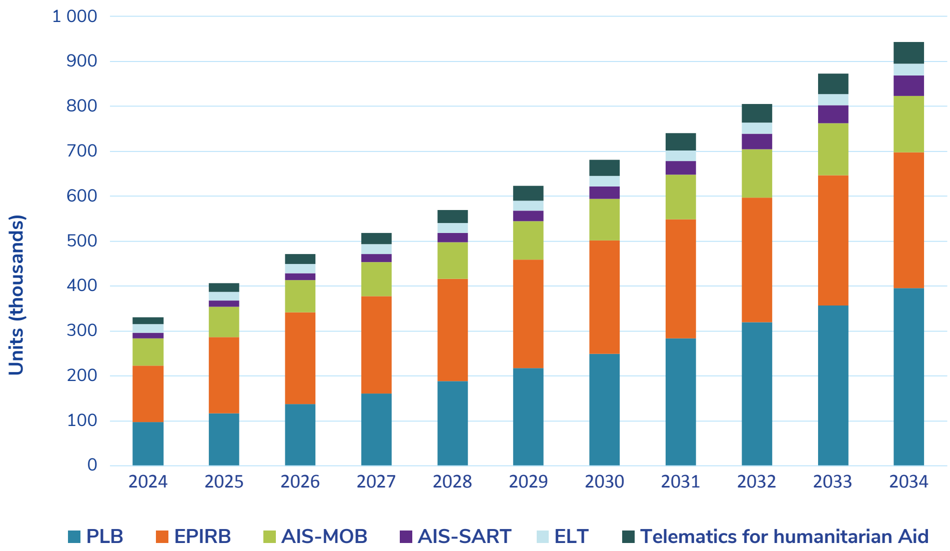
SAR has become one of the backbones of crisis management. Unlike optical sensors, **SAR 'sees' through clouds, smoke and darkness, delivering all-weather, day-and-night imagery**. Sentinel-1 is at the core of this capability, feeding the Copernicus Emergency Management Service (CEMS), which can be activated worldwide within hours or days to map flood extents, burn scars, landslides and other hazards as they evolve. At the same time, **commercial SAR constellations are scaling up rapidly**. ICEYE, for example, already deployed more than 60 small SAR satellites and offer near-real-time imaging for security and crisis-response users. These systems shrink revisit times from days to hours (or less over hotspots), providing dense time series that support dynamic hazard tracking, such as early warning for slope failures, dam stability or changing river levels.

AI-based segmentation and change-detection algorithms increasingly process SAR data to automatically extract flooded areas, damaged infrastructure or ground deformation and flag anomalies, prioritise new acquisitions and generate rapid products for operators.

The result is a powerful synergy: CEMS builds on a robust public SAR backbone, while responders and service providers increasingly plug in AI-enhanced commercial SAR services to fill temporal and geographic gaps. Together, they enable faster, more frequent and more reliable monitoring of unfolding disasters, turning radar constellations into a critical pillar of modern emergency management.

Next-generation crisis response: secure GNSS, SATCOM and predictive EO powering adaptive operations

Shipments of GNSS devices by application



Predictive hazard modelling based on multi-sensor fusion

The next big step in Earth Observation is a shift from seeing what is happening to anticipating what will happen next. Instead of just mapping current floods, fires or landslides, emerging systems start to provide forecasts on how these hazards are likely to evolve over the coming hours and days. This relies on multi-sensor fusion: combining Synthetic Aperture Radar, optical and thermal imagery, and GNSS-enabled ground sensors into a single data stream. Layered with AI-driven analytics, these inputs feed models that simulate the future spread of wildfires, the downstream movement of flood waves and the stability of slopes in near real time.

For civil protection agencies, predictive hazard modelling means a genuine shift from reactive response to **anticipatory action**. Forecast-based products can shape evacuation plans, guide the pre-positioning of equipment and inform early warning messages, helping to cut both human and economic losses. Wildfire spread models, for example, can steer aerial firefighting and ground containment lines, while flood progression forecasts can optimise where and when to deploy pumps, barriers and emergency teams before critical thresholds are reached.

This evolution is already visible in pilot projects that blend Copernicus data with commercial constellations, but the next generation of operational services will go further by delivering dynamic, continuously updated risk layers directly into control rooms. As these capabilities mature, emergency management will increasingly be driven by **forward-looking, scenario-based intelligence**, enabling authorities to act earlier, faster and with much greater precision.

Annual shipments of GNSS emergency devices are expected to exceed 900,000 units within a decade. Growth is driven less by incremental demand by volume expansion and more by a structural shift towards tighter safety rules, climate-related risks and a modernisation of emergency management and humanitarian operations.

EPIRBs & PLBs will likely remain the regulatory a backbone of the market, with replacement cycles and wider uptake on smaller vessels and in outdoor recreation. **AIS-MOB** is set to move from niche to near-standard crew protection, as more fleets, offshore wind operators and high-end yachts adopt wearable safety devices that integrate with bridge systems. Smaller segments, such as **AIS-SART** and **ELT** should grow steadily, closing gaps in maritime and aviation SAR chains through ongoing fleet modernisation.

The most transformative trend will be the rise of **GNSS telematics for humanitarian aid**, becoming a core tool for real-time tracking of convoys, warehouses, cold chains and field teams. As crises increasingly unfold in contested RF environments, interference, jamming and spoofing will become central design constraints rather than edge cases. **Galileo OSNMA** is poised to become a default requirement for humanitarian telematics, authenticating signals, while PRS will progressively equip authorised civil protection and security actors with encrypted, anti-jamming positioning. Together, these secure-GNSS capabilities will drive growth in the humanitarian aid GNSS devices shipments, and in the whole crisis-response segment.

Adaptative logistics supported by EO and GNSS

Humanitarian and emergency logistics are moving toward adaptive, data-driven systems that integrate EO and GNSS technologies for **real-time decision-making**. High-resolution EO imagery can provide road damage assessments and infrastructure status after disasters, feeding into **routing platforms that dynamically adjust convoy paths**. This capability is critical when floods, landslides or earthquakes disrupt traditional supply routes.

GNSS-enabled tracking ensures end-to-end visibility of convoys and assets, while geotagged delivery confirmations can **link to automated financial systems**, releasing donor funds once proof of delivery is verified. These innovations improve accountability, speed and resilience in supply chains for health commodities, emergency relief, and infrastructure restoration. Future systems will combine EO, GNSS, and AI-driven analytics to create fully adaptive logistics networks, reducing delays and optimising resource allocation in crisis environments.

SATCOM as the new lifeline in search and rescue operations

Rescue efforts have long depended on terrestrial radio and mobile networks, which frequently fail in remote terrain or harsh conditions. Integrating satellite communications improves this situation by providing seamless connectivity even in isolated regions, enabling real-time coordination between rescue teams, command centres and the vehicles or vessels on scene.

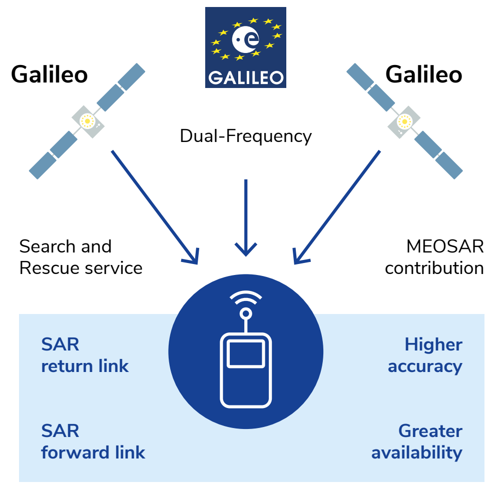
SATCOM systems carry critical information: distress alerts, precise geolocation and situational updates over vast distances, improving both the speed and accuracy of response. Beyond basic voice and data, SATCOM-enabled platforms support digital mapping, live video and resilient PNT services and act as a broadcast channel for GNSS augmentation and integrity information. It creates backbone for networking remote sensors and monitoring stations, extending high-accuracy and resilient positioning into areas with little or no ground infrastructure. This convergence extends the reach, reliability and safety of search and rescue missions, ultimately reducing response times and saving more lives.

The EU Space Programme supports R&I activities in agriculture

Current and future use of EGNSS

The Galileo Return Link Service continues to provide a worldwide, free-of-charge service for COSPAS-SARSAT RLS-compatible beacons. Unique to Galileo, this service establishes a two-way communication link, sending Return Link Messages back to the beacon, confirming that the alert has been received and the location determined.

In 2025 RLS moved from a niche capability to an operational tool, with emergency services and humanitarian organisations embedding it into wildfire and flood response procedures. When combined with Copernicus-based situational awareness and hazard-monitoring initiatives such as UNICORN, RLS closses the loop between alert, confirmation and action, giving responders faster confidence that help is on the way. Galileo RLS proves Europe's position at the forefront of life-saving operations.



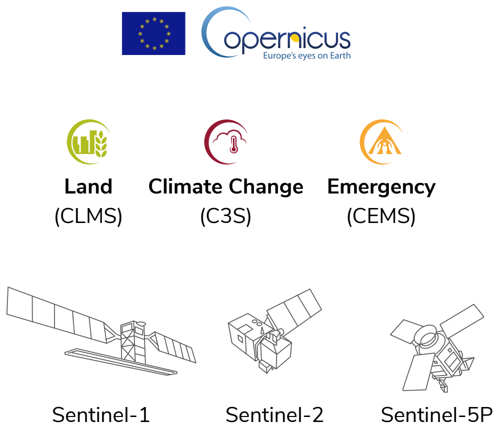
Copernicus Demonstrator for flood awareness

The Copernicus Demonstrator initiative shows how Earth Observation can move beyond data delivery to **operational tools** for flood-risk and infrastructure management.

The Waterjade demonstrator focuses on flood preparedness and early warning, providing hydrological forecasting for municipalities, utilities and grid operators. It supports preparedness, optimises reservoir and network operations, and enables timely responses to heavy rainfall and flooding.

Copernicus services are the main data source. **The Copernicus Climate Change Service** (C3S) delivers climate indicators and hydrological variables for long-term risk assessment, while **Copernicus DEM** (GLO-30/GLO-90) supports floodplain mapping and exposure analysis. These datasets feed directly into user platforms, enabling scenario simulations and informed decisions for emergency planning and infrastructure design.

Cities such as Essen (Germany) and Viacqua (Italy) have piloted the Waterjade platform, using it to identify flood-prone areas and act proactively before and during extreme rainfall. By combining Copernicus data with local weather and historical water observations, planners and utility managers can integrate EO-driven insights into daily risk-management workflows.



Horizon Europe, a programme of the European Union

UNICORN – Copernicus emergency applications for resilience

The UNICORN project is developing advanced Copernicus-based applications to strengthen emergency preparedness and response. It combines Earth Observation with weather forecasts, numerical models and AI to support early warning, forecasting and hazard monitoring as extreme events such as floods, wildfires and geohazards become more frequent and intense.

UNICORN is being validated through four operational use cases: flood forecasting in Attica (Greece), wildfire detection and forecasting in Corsica (France) and north-west Spain/northern Portugal, as well as lava-flow emergency management in Sicily (Italy). Designed for local authorities, policymakers, citizens and industry, the solutions aim to improve coordination and response times during disasters, boosting resilience and reducing impacts on communities, the economy and the environment.


© pexels

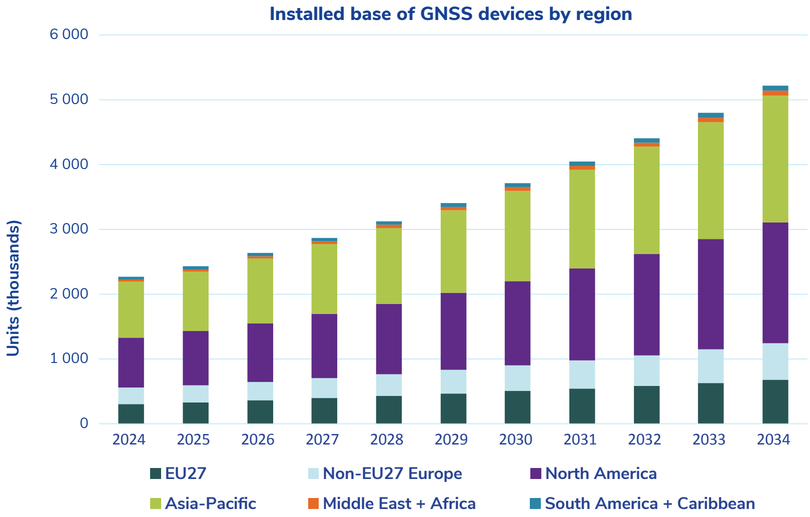
Horizon Europe, a programme of the European Union

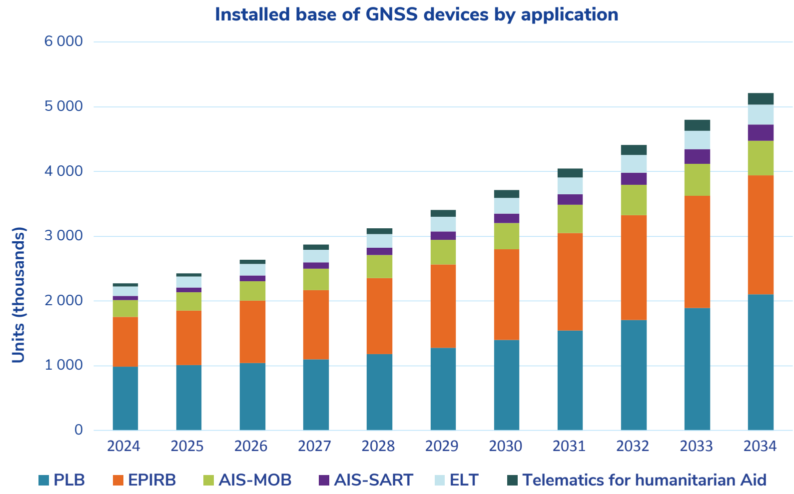
EUSatFinder – integrated space & terrestrial assets for first responders

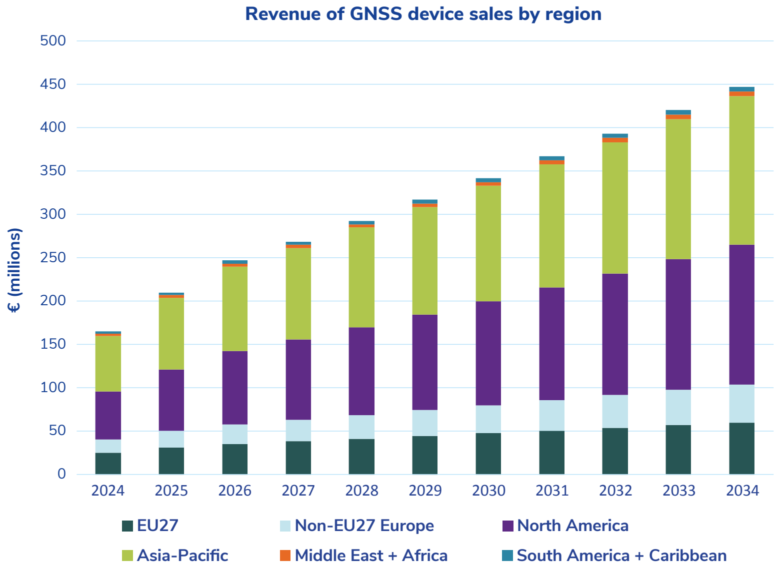
EUSatFinder is developing a portable, multi-orbit satellite terminal tailored to emergency and humanitarian missions. Designed for use on the move on vehicles, boats or in a backpack, it offers automatic setup, including GNSS-based self-location, autonomous satellite acquisition and tracking, and seamless handover between GEO and LEO links.

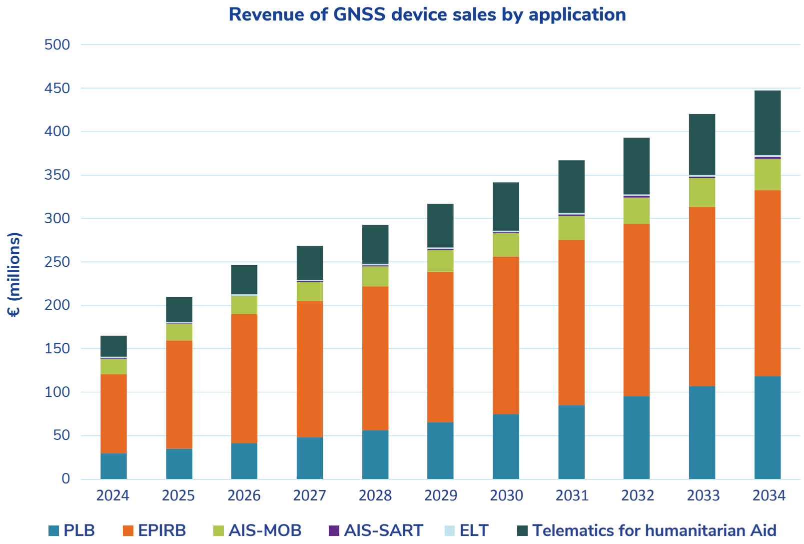
Galileo provides precise positioning and geotagging, while GOVSATCOM ensures secure, resilient voice and data connectivity, including protection against jamming and spoofing. Copernicus imagery and weather layers are integrated into the mission software to create a live operational picture for rescue coordination centres and teams in the field.

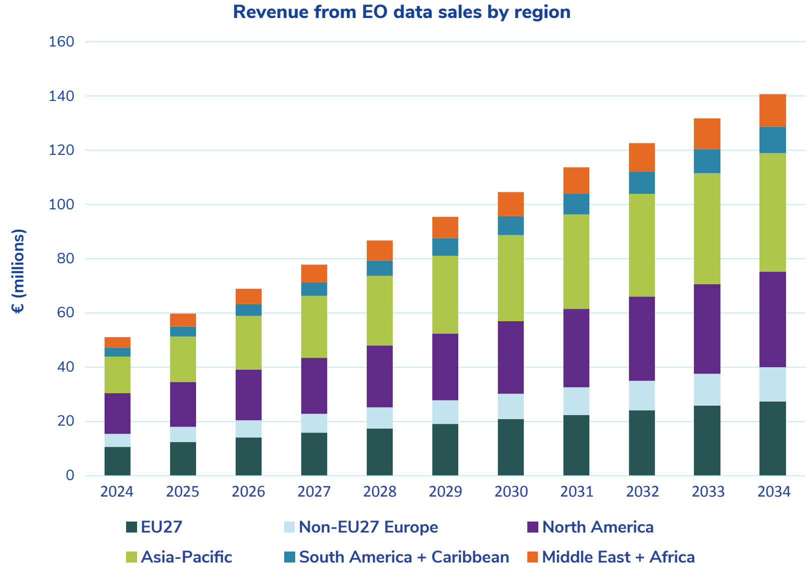
The project will deliver and field-test the terminal in mountain, maritime and urban disaster scenarios. Expected benefits include assured connectivity in network-denied areas, faster and better-coordinated interventions, and safer, more data-driven operations for first responders and humanitarian actors.

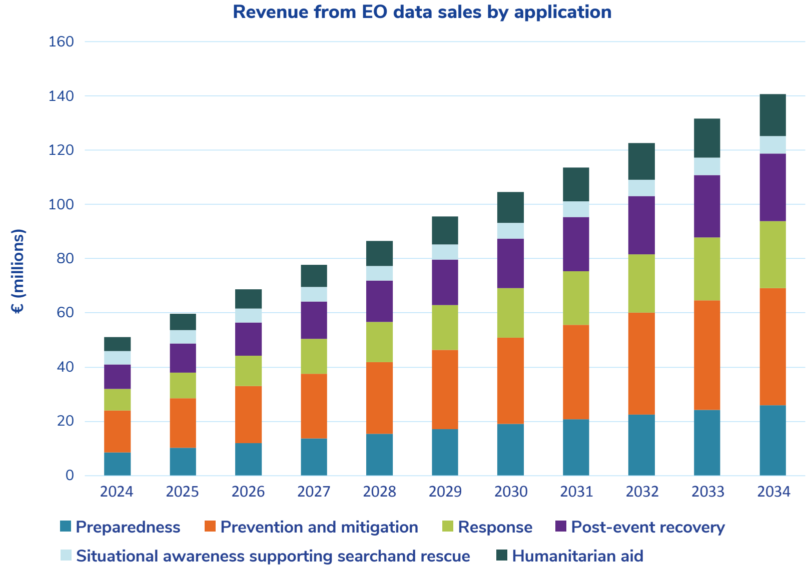

Installed base of GNSS devices by region
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean

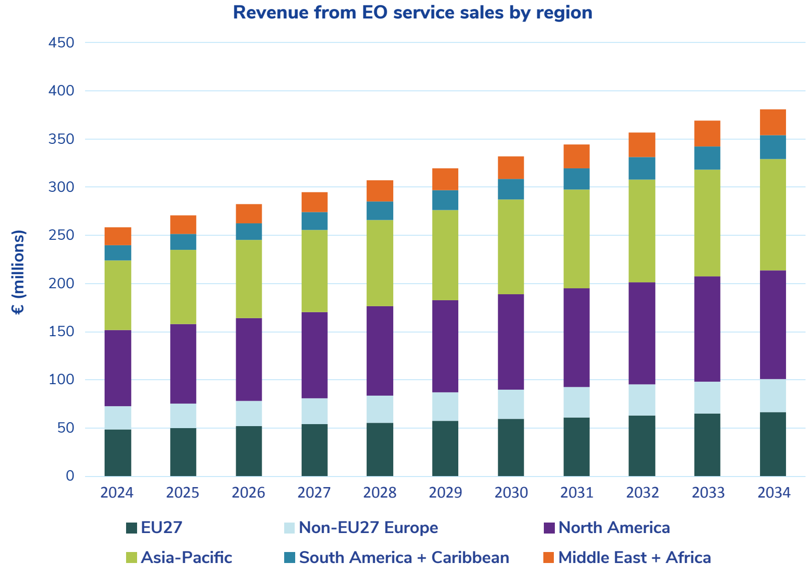

Installed base of GNSS devices by application
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
PLB
EPIRB
AIS-MOB
AIS-SART
ELT
Telematics for humanitarian Aid

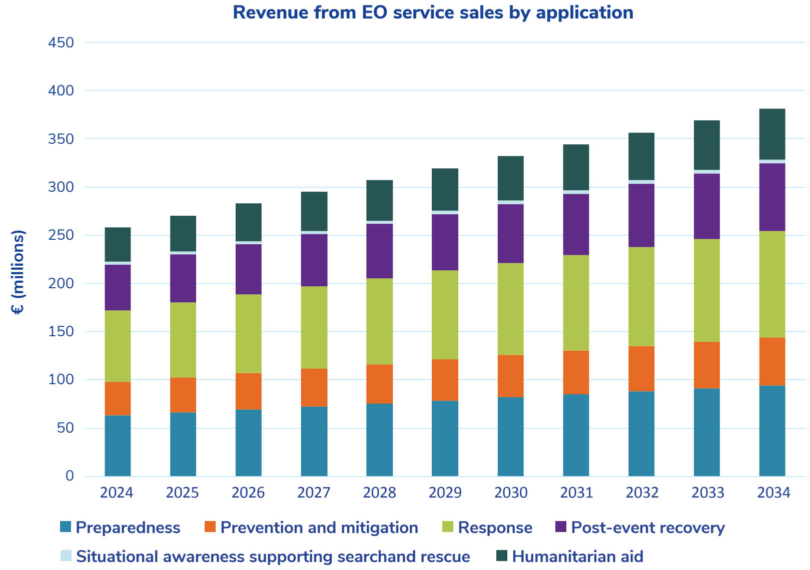

Revenue of GNSS device sales by region
500
450
400
350
300
250
200
150
100
50
0
€ (millions)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
500
450
400
350
300
250
200
150
100
50
0
€ (millions)
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
PLB
EPIRB
AIS-MOB
AIS-SART
ELT
Telematics for humanitarian Aid


Revenue from EO data sales by region
€ (millions)
160
140
120
100
80
60
40
20
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
160
140
120
100
80
60
40
20
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Preparedness
Prevention and mitigation
Response
Post-event recovery
Situational awareness supporting searchand rescue
Humanitarian aid


Revenue from EO service sales by region
€ (millions)
450
400
350
300
250
200
150
100
50
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO service sales by application
€ (millions)
450
400
350
300
250
200
150
100
50
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Preparedness
Prevention and mitigation
Response
Post-event recovery
Situational awareness supporting searchand rescue
Humanitarian aid

ENERGY AND RAW MATERIALS

Energy Network Fidelity
- Energy network planning and monitoring
- Phasor measurement units (PMU)

Renewable Energy
- Renewable energy site planning and monitoring
- Risk assessment for renewable energy assets

Environmental monitoring
- Environmental impact assessment for energy
- Environmental impact assessment for raw materials

Market Intelligence
- Supply chain insights

Market Intelligence
- Mineral exploration, site planning and monitoring
- Mining vehicle management and control

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

ENERGY AND RAW MATERIALS

Electricity systems are being reshaped by rapid electrification and the fast expansion of renewables, with demand from data centres, EVs, heat pumps and industry rising faster than grids can expand. In Europe, saturation is already visible (some utilities report 80% of its nodes at full capacity) and the European Commission estimates that €584 billion in grid investment is needed by 2030 to meet electrification goals. Recent outages on the Iberian Peninsula also show how quickly disturbances can cascade across interconnected grids, highlighting the importance of a balanced grid. Phasor Measurement Units and the GNSS timing that underpins them offer one way to improve grid stability. GNSS also supports energy network planning and monitoring, as well as new site surveying. Furthermore, managing variability from wind and solar, along with growing physical risks such as floods and wildfires, is pushing operators toward smarter and more flexible grid management supported by EO. Space data are increasingly used to map natural hazards, forecast renewable generation, support curtailment decisions, and inform storage and flexibility markets. At the same time, energy developers are repurposing retired fossil-fuel plants into renewable or storage hubs to bypass lengthy permitting processes. EO supports these transitions by assessing the suitability of sites and environmental constraints, while enabling long-term monitoring for compliance.

Stakeholders in the raw materials sector – mining companies and associations, financiers, government institutions, commodity traders and supply chain managers – use EO and GNSS-powered services to strengthen critical-raw-materials security, support strategic projects and meet rising ESG transparency requirements. Space-based data improve operational efficiency, asset tracking (including GNSS-enabled fleet management and autonomous operations) and environmental monitoring with greater traceability across supply chains. In exploration, satellite imagery helps identify high-potential mineral areas more cost-effectively. In operations, EO supports safety by monitoring the stability of mine pits and tailings in line with stricter standards, and it is also used to detect illegal mining and track post-closure activities (e.g. site clean-up, rehabilitation and waste management).

Note: the sub-segment **Energy** is showcasedwith a **lightning icon** , while the sub-segment **Raw Materials** is showcased with a **wagon icon** .

What you will find in this chapter

- **Key trends:**
  1. Next-generation grids must balance surging data centre demand, renewable energy variability and natural hazard risks driven by climate change.
  2. The global race for critical raw materials features a growing importance of ESG transparency, safer operations and strategic projects.
- **Industry:** Energy and raw materials value chains.
- **Recent developments:** Insights driven by space data play an increasingly larger role in environmental impact assessments and social licenses to operate.
- **Recent developments:** Mining's recent momentum: GNSS monitoring, tighter sustainability standards, and shifting critical-minerals investment.
- **Future market evolution:** GNSS adoption in mining will more than double by 2034, boosting autonomous operations and safer, data-driven extraction.
- **European systems:** Unlocking energy and raw-material insights with GNSS positioning and Copernicus EO data.
- **European projects:** Several European funded projects combine space data to propose solutions in support of the energy and raw materials sector.
- **Reference charts:** Annual evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now features the estimation of the market for Mineral exploration, site planning/monitoring. It also relies on an improved methodology for the estimation of EO service

Next-generation grids must balance surging data centre demand, renewable energy variability and natural hazard risks driven by climate change

Key market trends

- Data centres are the backbone of AI and cloud computing growth, and their electricity demand rivals that of heavy industry.
- Balancing the grid and protecting it from extreme weather are key challenges facing infrastructure operators.
- Curtailments are increasingly a feature of modern energy systems.
- PMUs play an increasingly important role in interconnected grids.

Data centres drive energy demand and offer consumption flexibility

Data centres are rapidly becoming a dominant force in the electricity landscape, consuming 460 TWh globally in 2022 (about 2% of global power demand), with some European regions seeing specific spikes in consumption: Ireland is projected to see its share jump from 21% in 2023 to 32% by 2026, and Denmark expects a six-fold increase by 2030. Hyperscale facilities, the backbone of AI and cloud computing growth, are driving this trajectory. Their energy demand now rivals that of traditional heavy industries, yet with the unique opportunity of being fully electrified and offering flexible consumption, they provide avenues for decarbonisation if powered cleanly.

One promising strategy to harmonise data-centre demand with renewable energy supply is to leverage computational flexibility, shifting workloads across locations and times to match the availability of wind and solar power. For example, processing can be redirected to regions where wind or solar generation is strong, alleviating both emissions and grid congestion. EO tools (e.g. satellite data for solar irradiance and weather patterns assessments) are invaluable in making this type of dynamic matching feasible, guiding scheduling decisions in real-time.

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Curtailments increasingly a feature of a mature energy system

Curtailment is emerging as a defining trend in modern energy systems. In high-renewables markets such as Europe, parts of the US and China, wind and solar output is often “switched off” as grids cannot absorb all the electricity being produced at certain times. While once seen as inefficiency, curtailment is now being reframed as a feature of a mature renewable system. The logic is economic and technical: solar and wind have near-zero marginal costs, and the capital costs of new capacity are falling fast. This makes it viable to build more renewable capacity, accepting some curtailment while ensuring supply is secure during periods of low generation.

EO supports such curtailment efforts as grid operators are informed by local solar energy asset managers how much generation is expected in the next 15 minutes – i.e. if there is ‘downward flexibility’ that allows the grid operators to switch off that asset to support a balanced grid. EO data, such as solar irradiance, aerosols in the air, and water column data, contribute to increasingly accurate ‘nowcasts’ used by solar PV asset managers such as Luminus.

Modernising grid management to cope with renewables and extreme weather

Transmission System Operators and Distribution System Operators are tackling two major challenges in the management of electricity grids: the integration of (intermittent) renewable energy sources and growing physical risks like floods and fires fuelled by climate change. The rapid integration of renewables like solar PV and wind is transforming power systems, demanding smarter, more flexible grids to handle their variability and ensure reliable supply. At the same time, rising temperatures, more frequent floods, wildfires and storms are already damaging substations, transmission corridors and distribution infrastructure. Utilities are investing in hardening assets, rerouting lines away from floodplains, and deploying AI-driven monitoring systems that can predict and respond to environmental threats in real time.

EO plays an important role in these monitoring and planning systems. Copernicus provides data that help generate risk maps for flooding and wildfires, as showcased for ENEL, which can inform grid planning and maintenance. Forecasting PV power generation of local assets connected to the grid using CAMS data has proven valuable for RTE. Combined with digital twins and predictive grid analytics, EO enables operators to both forecast renewable variability (e.g. wind and solar output) and anticipate climate-driven disruptions, making grids smarter and more climate-resilient.

GNSS and PMUs reshaping energy systems

Wide-area monitoring using PMUs (devices which provide synchronised, high-frequency measurements of voltage and current across the grid, up to dozens of times per second) offers a way to identify grid instabilities before they propagate, supporting faster and more targeted interventions.

A critical enabler of PMUs is their reliance on Global Navigation Satellite Systems (GNSS), such as Galileo, to provide precise timing signals that synchronise measurements across vast areas. This timing accuracy allows operators to compare data from hundreds of PMUs in real time, giving a coherent picture of grid dynamics. Strengthening both PMU deployment and the resilience of their GNSS timing links is emerging as a vital step for Europe’s energy transition, ensuring that blackouts are less disruptive and that renewable-heavy grids remain stable.

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The global race for critical raw materials features a growing importance of ESG transparency, safer operations and strategic projects

Key market trends

- Global race for critical raw materials.
- Growing importance of safety in Tailings Storage Facilities (e.g. embankments and pond/beach areas where solids settle and water is managed/recycled).
- Consumers and investors are demanding greater transparency and ethical practices in the mining industry.
- CRMA and Strategic Projects.

A global race for critical raw materials

The increasing global demand for critical raw materials, geopolitical tensions and supply chain vulnerabilities have resulted in a series of export tariffs and industrial policies at international level. In this context, China's export restrictions on critical minerals, like gallium, germanium and graphite, have coincided with US plans to impose a 93.5% tariff on Chinese graphite by 2025, along with a series of executive orders to accelerate permitting and increase investments in domestic projects. Meanwhile, many other resource-rich countries (e.g. Chile, the Democratic Republic of Congo, Indonesia, Malaysia, Mexico, Namibia, Philippines and Zimbabwe) are also tightening controls to force local processing and value-capture.

Many of these raw materials are crucial for both the space and defence sectors across various domains due to their unique properties and not yet having valuable substitutes. Indeed, these materials enable advanced radar, sonar, laser guidance, communication and propulsion technologies, ensuring precision, stability and resilience in combat environments. Furthermore, they contribute to high-performance electronics, sensors and control mechanisms across land, air and sea. Finally, they are also key to producing satellite solar panels (e.g. silicon and gallium) or as material for aircrafts (e.g. titanium and aluminium). Consequently, achieving mineral security for **defence and space sovereignty** has now become a critical need at international level, which is expected to continue in the near future.

Growing importance of safety in Tailings Storage Facilities

The mining industry is witnessing the growing importance and widespread adoption of the Global Industry Standards on Tailings Management (GISTM), applicable to both existing and future tailings facilities, pushing operators toward auditable, ongoing surveillance. GISTM underlines the consequences for people and the environment of catastrophic tailings facility failures; these must be avoided and operators must adopt best practices in planning, design, construction, operation, maintenance, monitoring, closure and post closure activities. Although GISTM is not legally binding and must be considered as a guideline framework, it indicates the direction taken by the industry.

In this context, relevant benefits for tailings management are expected from the combination of different tools, such as AI and Machine Learning (ML), and types of data used in various R&D projects. For instance, the **EU-funded Multiscale observation services for mining-related deposits** (MOSMIN) project is developing multiscale services that combine ground, aerial and satellite data to monitor TSF geotechnical stability and environmental risks and to measure the potential to extract valuable materials from mining waste.

© Miningdoc

Greater transparency and ethics becoming a must-have for the industry

Customers, investors and regulators are increasingly demanding **greater transparency and ethical practices** from the mining industry, pushing it to include environmental, social and governance principles in their operation. For instance, the Corporate Sustainability Due Diligence Directive (CSDDD, 2024/1760) aims to foster sustainable and responsible corporate behaviour in companies' operations, requiring them to identify, assess and mitigate adverse impacts on human rights and environmental impacts across their global value chains, with a planned implementation phase by 2027. Furthermore, the London Metal Exchange, the world centre for the trading of industrial metals, requires responsible-sourcing compliance from listed brands. **Global mining standards** are also becoming more important (e.g. the Initiative for Responsible Mining Assurance – IRMA which indicates satellite data as a base for auditing mining activities).

In this context, EO can provide independent evidence for disclosure – deforestation, water use, tailings stability and land restoration – while GNSS-tagged field data underpins traceability and supports the spatial audit trails in response to other initiatives, such as the EU Battery Regulation (2023/1542). This regulation introduces binding provisions on battery sustainability, including carbon-footprint declarations, material-recovery targets, due diligence, labelling requirements and digital battery passports to ensure traceability throughout the lifecycle of batteries.

Critical Raw Materials Act (CRMA) and strategic projects

In June 2025, the European Commission selected 60 strategic projects under the CRMA mandate to support resilient and secure value chains. The selected projects involve countries and areas both in the EU (47) and outside (13). The projects are considered strategic due to their **meaningful contribution** to the security of the EU's supply of strategic raw materials and because they are or will become **technically feasible** within a reasonable timeframe, having expected production volumes, and implemented sustainability.

The strategic projects benefit from support for **access to finance and shorter permitting timeframes** (27 months for extraction permits and 15 months for processing and recycling permits). Together, the project portfolio is intended to support the **CRMA's 2030 benchmarks** – at least 10% extraction, 40% processing and 25% recycling in the EU, while keeping reliance on any single third-country source below 65%.

Map of strategic projects under the CRMA

© EC

Energy EO and GNSS Value Chains[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- E-GEOS*
- GEOSAT*
- GHGSAT
- ICEYE*
- PLANET
- SATELLOGIC*
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- ENMAP*
- PRISMA*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS
- RELEVANT IN-SITU NETWORKS
- NISAR (NASA/ISRO)

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- OVH CLOUD*
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G.GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CREODIAS*
- EDS CEODE
- ESRI ARCGIS
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- OPENEO*
- SENTINEL-HUB (PLANET)
- SKYWATCH
- SPATIAL SERVICES*
- UP42*

- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- OPENEO*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

- CLIMATESCALE*
- CLS GROUP*
- COTESA*
- DHI GROUP*
- GECOSISTEMA*
- IMAGERYST**
- KAYRROS*
- KSAT*
- LIVEEO*
- METEODYN*
- NEO*
- OHB*
- ORBITAL EYE*
- PLANETEK*
- REBASE.ENERGY*
- REUNIWATT*
- SATELLOGIC*
- SOLARGIS*
- SOLEA*
- TRANSVALOR*
- VORTEX*
- WEGAW*

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS MARINE SERVICE (CMEMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*

INFORMATION PROVIDERS

- BLOOMBERG
- CYIENT
- GEODATA*
- ICIS*
- OILX*
- NOVELTIS*
- S&P GLOBAL
- THE SNIFFERS*

END USERS

- ENERGY COMPANIES
- ENERGY TRADERS
- ENVIRONMENTAL AGENCIES
- GOVERNMENTAL AUTHORITIES
- GRID OPERATORS
- PROJECT DEVELOPERS
- SUPPLY CHAIN MANAGERS
- UTILITY COMPANIES

LEGEND

Commercial offering
Public offering
User segments

European[2] EO & GNSS industry in the global arena

In 2024, European EO companies in the Energy and Raw Materials segment held an estimated 57% of the global market share. Top European companies in the segment include Vaisala, Airbus, and Leonardo. GNSS receivers in Energy are primarily used for timing and synchronisation purposes. European T&S System Integrators such as Ericsson, Hexagon and Nokia capture a combined 36% of the market share.

GNSS

AUGMENTATION SERVICE PROVIDERS

- FUGRO*
- CNH INDUSTRIAL* (INCLUDING HEMISPHERE)
- HEXAGON*
- POINT ONE NAVIGATION
- SWIFT
- TERIA*
- TOPCON
- TRIMBLE
- U-BLOX

- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS

COMPONENT AND RECEIVER MANUFACTURERS

- ANALOG DEVICES
- BROADCOM
- CAMPBELL SCIENTIFIC
- HEXAGON*
- MEINBERG*
- QUALCOMM
- SCHNEIDER ELECTRIC*
- TRIMBLE NAVIGATION
- VICTRON ENERGY*

DEVICE MANUFACTURERS

- ARBITER
- BRANDYWINE
- CHRONOS TECHNOLOGY*
- ELPROMA*
- ENDRUN
- GORGY TIMING*
- HEXAGON*
- HOPF ELEKTRONIK*
- MASTERCLOCK
- MICROCHIP TECHNOLOGY
- OMICRON*
- SAFRAN TIMING SYSTEMS*
- OSCILLOQUARTZ*
- SEIKO
- SEL
- SYNERGY SYSTEMS
- TIMELINK*

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

- ABB*
- ERICSSON*
- HITACHI ENERGY
- HUAWEI
- NOKIA*
- SIEMENS SMART INFRASTRUCTURE*

END USERS

- TRANSMISSION and DISTRIBUTION SYSTEM OPERATORS

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers' step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 13 and 22 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded with a prize by the EU CASSINI initiative.

Raw Materials EO and GNSS Value Chains[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- E-GEOS*
- GEOSAT*
- GHGSAT
- ICEYE*
- OHB
- PIXXEL
- PLANET
- SATELLOGIC*
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- ENMAP*
- PRISMA*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS
- RADARSAT (CSA)
- NISAR (NASA/ISRO)

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G.GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CREODIAS*
- EDS CEODE
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- SENTINEL-HUB (PLANET)
- UP42*

- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- OPENEO*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

- DARES TECH*
- EARTHDAILY
- EARTH-i
- EFTAS*
- GAF*
- GEOKINESIA*
- GEOVILLE*
- GHGSAT
- KAYRROS*
- OHB*
- ORBITAL INSIGHT
- PICTERRA
- ROSA EARTH*
- SATELLOGIC*
- S[&]T*
- SKYGEO*
- TERRAEYE**
- THEIAX*
- TRE ALTAMIRA*
- VITO*

- COPERNICUS EUROPEAN GROUND MONITORING SERVICE (EGMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*

INFORMATION PROVIDERS

- AGP MINING
- FLSMIDTH*
- FUGRO*
- KAYRROS*
- SLR CONSULTING*
- STANTEC
- SRK*
- VIRIDIEN*

END USERS

- MINING COMPANIES
- SUPPLY CHAIN MANAGERS
- RAW MATERIALS TRADERS
- GOVERNMENTAL AUTHORITIES

LEGEND

- Commercial offering
- Public offering
- User segments

European[2] GNSS industry in the global arena

In the combined Energy and Raw Materials segment, European companies account for approximately one-third of the global GNSS market share for component and receiver manufacturing, largely captured by Hexagon.

GNSS

AUGMENTATION SERVICE PROVIDERS

- FUGRO*
- CNH INDUSTRIAL*
- HEXAGON*
- QIANXUN
- SWIFT
- TERIA*
- TOPCON
- TRIMBLE
- U-BLOX*

- GALILEO HIGH ACCURACY SERVICE
- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS

COMPONENT AND RECEIVER MANUFACTURERS

- ANALOG DEVICES
- CADDEN*
- CAMPBELL SCIENTIFIC
- CHCNAV
- CNH INDUSTRIAL*
- HEXAGON*
- JACKSON LABS
- MICROCHIP TECHNOLOGY INC
- MEINBERG *
- NOVATEL
- NUVOTON
- OXFORD TECHNICAL SOLUTIONS*
- QIANXUN
- TOPCON
- TRIMBLE NAVIGATION
- YAGEO

DEVICE MANUFACTURERS

- CHCNAV
- HEXAGON*
- OUSTER
- RIEGL LASER MEASUREMENT SYSTEMS*
- TRIMBLE NAVIGATION

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

- AB VOLVO*
- CATERPILLAR
- CHCNAV
- EATON*
- ERICSSON*
- HEXAGON*
- HUAWEI
- KOMATSU
- NOKIA
- RIEGL LASER MEASUREMENT SYSTEMS*

END USERS

- MINING COMPANIES
- REGULATORY AUTHORITIES
- ENVIRONMENTAL AGENCIES

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers' step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

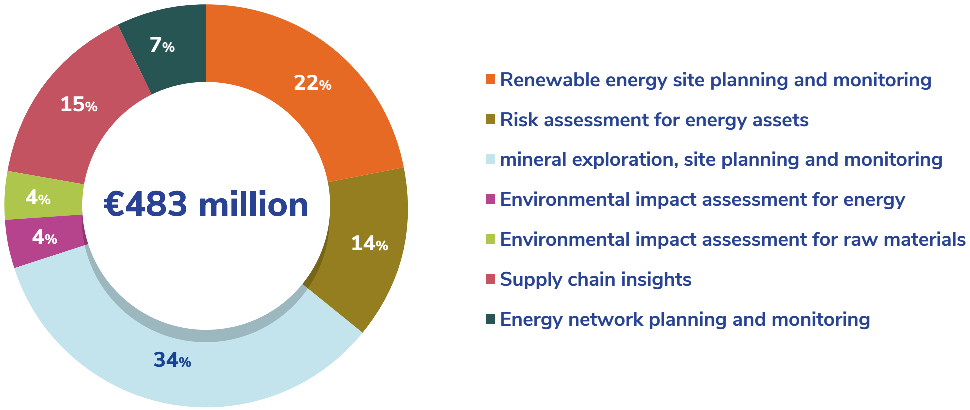
2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

Insights driven by space data play increasingly important role in environmental impact assessments and social licenses to operate

Energy and Raw Materials revenues from EO data and services sales 2024



Over half of the revenues generated in this segment revolve around the planning and monitoring of raw material assets (e.g. open pit mines, tailings facilities, waste dumps) and **energy assets** (utility-scale wind/solar parks, commercial and domestic installations, hydropower facilities). However, in recent years, applications revolving around energy asset risk assessments, such as flood and fire risks to grid infrastructure, as well as those related to environmental impact assessments, are increasingly getting traction in the industry.

EO data and services lend themselves well to the **mapping of natural hazard risks** faced by critical infrastructure such as power grids. Services support the identification of specifically vulnerable parts of the infrastructure and enable preventative measures including fire-resistant designs, vegetation management and early warning systems. Such risk maps additionally support the planning of future gridlines.

Space-data powered applications also see an increase in uptake around **environmental impact assessments** and **social licences to operate** in both industries. For instance, companies are using EO to assess baseline environmental conditions and anticipate biodiversity sensitivities long before project development begins. This helps developers reduce permitting timelines and demonstrate greater transparency and accountability in areas where public scrutiny is rising.

Storage and flexible markets take off

With renewables now providing most of the new energy capacity, power systems increasingly require stronger balancing tools to manage variability. Battery storage is expanding at an exceptional pace, with more than 20 GW added in 2023, over twice the deployment seen in 2022 (IEA, 2024). At the same time, flexibility services such as demand-side response, virtual power plants and dynamic line rating are maturing into structured markets across Europe, the USA and parts of Asia.

Beyond batteries, options like hydrogen storage, pumped hydro and even vehicle-to-grid technologies, are moving into mainstream system planning. Together, storage and flexibility help reduce renewable curtailment, smooth grid operations and build resilience against sudden shocks. Enhanced nowcasting and short-term forecasting of renewable generation using EO data further support operators in deciding when storage should charge or discharge and in anticipating periods of grid stress that require rapid flexibility responses.

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Strengthening grid resilience against GNSS jamming and spoofing

Modern electricity grids rely on precise timing signals from GNSS to synchronise transmission networks, particularly in cross-border interconnections and systems with a high share of renewables. Recent incidents of GNSS jamming and spoofing in Europe and elsewhere have raised concerns about the vulnerability of these timing systems.

If disrupted, GNSS timing can introduce phasor measurement unit errors, trigger grid instability or, in extreme cases, contribute to blackouts. In response, grid operators and regulators are beginning to invest in redundant timing solutions – such as multi-GNSS receivers, terrestrial backup systems and network-based time distribution – to reduce dependence on any single signal. This shift is opening a growing market for GNSS resilience services, creating opportunities for space companies to deploy anti-jamming, anti-spoofing and authentication technologies tailored to the needs of critical energy infrastructure.

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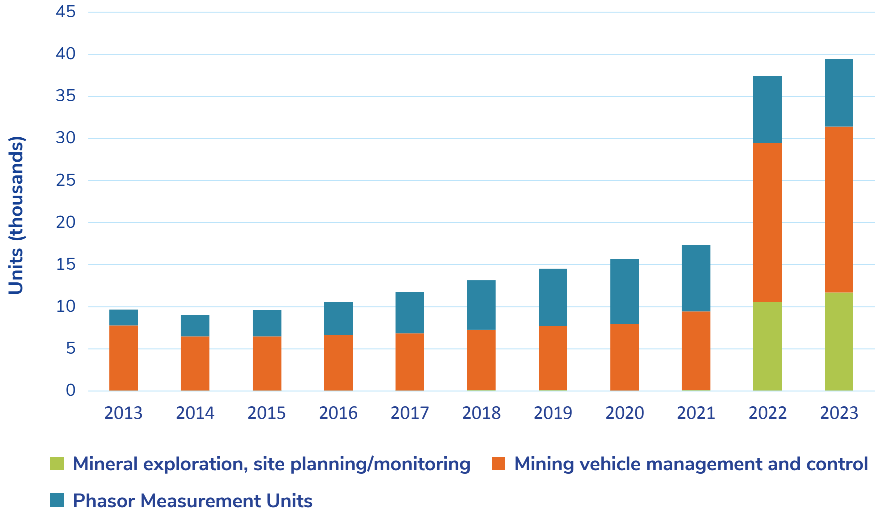
Industry commits to sustainability standards and increases exploration expenditures

Shipments of GNSS devices by application



As mining companies continue to prioritise efficiency and safety, shipments of GNSS devices have shown steady growth over the past decade. The Mining vehicle management and control and the Mineral exploration, site planning and monitoring applications have received a methodological update, resulting in larger market estimations. Specifically, receivers installed on mining machinery such as autonomous haul trucks and drilling rigs, which typically carry two GNSS units each, are accounted for. Shipments of GNSS devices in these new and updated applications amounted to almost **30,000 units in 2022**, rising to just **over 31,000 units in 2023**. Most of these units are associated with vehicle management and control, reflecting the rapid uptake of fleet-management, guidance and autonomous-haulage systems, while exploration and site-planning deployments grow in parallel as GNSS becomes standard for surveying and monitoring.

Shipments of **PMUs** have also seen steady growth over the decade, rising from around **2,000 units in 2013** to nearly **16,000 units in 2023**, illustrating their increasing importance in the management of energy infrastructure. As smart grids dependent on PMUs become more common and utilities roll out wide-area monitoring and control schemes, this upward trend in PMU deployments is expected to continue.

Industry commitment towards best sustainable practices standardisation

In response to society's growing demand for responsible mining, as well as to reduce complexity and clarify responsible mining practices for all-size companies, the Consolidated Mining Standard Initiative (CMSI) aims to merge the best features of four other standards – the Copper Mark's Risk Readiness Assessment (RRA), Mining Association of Canada's Towards Sustainable Mining, World Gold Council's Responsible Gold Mining Principles and ICMM's Mining Principles – to provide one global standard. The long-term goal is to eliminate duplication, fill gaps and make improvements where needed, comprising 24 performance areas **covering responsible mining topics under the four pillars**:

ethical business practices; worker and social safeguards; social performance; and environmental stewardship. Each performance area features requirements grouped into **three levels: foundational practice** – a starting position of compliance with the preparatory steps that enable companies to start the journey towards **good practice**; good practice – a level of practice in line with industry standards and international norms, frameworks and guidelines; **leading practice** – a level of practice which goes beyond good practice and demonstrates leadership or best practice. CMSI Partners have recently announced the publication of CMSI Governance Model, ahead of a public, open call for board applications to follow. CMSI underlines the commitment of the industry for standardisation of mining sustainability.

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Recent Investment trends in mining

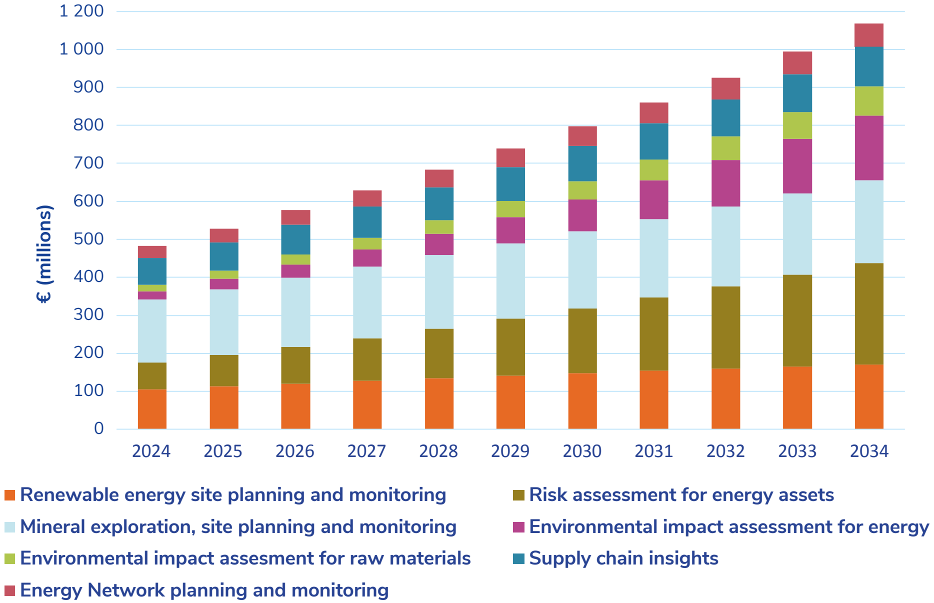
According to a recent publication from the International Energy Agency (IEA), exploration expenditures grew by around 20% between 2020 and 2023 but plateaued in 2024 at $6.7 billion (€5.6 billion). Specifically, **lithium and uranium exploration surged** (up 30% and 35% respectively), while **nickel and cobalt exploration dropped** by over 30%. This divergence suggests capital is shifting toward minerals tied to clean energy demand, while traditional battery metals like nickel and cobalt are losing investor momentum. Due to ongoing price declines, capital investment in critical minerals mining **slowed in 2024**, growing just 5% (only 2% in real terms after cost inflation) compared with 14% in 2023.

More precisely, diversified mining majors raised spending (+15%), while specialist firms scaled back (–15%). **Greenfield mining investment** has increased significantly over the past decade, with the 2020-2024 investment being 50% higher than the level seen in the 2015-2020 period. **Geographically**, most financial investment went to copper in Latin America (€51bn), nickel (€21bn) and cobalt (€13bn) in Indonesia and Africa, and lithium in Australia, showing strong allocation to large-scale upstream projects.

© pexels

Main growth drivers include continued build-out of renewable energy capacity and decreasing Europe's reliance on imported critical raw materials

Revenue from EO services & data sales by application



In 2024, the total estimated revenues generated by EO data and services sales in this segment were €483 million and **forecast to nearly double over the next decade** as mining and energy developers and operators increasingly understand, and are willing to invest in, solutions powered by EO data to improve efficiency and safety.

Applications with the largest forecast growth per year are concerned with **environmental impact assessment (EIA) for energy, EIA for raw materials and risk assessment for energy assets.** The forecast growth of EIA applications is driven by technological advances in the use of EO data for related activities, such as habitat mapping and linked biodiversity estimations, both to serve as a baseline for future mitigation and restoration measures, as well as to continuously monitor potential impact on areas surrounding energy and raw material assets. Furthermore, natural hazard risks to energy assets are increasing year on year due to climate change and require accurate mapping to mitigate and improve the resilience of existing and future infrastructures.

Beyond the growth in EIA- and risk-related applications, the overall expansion of this segment is driven by wider shifts in the energy and raw materials sectors. The **continued build-out of renewable energy capacity and decreasing Europe's reliance on other continents for critical raw materials** are driving the demand across segments.

Electrification outpaces grid expansion

Global electricity demand is rising faster than grids can expand, pushed upward by the rapid uptake of EVs, heat pumps, data centres and industrial electrification. In Europe, this strain is already visible: many grid nodes are saturated, with Spanish utilities reporting that 80% of their nodes are at capacity (Reuters, 2025). Such constraints heighten the risk of congestion, extend connection delays for new renewable projects and ultimately raise costs for consumers.

To address these pressures, the European Commission estimates that European grids will require investment of around €584 billion by 2030 (across both transmission and distribution networks) to meet clean-energy and electrification targets (WindEurope, 2024). As part of this build-out, EO is increasingly used to map and monitor natural hazard risks, such as wildfires and floods, in areas where new lines or substations are planned, helping planners avoid vulnerable zones or incorporate mitigation measures early in the design process.

© EDF Power Solutions

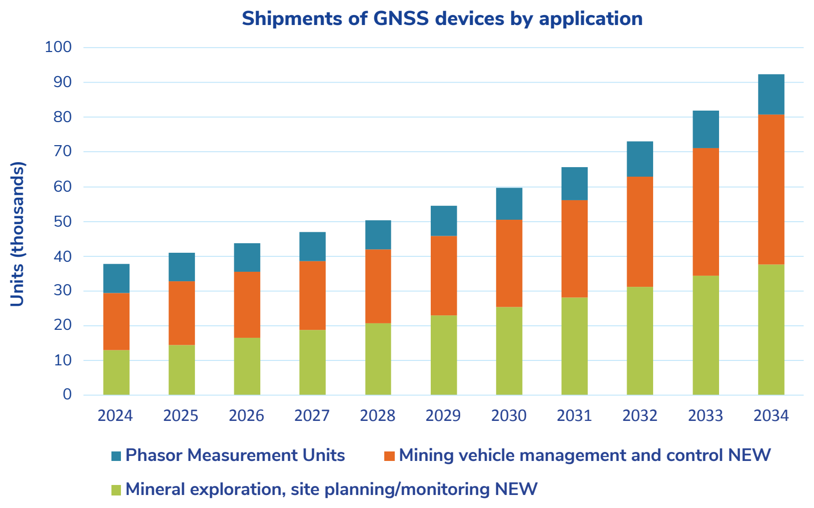
Old fossil fuel plants transitioning to clean energy hubs

Around the world, retired or underused fossil-fuel plants are increasingly being repurposed as renewable energy and storage sites rather than dismantled, marking a major shift in how legacy energy infrastructure is used (Economist, 2025). Europe is working on 67 plants currently under evaluation for conversion and a growing set of technologies (ranging from battery storage to hydrogen production) being deployed to enable these transitions.

The momentum behind this reuse strategy is driven by the need for faster grid connections: by building on existing substations, grid links and permitting footprints, repurposed sites can avoid the multi-year delays that typically hold up new projects. This is particularly important given that roughly 3,000 GW of renewable projects worldwide are stuck waiting for grid access (IEA, 2025). EO can improve the screening and planning of sites suitable for conversion by assessing renewable resource potential, detecting soil instability and identifying other environmental constraints early in the process.

© pexels

GNSS adoption in mining will more than double by 2034, boosting autonomous operations and safer, data-driven extraction



By updated modelling methodology, **the "NEW" categories** capture GNSS receivers that were not included in the previous outlook, notably those installed **on additional mining machinery** such as autonomous haul trucks and drilling rigs, which typically carry two receivers each for safety of operations.

Between 2024 and 2034, global shipments of GNSS devices in the **raw-materials applications** – mineral exploration, site planning/monitoring (NEW), and mining-vehicle management and control (NEW) – rise strongly over the forecast period. **Combined shipments** for these uses increase from around **30,000 units in 2024 to roughly 81,000 units in 2034**, more than doubling. Mining-vehicle management and control (NEW) remains the largest of the two, growing from about 18,000 to over 43,000 units as fleets adopt advanced guidance, collision-avoidance and autonomous haulage systems. Mineral exploration, site planning and monitoring (NEW) expands at a similar pace, with shipments climbing from about 14,500 to nearly 38,000 units as GNSS is rolled out more widely in surveying, geotechnical monitoring and construction preparation.

On **the energy side**, **PMUs** continue to represent a smaller but steadily growing share of GNSS device shipments. From just over **8,000 units in 2025**, annual PMU shipments rise to around **11,500 units by 2034** as utilities expand wide-area monitoring, protection and control schemes. Although PMU volumes grow more modestly than mining-related applications, their continued increase ensures that energy-sector deployments remain an important and stable component of total GNSS shipments, which overall more than double from about 41,000 units in 2025 to over 92,000 units in 2034.

Mining industry towards 2035

Recent insights indicate that by mid-century most people will live in cities, with per-capita energy consumption expected to grow. By 2035, this will translate into **sustained pressure for a greater supply of minerals**. In addition, unstable weather is expected to lift energy use (e.g., air conditioning, heating and the pumping of water) and complicate mine logistics through droughts, floods, and sea-level rise. At the same time, increasingly navigable Arctic routes and rising regional infrastructure/military investment could lower barriers to **northern mining**. In this context, **advancements in mining equipment** are expected to allow for higher output with reduced resource consumption and improved safety through smarter and more efficient equipment and automation.

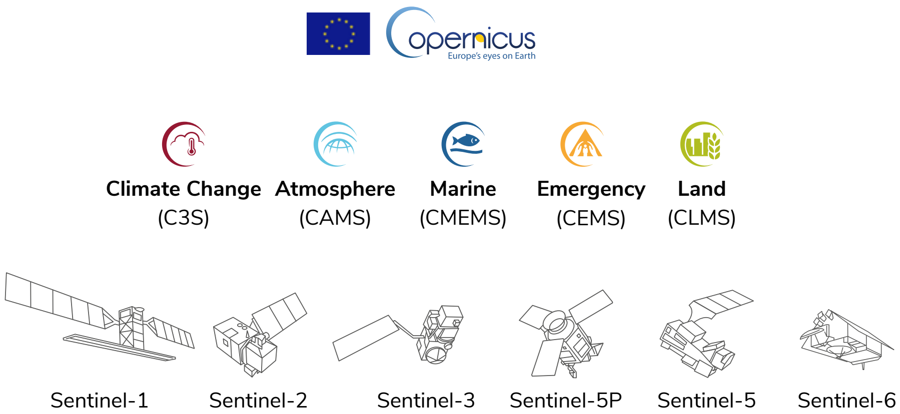
As the current geopolitical situation is expected to last also in the upcoming years, so will **the drive for supply security through 2035**. EO-powered services are expected to play a much bigger role in mining by 2035, becoming an important tool **across the value chain from exploration to closure**. Satellite data will increasingly support decision-making by **improving mineral prospecting, monitoring environmental impacts, and managing operational risks** such as extreme weather or tailings dam safety. Uptake will be driven both by technology **advances** (e.g., higher-resolution sensors, AI-driven analytics) and by **regulatory and investor pressure for transparency** on environmental, social and governance (ESG) performance.

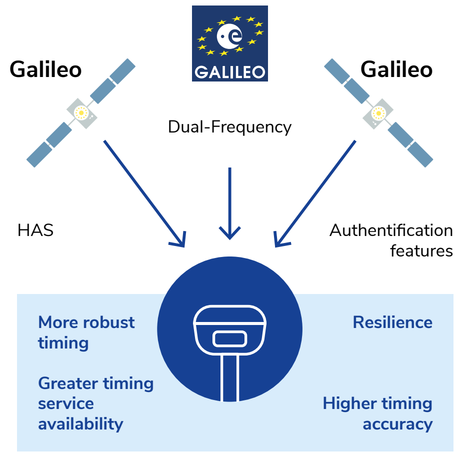
© PWC

Mining beyond the Earth's orbit

As underlined in a recent publication by the European Commission (EC), space activity is shifting from a purely orbital economy to ambitions in cislunar and deep space, marking a turning point for **resource extraction beyond Earth**. The EU Member States, already engaged in deep space mainly via ESA's scientific missions, have now started to consider also **space mining**, as global powers race to the Moon and farther. Indeed, space resource utilisation is projected to generate **EUR 73–170 billion in market revenues** (2018–2045), with end users potentially **saving EUR 54–135 billion** through lower exploration costs and **around EUR 2.5 billion in technology spillovers** over 50 years. In this context, the EC plans preparatory research and innovation (concept studies, scientific instruments, mechanism actuators, cooperative robotics, and sample extraction) to enable resource extraction and use. The EC will also examine the most suitable legal framework to govern space resource extraction and use, paving the way for responsible market development. Together, these steps aim **to position Europe competitively in the emerging space-resources economy** while amplifying tech and knowledge spillovers back on Earth.

Unlocking energy and raw-material insights with GNSS positioning and Copernicus EO data





Current and future use of Copernicus for Energy

C3S and **CAMS** provide valuable inputs for energy yield assessments such as solar radiation or wind speeds, useful for planning and operating solar and wind energy assets. Offshore wind, wave and tidal energy developers leverage inputs from **CMEMS**, partially powered by **Sentinel-3 and -6**, such as wave data and ocean physics information, when planning the deployment of assets. **CEMS** enables grid operators to assess physical risks to their infrastructure, enabling them to take mitigative action and plan future expansions accordingly. **The Energy Operational Service** of **C3S** provides key information on climate-related indicators relevant to the European energy sector, such as electricity demand and renewable energy production. The Copernicus services furthermore improve our understanding of how renewable energy sources depend on, and are affected by, a changing climate. The Sentinel satellites add further value: **Sentinel-1** provides radar data used for offshore wind resource mapping, infrastructure monitoring and assessing sea surface conditions. **Sentinel-2** delivers high-resolution optical data used for solar farm siting, land cover monitoring, and hydropower catchment analysis. Lastly, **Sentinel-5 and -5P** provide data on aerosols and trace gases, improving solar power forecasting.

Current and future use of Copernicus for Raw Materials

The **European Ground Motion Service**, powered in part by **Sentinel-1** InSAR data, enables services for ground motion monitoring. Such services, often working in conjunction with GNSS, are essential for mining (safety) operations. **Sentinel-1** data also enables water regime monitoring to map acid mine drainage characteristics and predict its impact on surrounding ground water levels. **Sentinel-2** data (e.g., Red-Edge, NDVI, etc.) is used to provide a baseline vegetation study prior to the start of mining activities and continuously monitor the stress on vegetation over time. **CLMS** provides a wide range of biophysical parameters (e.g. land cover) which further support site selection and monitoring in the mining sector.

Current and future use of EGNSS for Energy

The integration of Galileo capabilities into **Phasor Measurement Units (PMUs)** is gaining momentum. PMUs, which continuously monitor real-time electrical parameters like voltage, current, power and frequency, **require highly accurate time synchronisation**. Historically, many PMUs have relied on GPS because of its wide availability and established infrastructure. In recent years, Galileo has moved from being just a supplementary system towards becoming a stronger alternative. Some projects (e.g. the RESPONDENT project) are already **prototyping or deploying Galileo-enabled PMUs** that reduce dependency on GPS and increase resilience and accuracy in grid operations. Furthermore, the Open Service Navigation Message Authentication (OSNMA) **allows receivers to verify the authenticity of the Galileo Open Service to guard against spoofing**. However, Galileo adoption in existing PMU infrastructure is still emerging rather than widespread. Many PMUs are legacy or installed with GPS only, and retrofitting or upgrading is not straightforward. Also, using dual-constellation (GPS + Galileo) receivers or updating firmware/hardware to accept Galileo signals, OSNMA etc., still takes time and investment.

Current and future use of EGNSS for Raw Materials

The highly accurate positioning capabilities of Galileo are crucial for the extraction, mining and transportation of raw material production. Supported by RTK networks, centimetre-level accuracy enables **precise surveying/monitoring** and **machine guidance** for resource exploration, optimised excavation and efficient logistics management. In this context, the **Galileo High Accuracy Service (HAS)** offers a free high-accuracy positioning service, delivering real-time PPP corrections via the E6-B signal and terrestrial means (Internet) for applications that need higher accuracy than the Open Service provides. In addition, Galileo provides integrity monitoring and authentication capabilities, ensuring the wholeness of the positioning information and protecting against spoofing or jamming attempts. These security measures can enhance safety in mining operations that rely on machine guidance.

Several European funded projects combine space data to propose solutions in support of the Energy and Raw Materials sector

Horizon Europe, a programme of the European Union

Blue-X – Blue Energy Offshore Installation Accelerator

The BLUE-X (Blue Energy Offshore Installation Accelerator) project, managed by EUSPA within the Horizon Europe framework, aims to **accelerate the roll-out of offshore renewable energy technologies** by providing a comprehensive **decision-support system**. At its core, the project integrates multiple information sources, including Copernicus Earth Observation data, metocean conditions, in-situ measurements, geophysical surveys, environmental datasets and advanced modelling tools. By combining these streams in a **cloud-based platform**, BLUE-X enables developers and planners to **evaluate potential sites more efficiently, optimise construction processes, monitor operations in real time, and plan safe and sustainable decommissioning**. The project specifically targets the key challenges faced by offshore energy projects: high investment costs, long development timelines and uncertainties linked to marine environments. By reducing risk and providing transparent, science-based assessments, BLUE-X supports informed decision-making and increases investor confidence in innovative technologies such as offshore wind, floating solar, wave, tidal and current energy systems.

Horizon Europe, a programme of the European Union

FOCCUS – Forecasting and Observing the Open-to-Coastal Ocean for Copernicus Users

The FOCCUS project strengthens the **coastal component of the Copernicus Marine Service** by improving the resolution and reliability of data on waves, currents, water levels and other nearshore dynamics. By combining open-ocean information with high-resolution coastal observations and models, FOCCUS delivers more accurate forecasts of complex coastal processes such as storm surges, tidal flows and flooding. This reduces uncertainty in areas where offshore and coastal systems interact and makes Copernicus data more actionable for end-users operating close to shore. **For the energy sector, these advances are particularly valuable**. Offshore wind, wave, tidal and floating solar projects depend on **robust marine forecasts for site selection, safe construction and efficient operations**. FOCCUS supports developers by providing reliable data for planning and permitting, while also helping operators **manage risks from extreme weather, optimise maintenance windows and reduce unplanned downtime**. By lowering uncertainty, the project contributes to more resilient offshore infrastructure design, reduced costs and improved investor confidence, ultimately supporting Europe's transition to secure, affordable and sustainable offshore energy.

Horizon Europe, a programme of the European Union

GAIA-TSF – Geospatial Artificial Intelligence Analysis for Tailings Storage Facilities

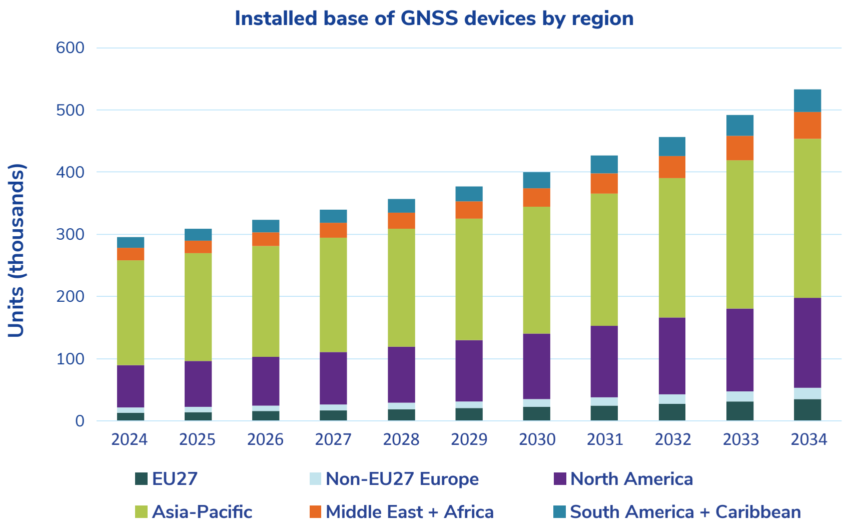
GAIA-TSF is an EU-funded Horizon Europe project developing a prototype system that fuses **satellite earth observation and machine learning** to enable continuous, multi-level, and multi-scale monitoring of **Tailings Storage Facilities (TSFs)**. Led by the Iberian Sustainable Mining Cluster (ISMC), the consortium unites top-tier universities and companies from Europe and Africa, underscoring a collaborative effort to address a global challenge.

Recent activities included presenting the project's approach and early work at **ESA's Living Planet Symposium 2025**, participation in the **S34I final conference on EO for raw materials** and organising a stakeholder workshop in Seville in September, 2025, to convene authorities, industry and researchers around best practices and emerging technologies for TSF monitoring.

Horizon Europe, a programme of the European Union

MOSMIN – Multiscale Observation Services for Mining-related Deposits

MOSMIN is developing **holistic, full-site services** for the **geotechnical and environmental monitoring** as well as **valorisation** of mining-related deposits based on a **combination of EO and in situ geophysical data**. In **June 2025**, MOSMIN ran a joint field campaign at the Roșia Poieni copper mine (Romania) with GeoKinesia, Babeș-Bolyai University, CupruMin and HZDR, combining drones, satellite data and ground surveys to map acid mine drainage (AMD) risks and advance mine-waste valorisation. Using **EnMAP hyperspectral imagery**, the team produced alteration-facies abundance maps tied to AMD risk levels, while a high-resolution UAV photogrammetric DEM simulated surface-water flow to trace potential AMD runoff and guide targeted sampling and placement of monitoring infrastructure. Furthermore, time-series tracking of AMD activity used an **AMD index** derived from **Sentinel-2 and PlanetScope imagery** alongside weather data and field pH/iron measurements. Also, Landsat NDVI with LandTrendr algorithms allowed the vegetation loss linked to mine expansion to be assessed. Along with the fieldwork carried out in Zambia, these case studies highlight how **MOSMIN's multi-sensor approach** can deliver actionable insights across the mining value chain.


Installed base of GNSS devices by region
Units (thousands)
600
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400
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200
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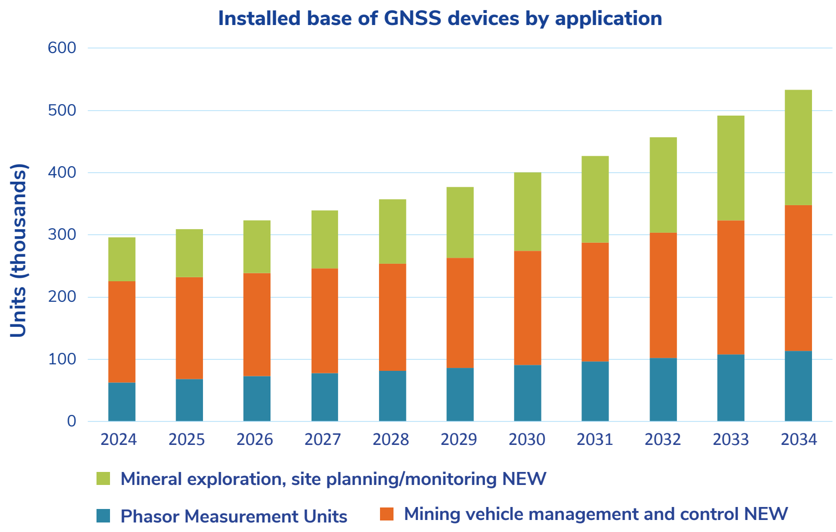
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Installed base of GNSS devices by application
Units (thousands)
600
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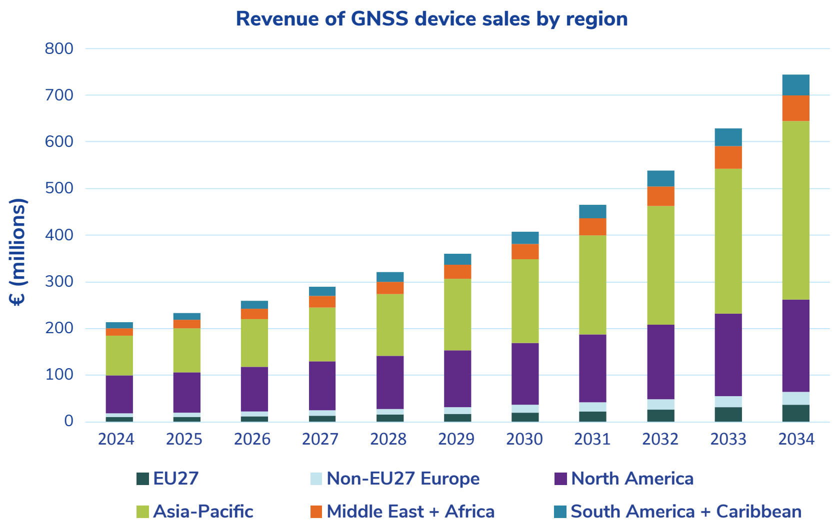
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Mineral exploration, site planning/monitoring NEW
Phasor Measurement Units
Mining vehicle management and control NEW


Revenue of GNSS device sales by region
€ (millions)
800
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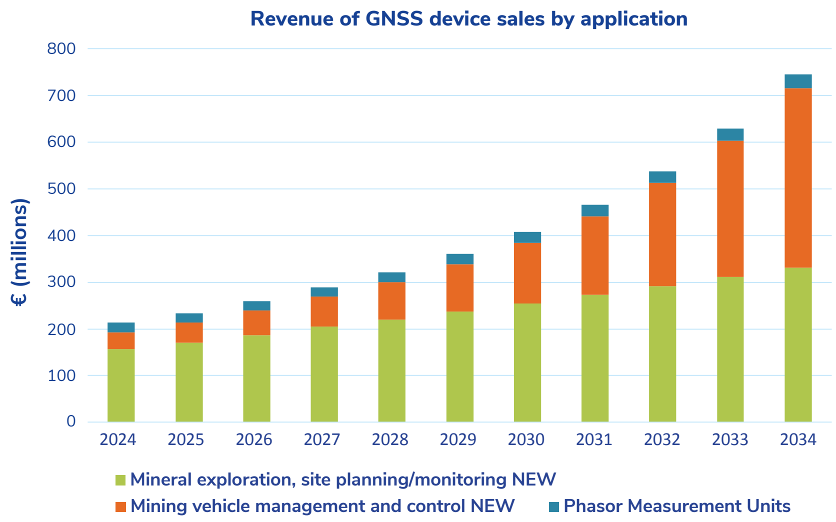
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
€ (millions)
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Mineral exploration, site planning/monitoring NEW
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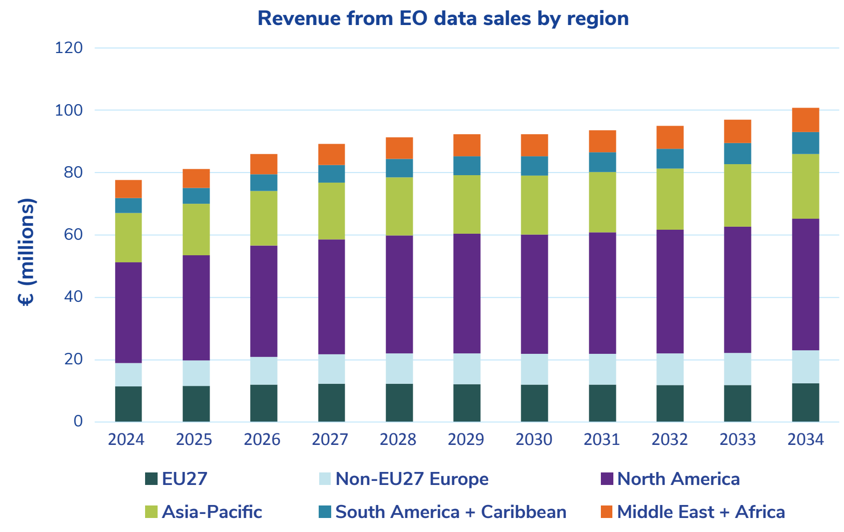
Revenue from EO data sales by region
€ (millions)
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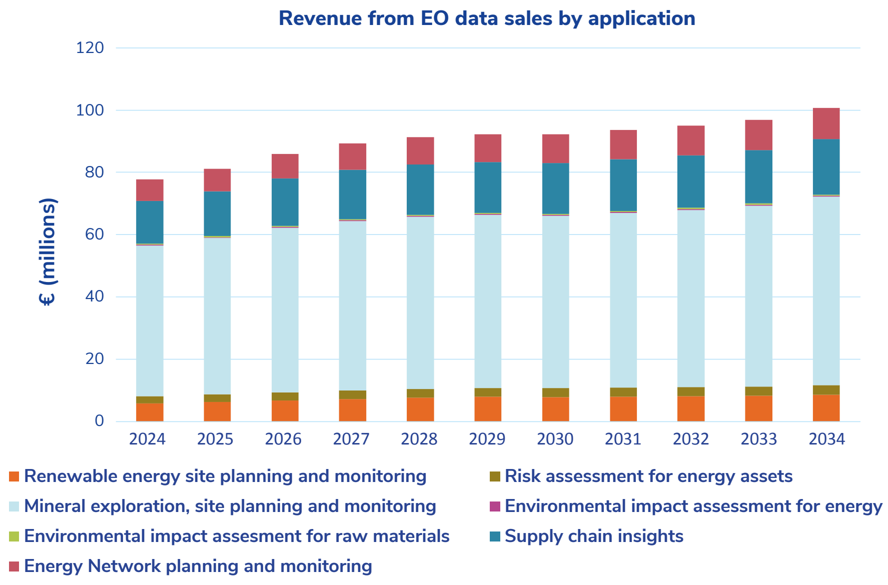
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
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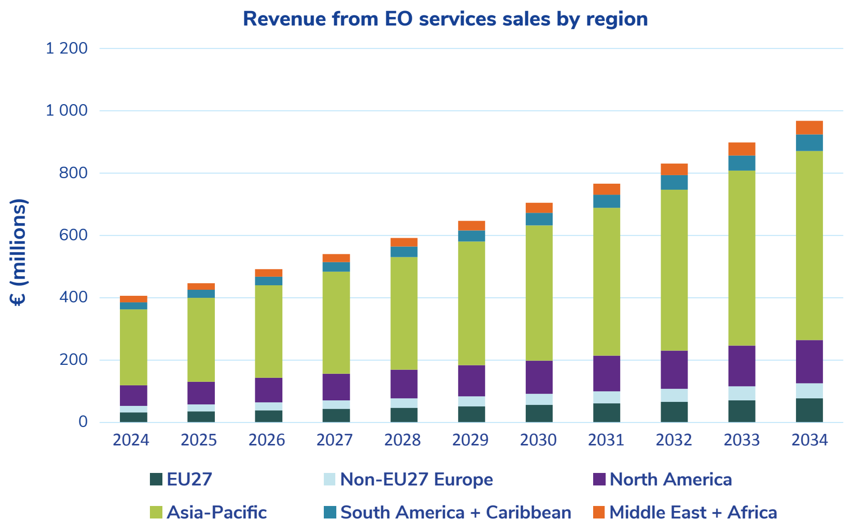
Renewable energy site planning and monitoring
Risk assessment for energy assets
Mineral exploration, site planning and monitoring
Environmental impact assessment for energy
Environmental impact assesment for raw materials
Supply chain insights
Energy Network planning and monitoring


Revenue from EO services sales by region
€ (millions)
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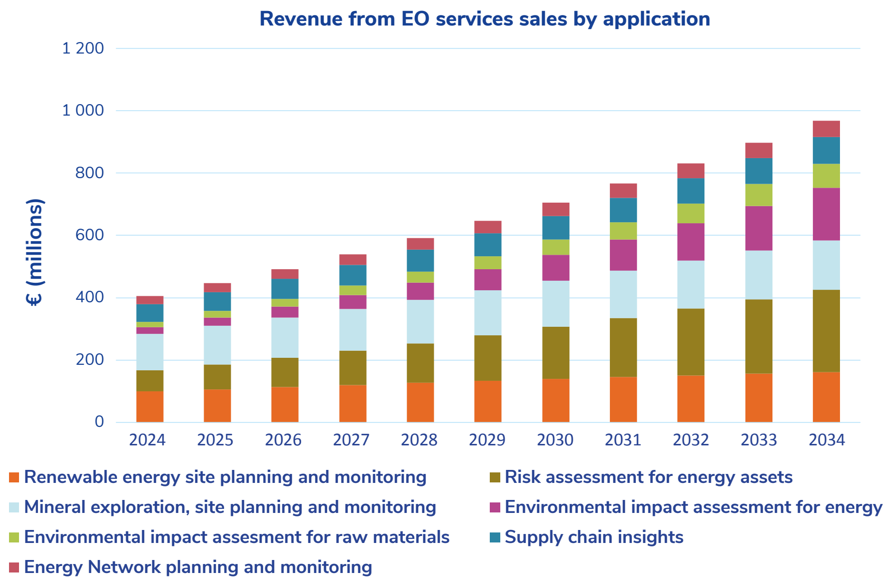
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO services sales by application
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Renewable energy site planning and monitoring
Risk assessment for energy assets
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Environmental impact assessment for energy
Environmental impact assesment for raw materials
Supply chain insights
Energy Network planning and monitoring

EU BORDER AND INTERNAL SECURITY

EU BORDER AND INTERNAL SECURITY

The EU Border and Internal Security market segment refers to non-military activities to protect people, the environment, the economy and the organisation of EU societies. The market segment covers applications aimed at preventing, deterring and mitigating activities undertaken by hostile actors and related threats, risks and hazards that could endanger EU assets, personal property and human life. The market segment covers a very wide and varied applications[2], in diverse scenarios and operating environments, for:

- **Protecting and safeguarding the security of the EU borders, in the domains of border management, customs operations, democracy and human rights**
- **Overseeing and ensuring the EU internal security and devoted to law enforcement and justice actions.**

The involved stakeholders and users include:

- **Governmental entities and Law Enforcement Agencies** (LEAs), operating at local/national and EU/international level, in charge of monitoring, control, prevention, risk management, prosecution and law enforcement action
- **Non-governmental organisations and bodies**; and
- Practitioners, such **as scientists and researchers**, supporting the governmental entities and LEAs.

In combination with other technologies and techniques, satellite technologies and services are essential tools to improve resilience, effectiveness and safety as well as to enhance situational awareness and risk assessment. Solutions exploiting EO and GNSS have already been adopted in diverse operations and scenarios. Satellite communications (SATCOM) are utilised to overcome the lack of terrestrial network coverage in open seas or remote territories. Communication links can be further strengthened by Secure SATCOM.

EU Border Security

Border management

- Land border surveillance
- Sea border and maritime surveillance
- Monitoring of irregular migration and smuggling of people

Customs operations

- Enhanced risk assessment for EU customs administrations
- Suppression and investigation of all illegal activities

Democracy and human rights

- Overseeing democracy and human rights
- EU civilian crisis management operations – Common Security and Defence Policy (CSDP)

Application descriptions can be found in Annex 3.

Internal Security

Law enforcement

- Maintaining public order and ensuring public safety
- Law enforcement assets and personnel monitoring
- UXO (Unexploded Ordnance) risk assessment and clearance

Justice actions

- Prevention, investigation, evidence collection and prosecution of law violations, and forensics[1]

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS along with (secure) SATCOM in some cases)

1: It includes the application related to the fight against environmental crime, for which revenues from EO service sales are quantified.
2: Application descriptions can be found in Annex 3.

What you will find in this chapter

- **Key trends:** Integration of EO and GNSS data with the use of (secure) SATCOM increases situational awareness across different operating scenarios.
- **Industry:** GNSS and EO value chains for EU Border Security and Internal Security.
- **Technology drivers:** Integration of EO, GNSS and (secure) SATCOM.
- **Recent developments:** Combination of EO and GNSS with other technologies and techniques.
- **Future market evolution:** Satellite data as acceptable legal evidence in forensics to prosecute criminals in court.
- **European systems:** EU space services providing significant value in applications for EU Border and Internal Security.
- **European projects:** Several European-funded projects proposing solutions based on EO and GNSS for EU Border and Internal Security.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

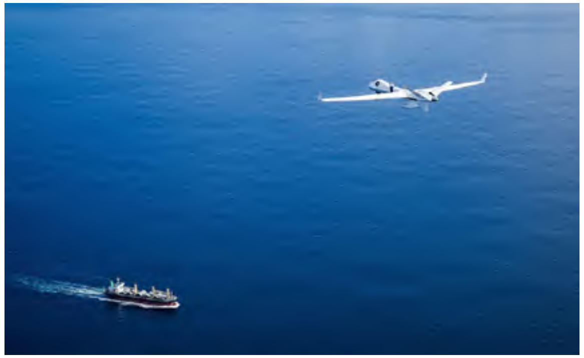
Note: The revenue estimation methodology in the EU Border and Internal Security segment adopts an incremental approach to the other market segments to avoid double counting (for example, AIS-related GNSS revenues are all quantified in Maritime and Inland Waterways, even for AIS transponders installed on coast guard and surveillance vessels. Considering EO, deforestation and illegal logging monitoring is covered in the Forestry segment and therefore not quantified under the application related to the fight against environmental crime). Therefore, the actual EU Border and Internal Security market is larger in terms of revenue than that which is captured in this segment alone.

Integration of EO and GNSS data increases situational awareness across different operating scenarios

Key market trends

- Users increasingly expect solutions that merge Earth-observation insights with GNSS positioning to create seamless, real-time situational awareness.
- Blending EO imagery with GNSS information strengthens the reliability of surveillance, monitoring, and decision-making systems, especially in high-pressure environments.
- Coupling satellite data with positioning enhances the accuracy, relevance, and timeliness of information delivered to frontline operators.
- Future systems are trending toward automated, AI-driven platforms that fuse EO, GNSS, and other data streams to support advanced, context-aware operations.

Border surveillance



EO images of the EU's external land and sea borders are combined with in-situ geospatial data and with the real-time information collected from the components of the physical surveillance systems (e.g., sensors and cameras) to support **situational awareness and operations in border surveillance and maritime security**. GNSS provides precise localisation and timing of in-situ elements and of the components of the physical surveillance systems. A wide range of in-situ elements is utilised, depending on the type of border (land, sea, coastal) and the area to be covered.

In **land border surveillance**, GNSS provides position and timing information related to sensors and cameras of **intrusion monitoring and detection systems**. In **maritime border surveillance**, GNSS enables to locate the sensors and the nodes of **IoUT (Internet of Underwater Things)** networks, composed of underwater multi-sensors objects, also equipped with cameras, and acoustic modem for shallow waters and for deep waters. Moreover, in maritime environments, GNSS technology also contributes to other key data sources, such as the GNSS-based maritime tracking systems – **ground-based and Automatic Identification System (AIS), Vessel Traffic Service (VTS), Vessel Monitoring System (VMS), and Long-Range Identification and Tracking (LRIT)**.

The in-situ data and the information acquired from several sources are transmitted through terrestrial networks, or (secure) SATCOM in the case of remote areas. They are aggregated **and overlayed on the top of satellite imagery** to produce **multilayered** georeferenced **maps of a surveyed area that can be visually assessed by the LEAs**. In border surveillance operations, EO data are key instruments to monitor and fight against irregular migration and people smuggling.

Additionally, researchers have shown that even if not specifically designed for PNT purposes, telecommunication signals transmitted from the recent LEO mega-constellations could be used as a complementary technology to calculate a positioning solution, leveraging LEO SATCOM transmissions as signals of opportunity[1].

1: More information regarding synergies of GNSS and Secure SATCOM can be found at page 99 of the GNSS Market report.

Drones in border patrol surveillance and law enforcement

Drones are instrumental for a variety of purposes in external border security and in law enforcement actions to oversee and maintain internal security. In border surveillance, in-situ data also include **images from airborne assets (aircraft and drones)**, complementing the satellite images, especially for specific targets and zones. Satellite images, supported by drones, are utilised by LEAs to plan in advance and gain **tactical advantages in their actions aimed at public order and safety**.

Equipped with **GNSS, advanced sensors, and high-resolution cameras**, drones deliver precise real-time geolocated data in a high range of contexts and complexities, seamlessly complementing the images from satellite. The drone's capabilities are also exploited in tracking the movements of criminals, including smugglers and human traffickers attempting illegal border crossings. Advanced drones, equipped with thermal imaging and facial recognition, operate in challenging terrains and adverse environments. **GNSS precise positioning, navigation and timing empower drone operations**. SATCOM is also utilised for the real-time transmission of data gathered by the drones, providing coverage to remote and hard-to-access areas, without the need for terrestrial infrastructure.

Today, unauthorised drone activities pose significant challenges, including potential threats to security. The use of **Counter - Unmanned Aircraft System (C-UAS)** technologies is being explored to detect, track, mitigate and neutralise hostile and 'non-cooperative' drones operated by organised crime or malicious actors. C-UAS solutions are becoming essential to support LEAs in **better protecting the integrity of external borders, safeguarding internal security and public safety**.

GNSS Value Chain for the EU Border and Internal Security market segment[1]

GNSS

AUGMENTATION SERVICE PROVIDERS

- FUGRO*
- GeodNet
- HEXAGON*
- TOPCON
- TRIMBLE
- U-BLOX*

COMPONENT AND RECEIVER MANUFACTURERS

- ADVANTECH
- ALPHATRON MARINE* (PART OF JAPAN RADIO CO)
- ATOS INFORMATION TECHNOLOGY GMBH*
- BROADCOM
- CARGOMON SYSTEMS GMBH*
- CARGOTRACK*
- DALLMEIER ELECTRONIC GMBH*
- GLOBALSTAR
- GENERAL ELECTRIC
- HERE*
- HEXAGON*
- KINEIS*
- KONGSBERG MARITIME*
- LEONARDO*
- ORBCOMM
- OVINTO*
- QUECTEL
- SAAB*
- SAFRAN*
- SAVI
- SAY TELEMATIC SYSTEM*
- SIEMENS*
- SONY SEMICONDUCTOR SOLUTIONS
- THALES*
- TRIMBLE
- U-BLOX*
- UNISTRONG GNSS

SYSTEM INTEGRATORS & SERVICE PROVIDERS

- CARGOMON SYSTEMS GMBH*
- CARGOTRACK*
- EAGLEPROJECTS*
- GLOBALSTAR
- HERE*
- KINÉIS*
- INFINEON*
- INMARSAT*
- KONGSBERG*
- LEONARDO*
- ORBCOMM
- OVINTO*
- SAAB*
- SAVI
- SAY TELEMATIC SYSTEM*
- THALES*
- UXORISK*

USERS

- GOVERNMENTAL AUTHORITIES
- LAW ENFORCEMENT AGENCIES
- NON-GOVERNMENTAL ORGANISATIONS AND BODIES
- OTHER PRACTITIONERS E.G., SCIENTISTS, RESEARCHERS AND PROFESSIONALS

LEGEND

- Commercial offering
- Public offering / entities
- User segments

The European[2] GNSS industry in the global arena

Europe is a major player in the global component and receiver manufacturing sector for EUBIS, accounting for around 27% of the worldwide market. Leading companies such as Thales and Safran contribute significantly to this share. However, the market remains largely dominated by North America, which controls over 50% of the global market.

In the integrator segment, Infineon, a major European player, commands an 13% market share on its own. This strong presence elevates the overall EU share in this segment to nearly 19%.

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

EO Value Chain for the EU Border and Internal Security market segment[1]

EO

AUXILIARY INFORMATION PROVIDERS

- WSENSE
- UNSEENLABS

INFRASTRUCTURE PROVIDERS

- AWS
- COPERNICUS DIAS*
- GOOGLE CLOUD PLATFORM
- HEWLETT PACKARD ENT
- HISDESAT*
- IBM CLOUD
- INTEL GEOSPATIAL
- MICROSOFT AZURE
- SATELLOGIC

- COPERNICUS COLLABORATIVE GROUND SEGMENT*

DATA PROVIDERS

- 21ST CENTURY AEROSPACE
- 4EI*
- AIRBUS*
- COPERNICUS DIAS*
- E-GEOS*
- GEOSAT*
- ICEYE*
- OHB*
- PLANET
- SATELLITE IMAGING CORPORATION
- SATELLOGIC
- UP42*
- VANTOR

- EU (COPERNICUS SENTINELS)*
- ASI (COSMO SKYMED)*
- DLR (TERRASAR-X)*
- ESA*
- USGS/NASA LANDSAT
- NISAR (NASA/ISRO)

PLATFORM PROVIDERS

- ADAM*
- CLEOS (E-GEOS)*
- COPERNICUS DIAS*
- GOOGLE EARTH ENGINE
- INDRA SISTEMAS*
- UP42*
- VANTOR

- COPERNICUS DATA SPACE ECOSYSTEM (CDSE)*

EO PRODUCT AND SERVICE PROVIDERS

- AIRBUS*
- BLACKSKY
- E-GEOS*
- GAF AG*
- GMV*
- GEOVILLE*
- PLANET
- SATELLITE IMAGING CORPORATION
- SCIDRONES*
- TELESPAZIO*

- COPERNICUS SERVICES*

END USERS

- GOVERNMENTAL AUTHORITIES
- LAW ENFORCEMENT AGENCIES
- NON-GOVERNMENTAL ORGANISATIONS AND BODIES
- OTHER PRACTITIONERS E.G., SCIENTISTS, RESEARCHERS AND PROFESSIONALS

LEGEND

Commercial offering
Public offering
User segments

The European[2] EO industry in the global arena

The European industry holds a substantial position in the EU Border and Internal Security (EUBIS) market segment, supplying EO data and services to Frontex, SatCen, and national authorities. Leading companies such as Airbus, e-GEOS (Leonardo), Indra, GMV, and Telespazio contribute significantly to EO-enabled EUBIS.

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

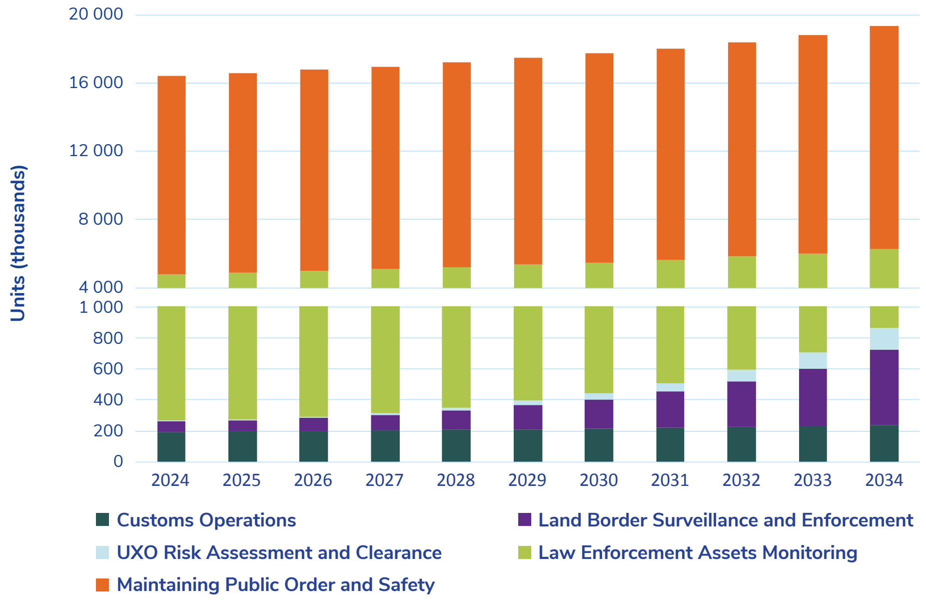
Please refer to page 20 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

Combination of satellite with other technologies and techniques enhances resilience

Installed base of GNSS devices by application



The applications quantified in this chart are a selection of the full list of GNSS applications for EU Border and Internal Security, as listed in the cover page of this segment.

Port security

Satellite technologies and services play an essential role in enhancing port security by helping port authorities to reduce vulnerabilities and to enhance surveillance. GNSS contributes to **smart fencing and geofencing of port areas**, through the implementation of '**virtual gates**'. GNSS-based virtual gates, combined with sensors and cameras of physical security systems, feed ports' Internet of Things (IoT) ecosystems and situation awareness platforms. Goods and vehicles moving within the port perimeter are checked at entry-exit points and virtual gates, ensuring seamless flows and secure transits across the ports. GNSS also provide the position and timing information of the sensors and cameras of physical security systems. Physical security systems can include IoUT networks, using GNSS for the localisation of the underwater sensors and objects.

Images provided by satellites and drones, integrated with Artificial Intelligence (AI), Machine Learning (ML), and data analytics techniques, deliver advanced **antitheft measures for cargo security in ports**, ensuring a prompt detection of anomalies and early warning. Recent developments in ports protection capabilities against threats and intrusions, indicate a **shift towards more automated surveillance tools**. Moreover, for the past few years the trend has been to exploit cutting-edge technologies, such as **robotics and unmanned systems**, relying on GNSS for PNT and deploying hybrid terrestrial/(secure) SATCOM networks.

The EU Border and Internal Security market, measured by installed base of GNSS devices by application, **shows stable growth driven by tech adoption** (drones, AI), with **rising investment in external border technology** (sensors, biometrics) and **internal surveillance technologies** (Smart CCTV, access-control systems).

The **total installed base is projected to increase by nearly 3 million** units with a CAGR of 1.5% over the next decade. This growth will be driven by wider adoption of GNSS mainly for tracking and tracing capabilities, as well as localisation and timing, further boosted by EU Regulations to enhance digitalisation, such as the EU Waste Shipment Regulation 2024/1157, EU Regulation 2020/1056 on electronic Freight Transport Information (eFTI), the new Union Customs Code (UCC) reform of customs and the establishment of a centralised EU Customs Data Hub.

When analysing the considered applications within the segment closely, **maintaining public order and public safety** will dominate with the installed base anticipated to reach 13.5 million units by 2034. **Land border surveillance and enforcement** and **UXO risk assessment and clearance** continue to be niche areas, but they are forecast to achieve an average CAGR of 28% for the period 2024-2034. This growth will be driven by rising security threats and corresponding government investments, including in the use of GNSS-enabled drones for aerial monitoring and remote operations in hazardous areas.

Digitalisation of customs processes

Satellite technologies, integrated with a variety of other technological tools and techniques, aid customs officials in the observation, analysis, investigation, inspection and supervision of the entry, exit and circulation of ships and freights moving across the seas and in ports.

GNSS-based tracking systems (often using SATCOM to overcome the lack of terrestrial network coverage in open seas or remote territories) are installed on board vessels, vehicles, trucks and containers to trace their movements, and to identify any deviations from authorised routes. The data gathered from the GNSS-based tracking systems, coupled with information from other sources, such as electronic seals, **Optical Character Recognition (OCR) and Radio-Frequency Identification (RFID)**, allow the integrity of the shipments to be checked and the occurrences of possible irregularities to be localised.

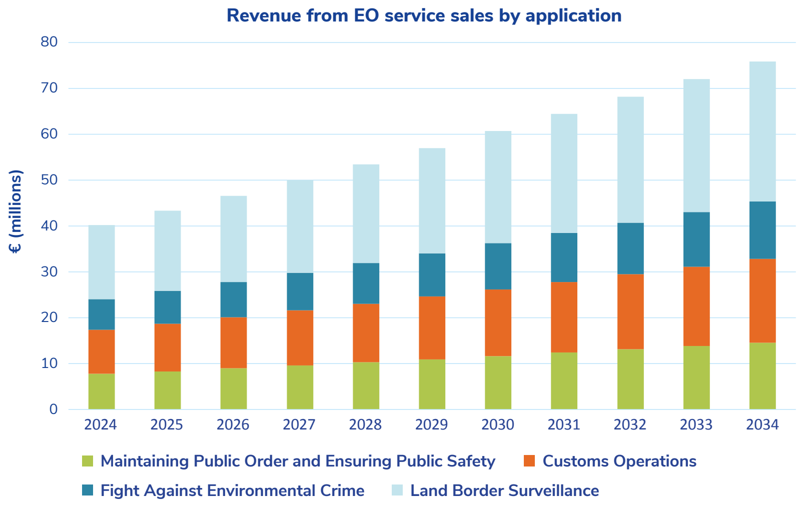
GNSS position and time information from the **vessels' AIS** are **coupled with images from satellites and drones**, allowing customs administrations to:

- Detect the movements of **suspicious vessels and monitor their activity in-real time**;
- Check the **actual shipment with respect to the expected journey**;
- Implement advanced risk assessment procedures; and
- Prevent and identify illicit activities related to **drug trafficking, looting of cultural heritage, smuggling of sensitive and counterfeited goods, illegal mining and fishing, for example**.

In particular, the employment of satellite radar or optical data make it possible to acquire images in near real time of all ships present in a certain area, including non-cooperative and 'dark' vessels. The current market development is to couple **Radio Frequency (RF) data and IoUT networks**, offering greater ability to detect the water movements generated by dark ships. Moreover, high-resolution images can be used for the detection of loading and unloading of illegal cargos.

Satellite technologies contribute to the digitalisation of customs processes, as envisaged in the **new UCC** presently under revision (as part of the customs reform package proposed by the European Commission), and to the envisaged establishment of an **EU Customs Data Hub**, serving as a central point where European customs authorities and other regulatory bodies can retrieve and add data.

Satellite data can provide acceptable legal evidence in forensics



The applications quantified in this chart are a selection of the full list of EO applications for EU Border and Internal Security, as listed in the cover page of this segment.

EO is increasingly recognised as a strategic instrument for **border management operations**, in combination with ground and airborne systems. EO data are increasingly used by competent authorities and LEAs to **detect and monitor environmental crimes**, and also gradually to provide **evidences for supporting prosecution**.

However, EO-based solutions are often implemented on a project basis (e.g., proof-of-concept, demonstrator) or on an ad hoc basis, although **routine operational uses still remain limited in volume**, which explains the relatively small market size. Land border surveillance is the application with the largest market share, driven in the EU by the EO-based solutions implemented by Frontex for the management of the EU's external borders.

In the near future, the segment may benefit from the deployment of **small satellites constellations**, which offer **Very High Resolution** (VHR) imagery with a **high revisit frequency at more affordable costs** than traditional large satellite missions. The market size is expected to **grow on a regular basis over the next decade**, even though constrained by the evolution of public spending, the vast majority of users being public authorities. A **wider acceptance in forensics** may further boost EO adoption in the segment.

Evidence of cultural heritage crimes

EO data are extensively used to monitor cultural heritage sites and spot damage caused by unauthorised excavations, looting, environmental degradation, armed conflict and natural hazards, particularly, particularly in areas that are difficult or impossible to access on the ground. **Multi-temporal analyses** (through past and ongoing satellite observations) enable regular updates of site conditions and of the looting features over time. **Multi-sensor approaches** exploit the synergy between complementary optical and radar satellite technologies data. Thermal and infrared capabilities effectively pinpoint (i) sites around a metre in depth and (ii) archaeological targets dug as tunnels and holes along slopes, or targets covered by accumulated sediment within structures and buildings.

The combination of EO data with **other technologies and techniques, including images acquired through** air-borne and drone surveys. 3D models and Light Detection and Ranging (LiDAR) offer more accurate and timely detection of damage, as well as a higher granular quantification, which enables detailed ground-level views of site conditions over time. Precise location of archaeological sites facilitate the discovery and recording of even minor changes. LiDAR allows the creation of topographic maps for recognising subtle surface variations and disruptions in terrain that might go unnoticed with other methods, thanks to the ability to penetrate vegetation and detect fine topographic changes of sites in forested or otherwise covered areas.

GNSS delivers the precise location of the endangered sites on top of **Geographic Information System** (GIS), integrating spatial data layers and contextual information, for advanced analysis, visualisation and reporting for investigation purposes and for raising public awareness. The produced reports can be a powerful tool to **undertake legal actions**. On-going initiatives are exploring the **potential of EO and GNSS data to provide acceptable legal evidence in forensics**, in order to prosecute criminals and looters in court proceedings. Definition of specific guidelines, protocols and procedures will facilitate and boost the legal and judicial admissibility of geospatial evidences.

Evidence of environmental crimes

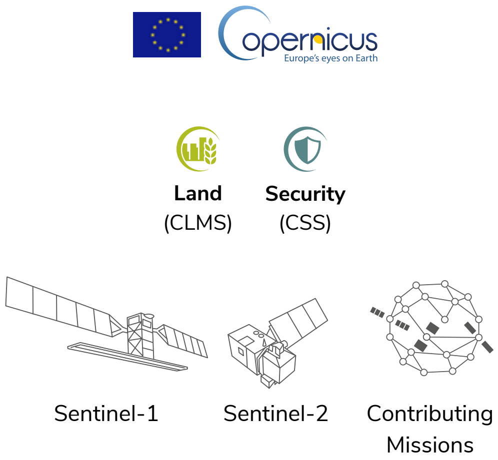
Remote sensing satellite technology brings instrumental environmental crime-fighting capabilities to LEAs, scientists, agencies and organisations, enabling them to **automate the surveillance, the detection and the investigation of illegal activities, and the production of the relevant evidence**. Satellite imagery is widely adopted in several contexts and situations, such as deforestation, waste dumps and disposal, irregular hazardous material landfills, water pollution, pesticide misuse, mining operations, wildlife crimes and resource misuse in protected areas. Satellite imagery is also utilised by national agencies and police forces to detect illegal buildings or verify cadastral information.

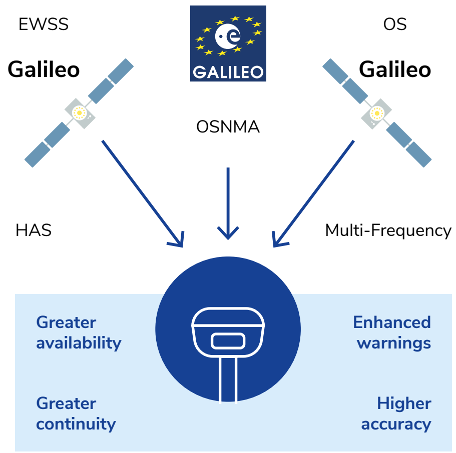
The added functionality of **satellite images coupled with GIS** is the ability to cover vast or inaccessible regions. Evolutions in sensor technologies and miniaturisation have expanded the capabilities of remote sensing and increased the availability of VHR images, also not weather or daylight-dependent, through Synthetic Aperture Radar (SAR), as well as thermal and spectral data.

Over smaller areas, aircraft and drones complement satellite imagery providing remote sensing data in real time, and with greater detail and precision. Equipped with specific sensors, drones analyse vegetation health, biodiversity and habitat disruptions. They also monitor water bodies, identifying pollution sources and changes in water quality, contributing to the overall health assessment of aquatic ecosystems, and ensuring a prompt response to possible threats.

The continuous stream of imagery and large volumes of data are retrieved and processed through **AI and ML techniques, and data analytics**, bringing significant value to the investigation, analysis and production of evidence. Remote sensing satellite technology has **great potential for use in court proceedings, as contemporary forensic evidence systems have been considered admissible in legal settings**.

EU Space services provide significant value in EU Border and Internal Security applications





Current and future use of Copernicus

Copernicus includes a service specifically dedicated to security application, the **Copernicus Security Service**, which improves prevention, preparedness and response in **Border Surveillance, Maritime Surveillance** and **Support to EU External and Security Actions**.

The **Copernicus Border Surveillance Service** helps to increase situational awareness at the EU external borders and pre-frontier area by providing officers on the ground with monitoring, mapping and risk assessment services. The **Copernicus Maritime Surveillance Service** provides a better understanding and improved monitoring of human activities at sea. It addresses domains such as maritime safety and security, customs, marine pollution monitoring or fisheries control. The **Copernicus** Support to EU External and Security Actions (SESA) delivers customised satellite-based geospatial products which help the EU and its Member States to face security challenges and to monitor the implementation of EU law. The services delivered include geospatial analysis, situational awareness and support to planning.

Thanks to the Full, Free and Open Copernicus data policy, all users have access to the satellite data delivered by the **Sentinel missions**. The radar data delivered by **Sentinel-1** and the optical data delivered by **Sentinel-2** are relevant to the actors of the EU border and internal security market segment. They can support a large range of applications including the detection of illegal activities at sea, the identification and prosecution of environmental crimes, and the characterisation of zones at risk in border areas.

These data can be complemented with the data delivered by the **Copernicus Contributing Missions**, which are operated by ESA, its Member States and international third-party operators and include commercial VHR optical and radar missions.

Current and future use of EGNSS

Galileo Open Service (OS) is operational and freely accessible to any user equipped with a compatible receiver. Galileo OS is interoperable with other GNSS services to deliver combined position, velocity and timing. In a multi-constellation environment, Galileo OS offers **high position and time accuracy and availability**, which are crucial **for enhancing operations especially in risky contexts**. Consumer grade receivers currently available on the market are multi-GNSS including Galileo OS, and they are largely utilised in off-the-shelf products and solutions for EU border and internal security applications.

Galileo Open Service Navigation Message Authentication (OSNMA) provides navigation message authentication function for Galileo OS signals, assuring that the information received is authentic and not altered by any spoofing attempt – i.e. the signals come from Galileo satellites and have not been modified in any way. Galileo OSNMA is operational and freely accessible. OSNMA capable receivers and technologies are increasingly becoming available on the market. By supporting **interference-resilient position, navigation and timing information**, Galileo OSNMA has the potential to be a fundamental service in EU border and internal security by providing the ability to fulfil the need for trustworthiness, robustness and reliability across applications. Particularly for maritime border surveillance, the proven benefit of Galileo OSNMA is in allowing LEAs to **recognise the threat of GNSS spoofing attacks in demanding environments and in offering the ability to mitigate possible consequences in critical operations**.

Galileo High Accuracy Service (HAS) delivers real-time, high-accuracy positioning with a horizontal accuracy at a decimetre level. Galileo HAS is operational and freely accessible to any user equipped with an enabled receiver. For EU border and internal security, Galileo HAS can be contribute to **digital twins' representations** of crime scenes, for example.

Galileo Emergency Warning Satellite Service (EWSS) will swiftly broadcast alerts globally. For EU border and internal security, Galileo EWSS could play a role in C-UAS, border management and law-enforcement operations by **disseminating messages to affected populations and to deployed assets, for warnings, effective risk management and response**.

Terminology used on this page is explained in Annex 2 for both GNSS and EO performance parameters.

Several European projects demonstrate value of EO and GNSS for EU Border and Internal Security

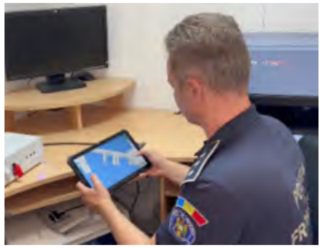
Pilot Project: Galileo-enabled Asset Tracking strengthens EU External Border Security

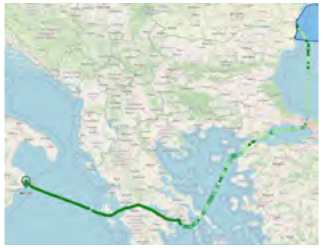
Carried out in the frame of a joint initiative between Frontex (the European Border and Coast Guard Agency), the **Romanian Border Police** and EUSPA, this pilot project demonstrated, under real operational conditions, the **added value of Galileo, particularly its Galileo OSNMA service in maritime border surveillance**.

The positive results of the pilot confirmed that authenticated GNSS services are moving from a technical enhancement to an operational requirement, contributing to stronger EU border security by delivering more robust, trustworthy and interference-resilient real-time localisation for fleet management and surveillance operations.

The core of the project was the development of Galileo-enabled equipment in line with Frontex requirements and use cases. The equipment was installed on board two Romanian Border Police's vessels engaged in patrolling and maritime surveillance operations in the Black Sea, between August and September 2025, and later in the Mediterranean Sea.

Operational testing proved the benefits of Galileo OSNMA authentication in detecting and protecting against GNSS spoofing attacks. Thanks to the Galileo-enabled asset tracking solution, coast guard officers gained interference detection capability resulting in greater confidence and trust in the position and time also displayed onboard.





For Frontex, the project's key benefits lie in the ability to cope with the growing need for **trustworthy, interference-resilient position, navigation and timing** in demanding environments and critical operations. The use of multi-constellation GNSS equipment supporting Galileo OSNMA enables Frontex to **recognise the threat of GNSS spoofing attacks and mitigate the possible consequences**, such as loss of real-time asset tracking, operational delays, mission disruption, safety risks to personnel and broader security implications. The pilot project also highlighted that **secure satellite connectivity** will be essential for the future of EU border management.

The pilot project provided Frontex with valuable insights for future positioning and tracking capabilities. First-hand operational experience was gained, validating Galileo OSNMA as a key service to **increase robustness and reliability in border surveillance, extending also to road and aerial fleets**. Additionally, Frontex had the opportunity to learn that **the integration of the European space services into existing surveillance and command-and-control systems supports enhanced situational awareness and better decision-making**.

Horizon Europe, a research and innovation programme of the European Union

EMERITUS - Environmental crimes' intelligence and investigation protocol based on multiple data sources

EMERITUS focused on the development of a single-entry point platform offering a package of capabilities for **LEAs and border guards**, enabling them to improve the **collection of evidence and proof as part of investigations into environmental waste crimes**. The provided capabilities include digital elements exploiting satellite technologies, in particular **intelligence functionality based on satellite imagery** (Copernicus Sentinel), and **advanced inspection instruments through drones assisted by EU GNSS services EGNOS and Galileo for positioning, navigation and timing**. The EO images and the data collected through drone's flights, processed by means of AI techniques, allow reconstruction of waste trafficking detection.

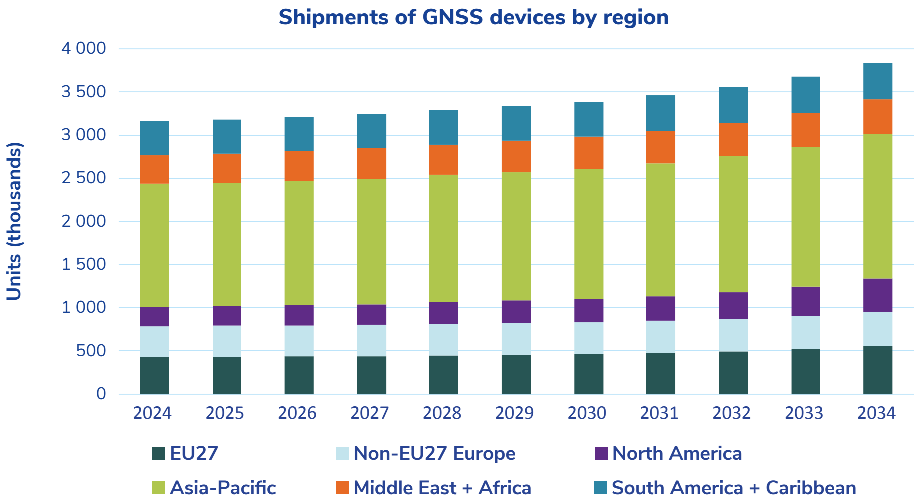
The developed technologies were proven in four use cases: **water contaminant source detection, waste storage centres monitoring, cross-border illegal waste trafficking monitoring, and identification of illegal waste discharge sites in broad areas**. Building on the outcomes of the four use cases, EMERITUS also drew up a training programme and an investigation protocol oriented towards environmental crimes in order to guide LEAs and border guards in the **integration of digital technologies in their daily operations**.

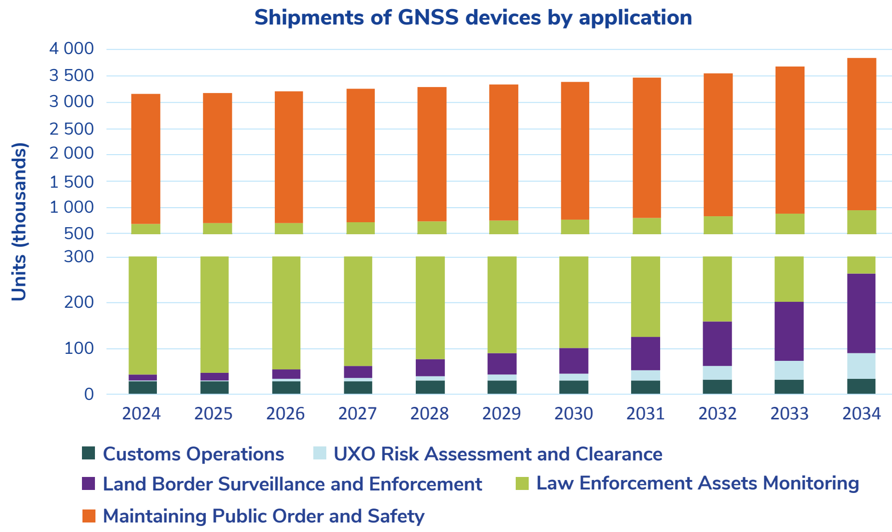
Horizon Europe, a research and innovation programme of the European Union

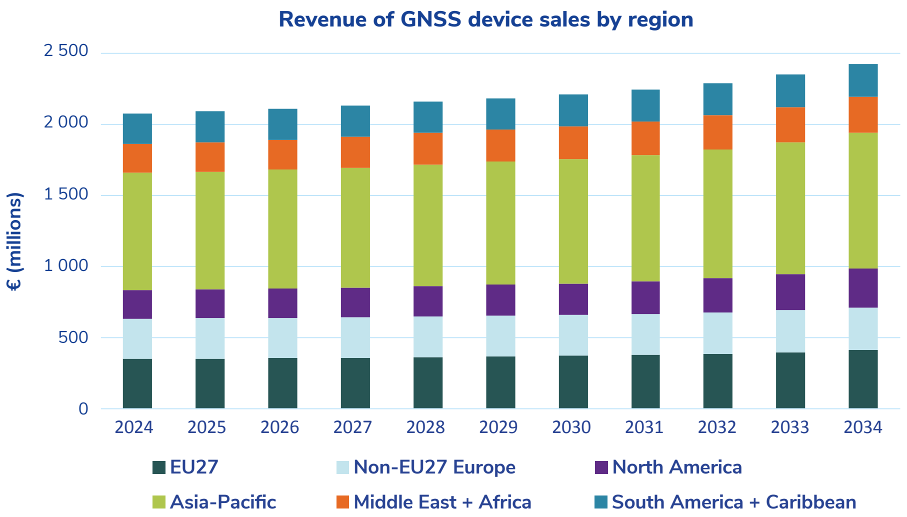
AI4COPSEC – Boosting EU Copernicus security and maritime monitoring with AI and ML

AI4COPSEC focusses on combining **satellite images with other data and cutting-edge technologies**, with a view to improve **maritime and border surveillance** and **environmental crisis response**. AI4COPSEC will develop deep learning and geomatics solutions, using **Copernicus data**, state-of-the-art AI and ML models and non-space data (including **GNSS data from AIS**, information generated through Open Source Intelligence and IoT).

AI4COPSEC solutions will provide functions delivering advanced anomaly and pollution detection, enhanced ship detection and identification, near real event detection and localisation, thereby improving awareness and speeding up response and decision-making. AI4COPSEC solutions and functions will be demonstrated in four use cases, including **search and rescue operations**, and in activities devoted to **oil spill response, illegal fishing identification** and **irregular migrations monitoring**.


Shipments of GNSS devices by region
Units (thousands)
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Shipments of GNSS devices by application
Units (thousands)
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
300
200
100
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Customs Operations
UXO Risk Assessment and Clearance
Land Border Surveillance and Enforcement
Law Enforcement Assets Monitoring
Maintaining Public Order and Safety


Revenue of GNSS device sales by region
€ (millions)
2 500
2 000
1 500
1 000
500
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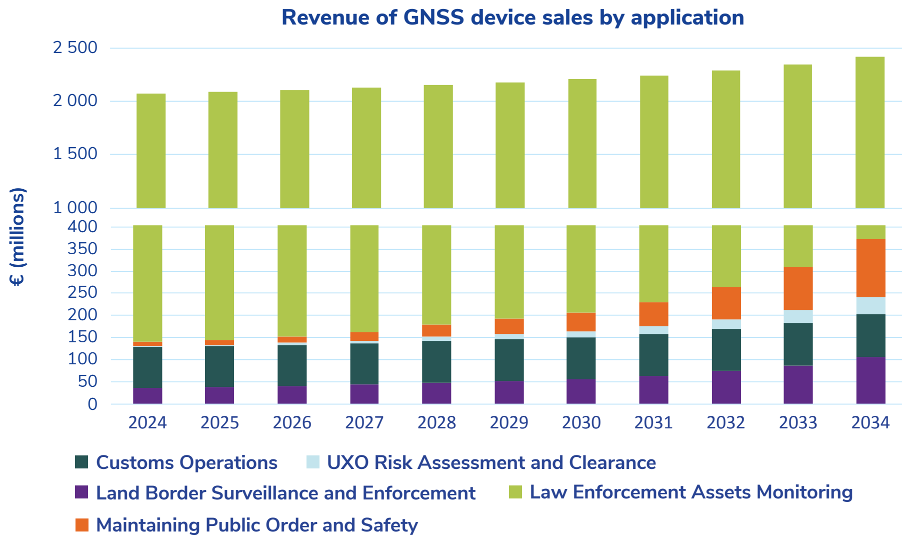
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
€ (millions)
2 500
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1 500
1 000
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350
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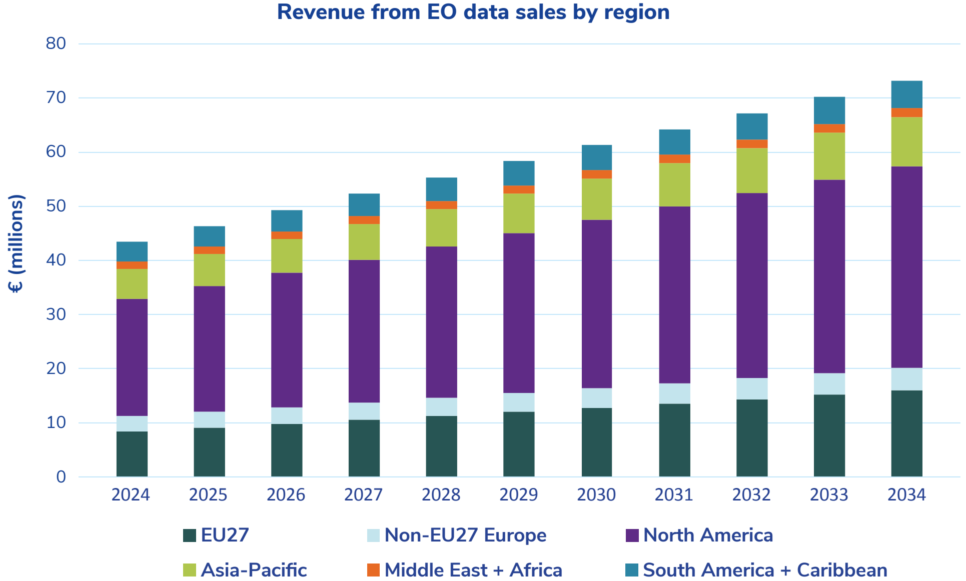
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Customs Operations
UXO Risk Assessment and Clearance
Land Border Surveillance and Enforcement
Law Enforcement Assets Monitoring
Maintaining Public Order and Safety


Revenue from EO data sales by region
€ (millions)
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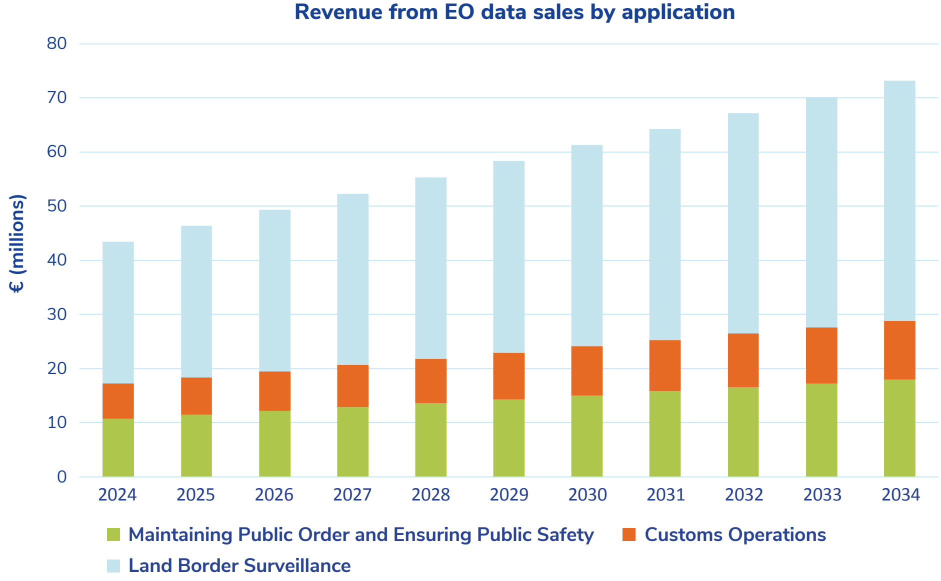
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue from EO data sales by application
€ (millions)
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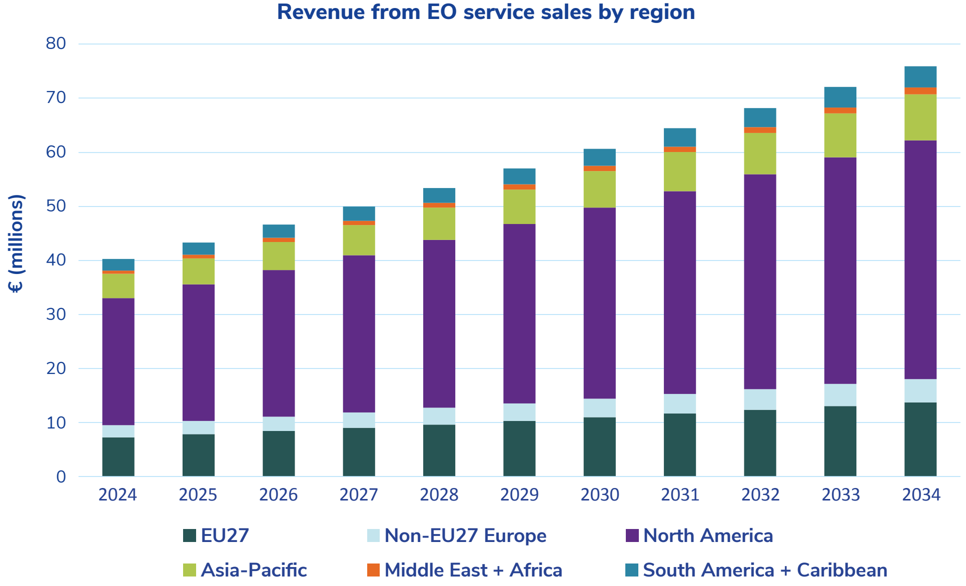
Maintaining Public Order and Ensuring Public Safety
Customs Operations
Land Border Surveillance


Revenue from EO service sales by region
€ (millions)
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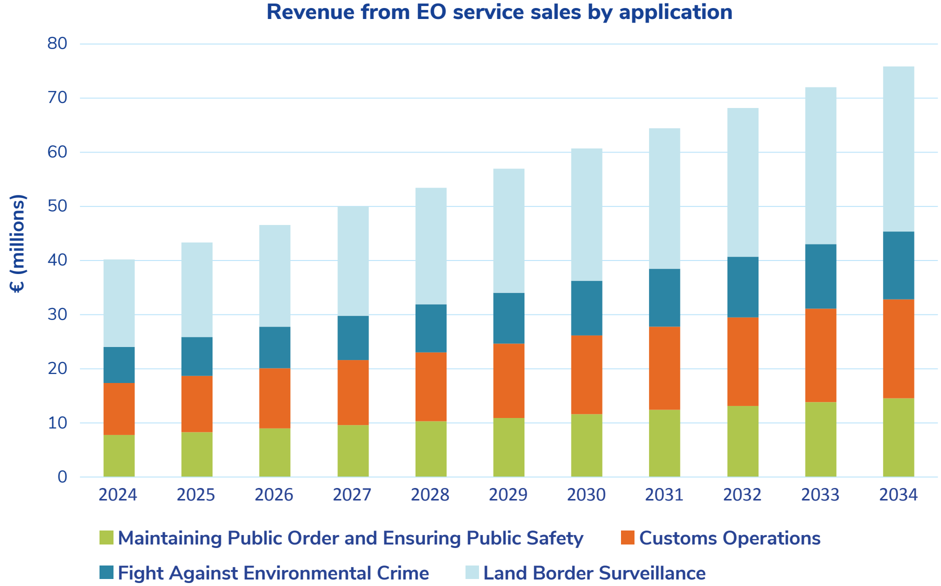
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue from EO service sales by application
€ (millions)
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2030
2031
2032
2033
2034
Maintaining Public Order and Ensuring Public Safety
Customs Operations
Fight Against Environmental Crime
Land Border Surveillance

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FISHERIES AND AQUACULTURE

Aquaculture

- Aquaculture operations optimisation and selection

Fisheries

- Catch optimisation and fish stock detection and modelling
- Fishing aggregating devices
- Fishing vessels navigation
- Vessel monitoring

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

FISHERIES AND AQUACULTURE

Fisheries and aquaculture remain vital pillars of the global food system and the blue economy, supporting livelihoods, coastal communities and long-term food security. As both sectors face rising environmental and economic pressures, from shifting fish stocks and climate-driven risks to the need for greater transparency and sustainability, space-based technologies are playing an increasing role in how they operate and evolve.

In fisheries, EO data provides intelligence for understanding ocean conditions, modelling fish habitats and improving catch planning. Optical and radar data help authorities detect, identify and monitor vessels, strengthening efforts to combat illegal, unreported and unregulated (IUU) fishing. GNSS remains an essential enabler for vessel positioning, navigation, safety and compliance, supporting tools such as the Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) that improve fleet monitoring and catch traceability.

Digitalisation is reshaping the aquaculture industry. EO supports selection, environmental risk assessment and continuous monitoring of conditions such as temperature, water quality and harmful algal blooms. As farms expand offshore and adopt more automated and sensor-rich operations, high-precision GNSS underpins the positioning of cages, platforms, feeding barges and robotic systems. Together, EO and GNSS deliver actionable insights that help aquaculture producers optimise operations, safeguard stock health and improve resilience in a changing climate.

Note: The sub-segment **fisheries** is showcased with a **fish icon**, while the sub-segment **aquaculture** is showcased with a **fish in captivity icon**.

Cross-reference: *GNSS-enabled Search and Rescue beacons, while used by fishermen and installed onboard fishing vessels, are presented and quantified in the Emergency Management and Humanitarian Aid market segment.*

What you will find in this chapter

- **Key trends:** Aquaculture's expansion and fisheries' sustainability are shaped by technological innovations, environmental concerns and policy drivers
- **Industry:** Fisheries and aquaculture value chains
- **Recent developments:** Stricter regulation for smaller vessels related to illegal, unreported and unregulated fishing is driving market growth
- **Future market evolution:** EO and Galileo support the growth and sustainability of the blue economy
- **European systems and projects:** Several European-funded projects utilise space data to develop innovative solutions in fisheries and aquaculture
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region

NEW! This edition now features the estimation of the market for Fishing aggregating devices. It also relies on an improved methodology for the estimation of EO service revenues.

Aquaculture's expansion and fisheries' sustainability are shaped by technological innovations, environmental concerns and policy drivers

Key market trends

- Aquaculture is one of the fastest-growing food sectors, now outpacing wild fisheries and driven by sustainable innovations.
- Global warming puts pressure on the aquaculture industry due to increased risks of harmful algal blooms.
- Modern technologies, from satellite-based vessel tracking to AI-powered aquaculture systems, are boosting sustainability in fisheries and seafood production.

Booming aquaculture production surpassed wild-capture fisheries production

Global aquaculture production has risen by 54% since 2011, making it one of the fastest-growing food sectors. In 2022, global farmed fish production surpassed wild-capture fisheries for the first time (see graph on the right)(FAO, 2024). The sector is projected to reach 111 million tons by 2032 (FAO, 2024) and is expected to account for over 56% of total fish production by 2034 (OECD/FAO,2025), with Asia remaining the primary aquaculture hub. Sustainable fish farming is increasingly recognised for its potential to reduce pressure on depleted wild fish stocks. Ocean-based startups focused on sustainability, which include food firms as well as other ocean-based sectors, grew by 91% between 2019 and 2022, with precision and smart aquaculture widely adopted. Meanwhile, the seaweed market is rapidly expanding, driven by growing demand for sustainable aquaculture and food security, alongside robust support from EU policies and increasing investments. Demand for nutritious aquatic protein or 'blue foods' could double by 2050, underscoring aquaculture's role in food security. EO data plays a role in supporting growth across the aquaculture market, including seaweed cultivation, by providing critical insights into water quality, temperature and salinity; enabling the prediction of harmful algal blooms; assisting in marine spatial planning for optimal farm selection; and supporting risk assessment and resource management for sustainable production.

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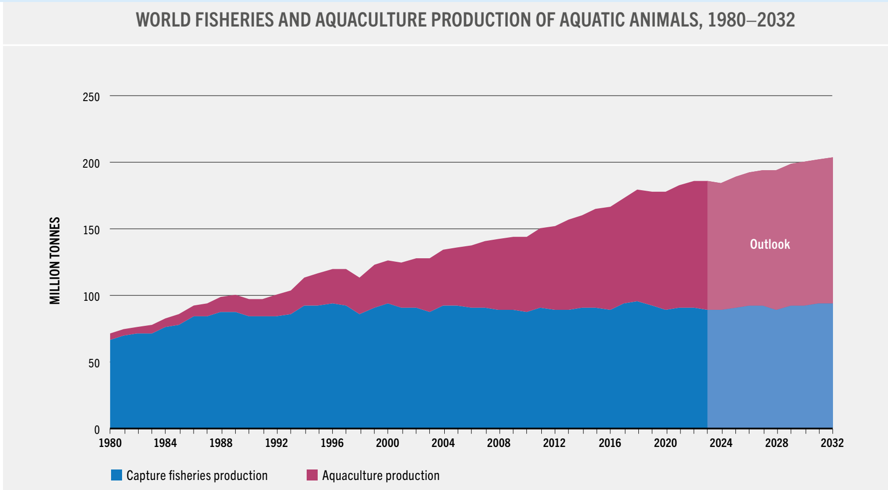
Global warming increasingly puts pressure on aquaculture industry due to increased risk of harmful algal blooms

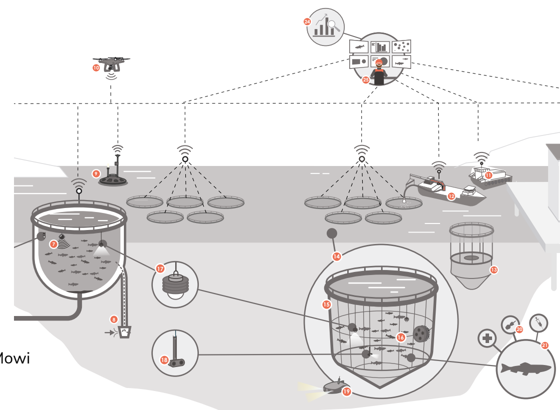
The IPCC warns that warming seas, ocean acidification, and business-as-usual fishing policies are projected to place around 60% of global fisheries at very high risk, threatening both marine ecosystems and the communities that depend on them. If greenhouse gas emissions continue to rise, losses in global fishing revenue could reach €13 billion by 2050 compared to 2000, driven by declining fish stocks. One of the most damaging consequences of warming waters is the increased frequency and intensity of harmful algal blooms (HABs). These events can rapidly wipe out entire harvests, causing mass fish mortality and triggering long-lasting ecological degradation that affects both wild fisheries and aquaculture. EO systems can identify areas prone to HAB development, monitor water quality and detect early bloom formation, helpful for planning and monitoring. In coastal environments, EO is also used to detect algal blooms.



© FAO, 2024

Technological breakthroughs are powering the future of fisheries and aquaculture

Internet of Things, machine learning and AI are widely adopted for monitoring water quality and environmental conditions, automating feeding, and detecting disease, with AI in fisheries and aquaculture growing fast. It was valued at €800 million in 2025 and forecast to hit €1.4 billion by 2029 at a 15% CAGR (The Business Research Company, 2024). Digitalisation allows real-time water quality monitoring, health tracking and optimised feeding. The need for risk reduction, scalability and transparency in seaweed aquaculture will be enabled by EO, as highlighted by user requirements collected at the EUSPA UCP 2024 for high spatial and temporal resolution, integrated in-situ modelling, accurate models for scenario prediction, and operational dashboards for decision making. Remote sensing, together with other pioneering technologies such as floating, submersible and platform-based cage systems, is helping to overcome the challenges of offshore marine aquaculture, a sector that is rapidly expanding to meet high demand. The use of modern technologies, including satellite- or non-satellite-based tracking of all vessels, supports traceability of fish from landing to retail. Selective breeding and alternative feeds (plant, insect, algae-based) are cutting waste and reducing reliance on fishmeal.



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Fisheries and Aquaculture Value Chains[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- GEOSAT*
- ICEYE*
- E-GEOS*
- PLANET
- SATELLOGIC*
- UMBRA
- PROMÉTHÉE EARTH INTELLIGENCE*
- SPIRE
- VANTOR

- COPERNICUS SENTINELS*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- RELEVANT EUROPEAN NATIONAL MISSIONS
- METEOROLOGICAL AGENCIES
- OCEANOGRAPHIC AGENCIES

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- SENTINEL COLLABORATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CLOUDEO*
- CREODIAS*
- EARTH-I*
- EDS CEODE
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- PLANET EXPLORER
- SENTINEL-HUB* (PLANET)
- TERRADUE*
- UP42*

- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- OPENEO*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

- ACRI *
- BERRING DATA COLLECTIVE*
- BIOCEANOR*
- CLS*
- DEIMOS*
- EOMAP**
- KSAT*
- MDA SPACE
- OCEANMIND*
- PLANETEK*
- PML*
- SKYTRUTH
- VAKE*
- VITO*
- WATER INSIGHT*

- COPERNICUS MARINE SERVICE (CMEMS)*
- EMODnet*

INFORMATION PROVIDERS

- BREVISCO*
- DELTARES*
- DNV*
- GLOBAL MARITIME*
- INNOVASEA
- SEASCAPE*

- BGS*
- ILVO*
- GFW

END USERS

- FISHING COMPANIES
- AQUACULTURE COMPANIES
- FISHERIES CONTROL AGENCIES
- ENVIRONMENTAL AGENCIES
- NGOS
- MARINE RESEARCH INSTITUTES
- MARINE PROTECTION AGENCIES
- SUPERMARKETS
- BLUE BIO-BASED INDUSTRIES
- SUSTAINABLE FINANCE & INSURANCE

European[2] EO and GNSS industry in the global arena

European companies hold a leading share of the global EO market for fisheries and aquaculture, supported by Copernicus and strong downstream providers such as Airbus, CLS, Leonardo (e-GEOS) and KSAT. GNSS receivers used in fisheries and aquaculture largely overlap with those in the wider maritime sector. European marine-electronics and system-integration companies such as CLS, Zunibal, Marine Instruments, Navico, Kongsberg and Wärtsilä are among the suppliers of GNSS-equipped navigation and monitoring systems for fishing and aquaculture vessels.

GNSS

MARITIME ORGANISATIONS

- **CIRM** - AN INTERNATIONAL ASSOCIATION FOR MARINE ELECTRONICS COMPANIES

- **EFCA** - EUROPEAN FISHERIES CONTROL AGENCY
- **EMSA** – EUROPEAN MARITIME SAFETY AGENCY

COMPONENT AND RECEIVER MANUFACTURERS

- ADVANTECH
- ALPHATRON MARINE* (PART OF JAPAN RADIO CO)
- BEIJER ELECTRONICS*
- CADDEN
- CLS
- COBHAM*
- FURUNO ELECTRIC
- GARMIN
- GENERAL ELECTRIC
- GMT CO.
- HEXAGON*
- INTELLIAN TECHNOLOGIES
- KONGSBERG MARITIME*
- MARINE INSTRUMENTS*
- NAVICO*
- NUVOTON
- ORBCOMM
- SEPTENTRIO*
- WARTSILA*
- U-BLOX*
- UNISTRONG GNSS
- ZUNIBAL*

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

- AB VOLVO*
- BEIBU GULF PORT GROUP
- COBHAM*
- FURUNO ELECTRIC
- GME
- HYUNDAI
- INMARSAT*
- INTELLIAN TECHNOLOGIES
- JAPAN RADIO CO
- JOHNSON OUTDOORS
- KONGSBERG MARITIME*
- MITSUBISHI
- PARTNER PLAST*
- PRONAV
- SAAB*
- SAMYUNG ENC
- WARTSILA*
- UNISTRONG GNSS
- VIASAT
- XIAMEN YAXON NETWORK
- XINUO

USERS

- FISHING BOAT OPERATORS
- RECREATIONAL BOATERS

USERS

- FISHING COMPANIES
- AQUACULTURE COMPANIES
- PORT AUTHORITIES
- SURVEILLANCE AUTHORITIES
- DATA-ANALYTICS COMPANIES
- MARINETRAFFIC, MYSHIPTRACKING, VESSELTRACKER

LEGEND

- Commercial offering
- Public offering
- User segments

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

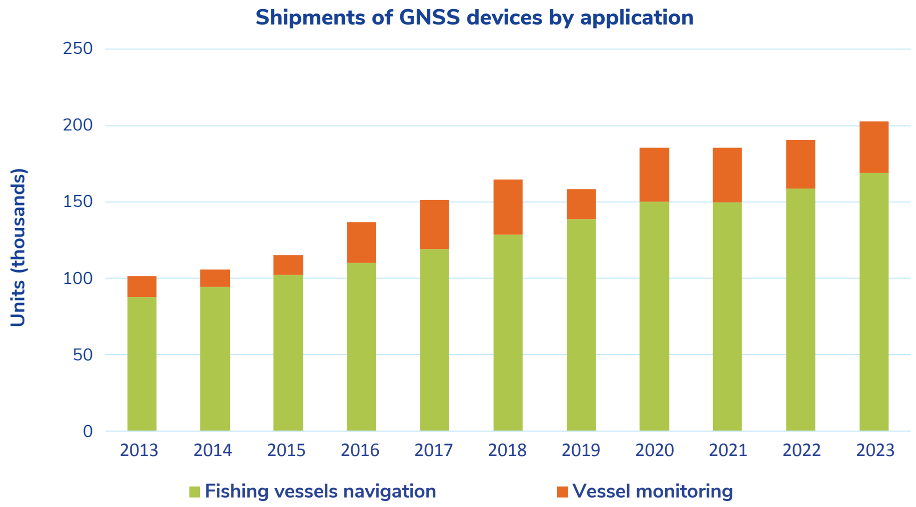
2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

Stricter regulation for smaller vessels related to illegal, unreported and unregulated fishing is driving market growth



EO data increasingly considered a complementary source of data for aquaculture monitoring

EO data is increasingly considered an asset in the monitoring of aquaculture sites, which more traditionally was performed using in-situ equipment such as water quality and acoustic sensors, current meters and underwater cameras. High-resolution satellite data (already used to detect algae indicators such as surface foam) gives aquaculture producers early warnings that they could not otherwise obtain owing to limited budgets from local sensors. This remote, scalable monitoring significantly reduces operational uncertainty.

As a single cage can contain up to €100,000 worth of fish, investors care deeply about risk management, and EO strengthens confidence by improving the predictability of environmental conditions. Early alerts on hazardous waves or changing ocean parameters allow operators to prepare, reinforce equipment and conduct emergency harvesting before losses occur. In short, EO gives producers tools that make aquaculture safer, more resilient and more investable.

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The GNSS application of fishing vessel navigation is driven by **increasing safety needs, replacement cycles of older equipment and the spread of affordable GNSS systems** across an already largely equipped fleet. Although smaller, vessels monitoring expands faster because of **regulatory tightening linked to illegal, unreported and unregulated (IUU) fishing controls and new requirements for tracking smaller fleets**.

The fluctuations after 2020 are likely related to **supply-chain disruptions and post-pandemic recovery**. The fisheries sector took a hit during COVID-19, with supply chains disrupted and export markets collapsing, which sharply reduced demand and revenue for producers. At the same time, labour shortages and restrictions on vessel operations made it harder to harvest, process and transport fish, deepening the sector's strain. However, both applications show sustained long-term momentum driven by changes in the fisheries sector. **Regulators are pushing for more precise vessel monitoring, catch traceability and compliance with sustainable fishing policies**. At the same time, operators increasingly rely on high-accuracy navigation and real-time positioning to optimise routes, reduce fuel costs and improve safety at sea, driving wider adoption of GNSS-enabled systems.

Key recent regulations are shaping the sector, notably the Revised EU Fisheries Control Regulation (EU) 2023/2842. In addition, the Commission Implementing Regulation (EU) 2025/2196 further specifies technical requirements, including Article 23 on the transmission of vessel position data. It requires satellite or equivalent connectivity and explicitly mandates confidentiality, integrity, availability, authenticity and non-repudiation of transmitted vessel position data, reinforcing the role of secure GNSS-based tracking and authenticated positioning in fisheries monitoring systems.

The EU supports the introduction and maintenance of modern control technologies

The EMFAF, with a budget of over €6 billion for 2021–2027, supports projects that enhance the sustainability and competitiveness of the fisheries sector. This includes funding for the adoption of GNSS and EO technologies, including the integration of Copernicus services for fishing operations optimisation, such as fish stock detection and route planning, to improve fleet management, data collection and environmental monitoring. The EU also uses satellite-based Vessel Monitoring Systems to track fishing vessels and ensure compliance with rules on when and where they can operate.

Around 15,000 fishing vessels in the EU are equipped with GNSS-based devices that transmit real-time data to fisheries authorities. Smart fishing buoys, deployed to detect fish schools such as tuna, are key to efficient and sustainable operations; equipped with echosounders, they rely on GNSS to deliver precise geolocation data via satellite, enabling vessels to optimize routes, save fuel, and cut CO_2 emissions. Electronic Reporting Systems used by vessel masters and authorities also benefit from GNSS, which links reported catches, landings and shipments to exact positions at sea, enhancing traceability, compliance and data reliability.

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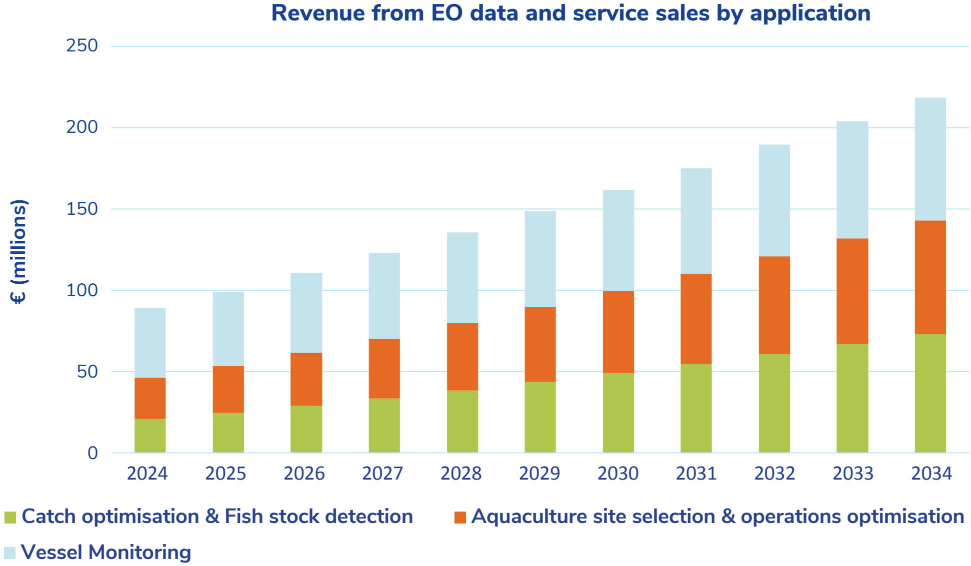
EO and Galileo support the growth and sustainability of the blue economy



Both fisheries and aquaculture are facing increasing complexity: climate variability, shifting stocks, extreme events, spread of disease, and harmful algal blooms create demand for tools that help operators understand where to fish, when conditions are safe and how to protect assets, resulting in a steady rise in revenues. Revenue for catch optimisation grows steadily as fleets integrate EO with acoustic and onboard systems to better understand habitat conditions, even though EO alone cannot detect fish directly. Adoption remains uneven; fishermen invest only when clear value is demonstrated, but demand is expected to rise as services mature and as smaller fishing vessels embrace more digitised solutions.

Aquaculture selection and operations are also estimated to grow in the coming decade as service providers and farmers increasingly see the value of integrating **EO-based warnings for algal blooms, wave events and water-quality shifts** in addition to the local monitoring sensors. Vessel monitoring revenues increase as regulatory requirements tighten, where remote sensing solutions (specifically radar data) can help support vessel identification. Together, these drivers explain the expected consistent growth in revenue year on year, shown across all three EO application areas. EO observations are however subject to limitations such as cloud cover, revisit frequency, and spatial resolution, meaning that EO insights are most effective when complemented by in-situ measurements and local monitoring systems.

Projected growth in aquaculture will increase the importance of selection and operation optimisation activities

The Food and Agriculture Organisation of the United Nations targets a 35% increase in aquaculture output by 2030 (AP News, 2024), which is important to meet rising demand while putting less pressure on fish stock by wild-catch fisheries. This growth is a strong market driver for EO-supported selection through marine spatial planning and operational optimisation. However, the FAO also notes that habitat degradation and ecosystem stress, resulting in environmental contamination and the spread of pathogens, are a key challenge for this industry. Many aquaculture areas are abandoned due to disease and are increasingly deployed offshore, which is currently a niche market but one where EO can add value (e.g. on metocean conditions like surface water temperature).

This growth is not limited to fish or shellfish: seaweed farming is also expanding fast. Seaweed is becoming a key sustainable resource for food, pharmaceuticals, carbon capture and bio-based industries. EO-powered tools can help farmers manage risks, expand operations and improve profitability by monitoring water quality, nutrients and oceanographic conditions.

© FAO

Integrating GNSS and EO for next-generation aquaculture and fisheries systems

In aquaculture, GNSS enables precise positioning of cages, buoys and offshore farms, improving safety and efficiency. As nearshore sites become saturated, farms are moving further offshore where currents, storms and waves make high-precision GNSS positioning essential for anchoring cages, mooring buoys and ensuring farm stability. EO complements this by monitoring water quality, harmful algal blooms, and temperature variations, providing important environmental data like marine spatial planning for selection and farm management decisions. Modern aquaculture increasingly uses autonomous feeding barges, drones, and robotic maintenance systems, all of which rely on both GNSS and EO.

Authorities require accurate GNSS tracking of aquaculture infrastructure and vessels to prevent conflicts with shipping lanes, enforce zoning and protect ecosystems. GNSS also underpins eco-label traceability by recording vessel and gear positions to prove catch origin. Advanced use cases include digital twin frameworks that combine GNSS with EO-derived metocean data and field sensors to monitor the structural health of cages in real time. For example, at SINTEF ACE Fish Farm in Norway, researchers from MIT and SINTEF developed a multi-fidelity digital twin framework to analyse the dynamic behaviour of floating net cages under real marine conditions.

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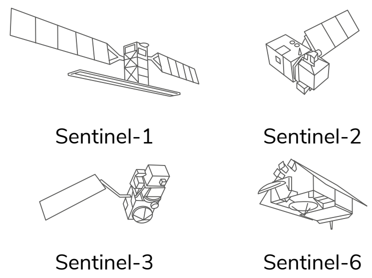
Several European-funded projects utilise space data to develop innovative solutions in fisheries and aquaculture

Current usage and future usages of Copernicus

The **Copernicus Marine Service (CMEMS)** supports various applications, including **fisheries management, marine safety, climate monitoring and environmental protection**. The service integrates data from various sources, including satellite, in situ, and models, to provide comprehensive and up-to-date information on the condition of the world's oceans. A related and important product is **MyOcean Viewer**. This tool gives users access to maps, charts and local time series based on information generated by CMEMS, **primarily based on the suitability indices** for fishing and aquaculture activities. Moreover, the **Copernicus Security Service** includes the Copernicus Maritime Surveillance Service that is used by EFCA for fisheries control.

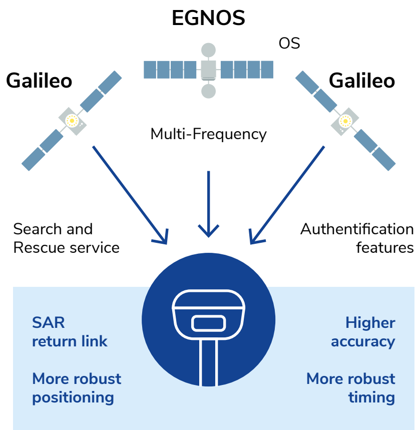
Marine (CMEMS) **Security** (CSS)



Current usage and future usages of EGNSS

Galileo enables essential positioning and navigation capabilities for fishing vessels. The **Automatic Identification System (AIS)** and **Vessel Monitoring Systems (VMS)** play central roles in monitoring these vessels and their activities. The new **Very High Frequency Data Exchange System (VDES)** is now transitioning from trials to initial operational deployment as a radio communication system between ships, shore stations and satellites. It offers **more efficient use of the radio spectrum** and meets growing data requirements by **building on AIS capabilities**.

In parallel, Galileo's Open Service **Navigation Message Authentication (OSNMA)** was declared operational in July 2025 and now provides receivers with assurance that navigation messages truly originate from Galileo, strengthening the efficiency and robustness of vessel monitoring activities when integrated with VDES and VMS.



Horizon Europe, a programme of the European Union

KijaniSpace - Aqua Management Pilot B

KijaniSpace integrates **Copernicus data** with in-pond IoT sensors (measuring dissolved oxygen, temperature, pH) to **improve fish-farm operations around Lake Victoria**. The solution uses the **KijaniBox IoT toolkit to deliver real-time monitoring, AI-driven alerts** and regional **water-quality maps via satellite + sensor fusion**. The pilot targets cage and pond farms, enabling farmers and authorities to deploy actionable insights and trend-maps for sustainable aquaculture. The broader project also supports **crop-farming**, as detailed in the agriculture segment of this report, but the Aqua-component centres on scalable digital tools for the blue economy.

Horizon Europe, a programme of the European Union

OLAMUR Offshore Low-Trophic Aquaculture in Multi-Use Scenario Realisation

The OLAMUR project, a Horizon Europe initiative, promotes **low-trophic aquaculture** (seaweed and mussel farming) **co-located with offshore wind installations** in the North and Baltic Seas. Drawing on **Copernicus Marine Service** data for sea-surface temperature, chlorophyll, turbidity, and currents, OLAMUR supports **continuous environmental monitoring and optimisation of farm operations**. Its MU-LTA Farm Service integrates EO information, in-situ sensors, and simulation models to plan and manage multi-use marine sites. Demonstration farms in Denmark, Estonia and Germany test new production systems, business models and regulatory pathways, paving the way for a **scalable offshore-aquaculture market that aligns food production with renewable-energy development.**

Horizon Europe, a programme of the European Union

Fish-X digital innovations for fisheries

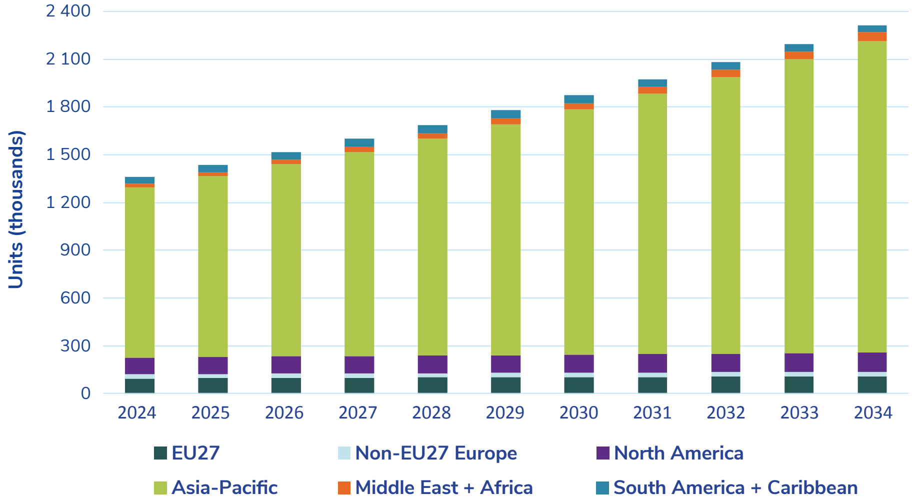
The Fish-X project, a **Horizon Europe initiative**, drives the digital transformation of EU fisheries through a secure, federated **data space** connecting fishers, regulators, and scientists. Its **Insight Platform** integrates **satellite-based vessel tracking, GNSS positioning and EO data from the Copernicus Marine Service** to map fishing activity, monitor marine conditions, and support sustainable resource management.
Key outcomes include the Insight Platform and a **blockchain-based Traceability App**, which enhance transparency, certification and sustainability across the seafood value chain.

Horizon2020 European Union Funding for Research & Innovation

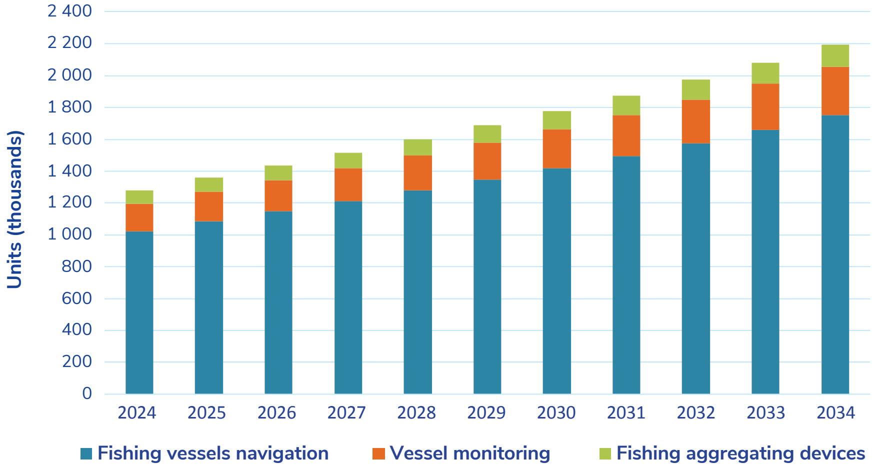
EcoScope – digital tools for marine conservation and food security

Part of a new generation of **data-driven management** services, the EcoScope project develops advanced digital tools that **apply ecosystem-based approaches** to fisheries management. Combining environmental and oceanographic inputs from the **Copernicus Marine Service** with fisheries and socio-economic datasets, EcoScope delivers a unified digital platform and decision-support toolbox for analysing fleet activity, species distribution and ecosystem productivity.

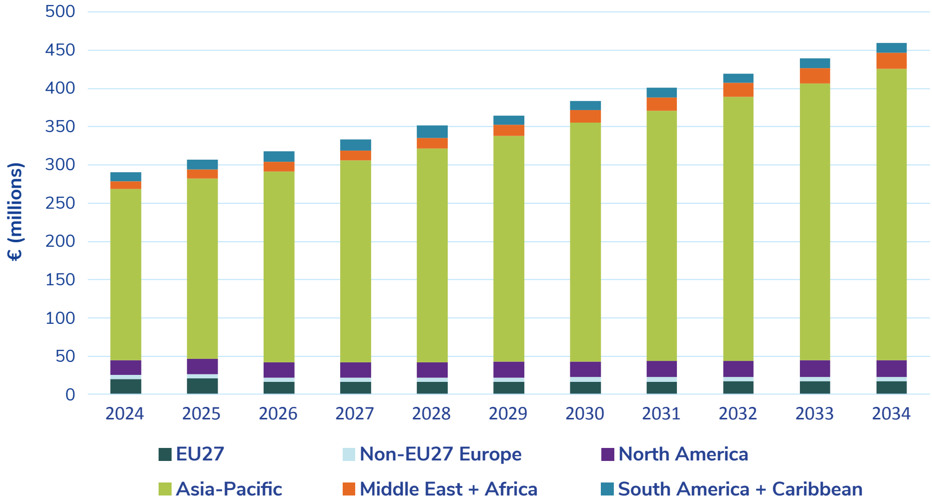
Installed base of GNSS devices by region



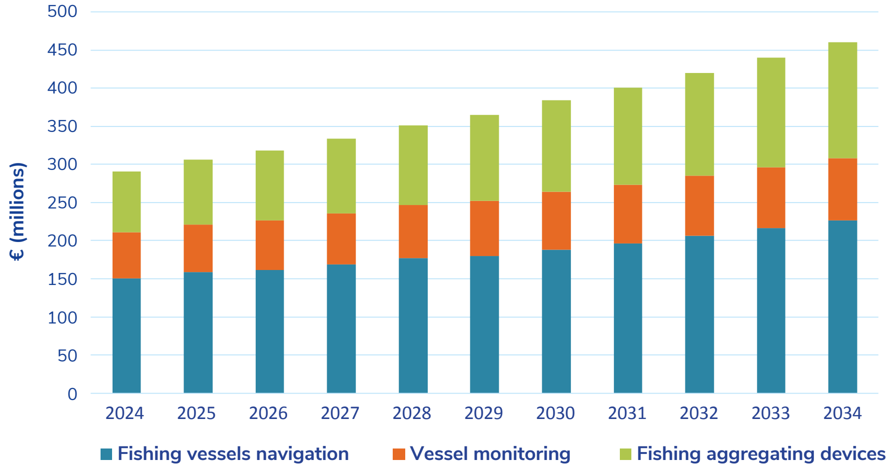
Installed base of GNSS devices by application

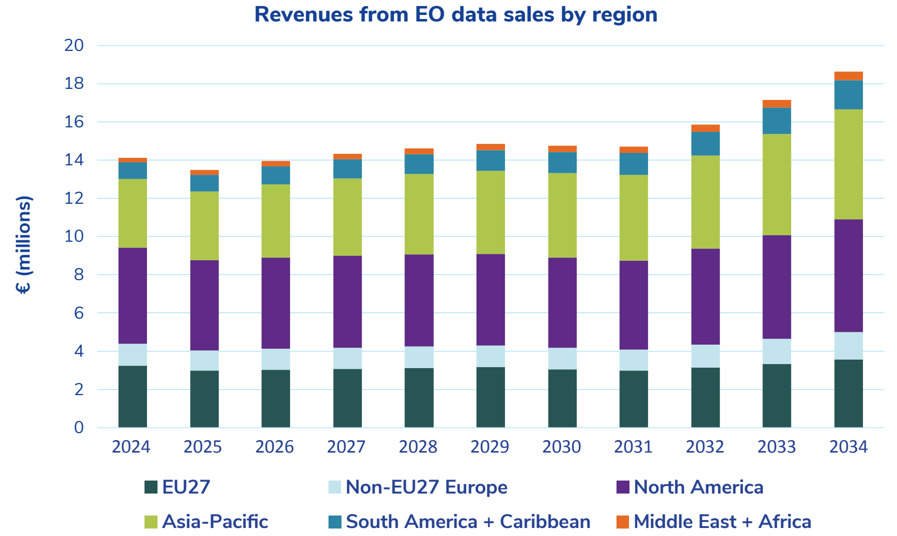


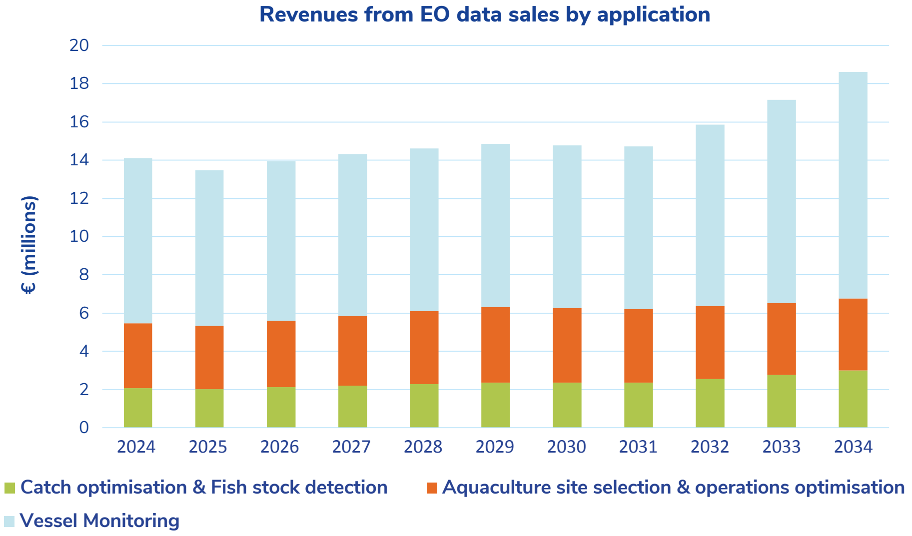
Revenue of GNSS device sales by region



Revenue of GNSS device sales by application




Revenues from EO data sales by region
€ (millions)
0
2
4
6
8
10
12
14
16
18
20
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenues from EO data sales by application
€ (millions)
0
2
4
6
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20
2024
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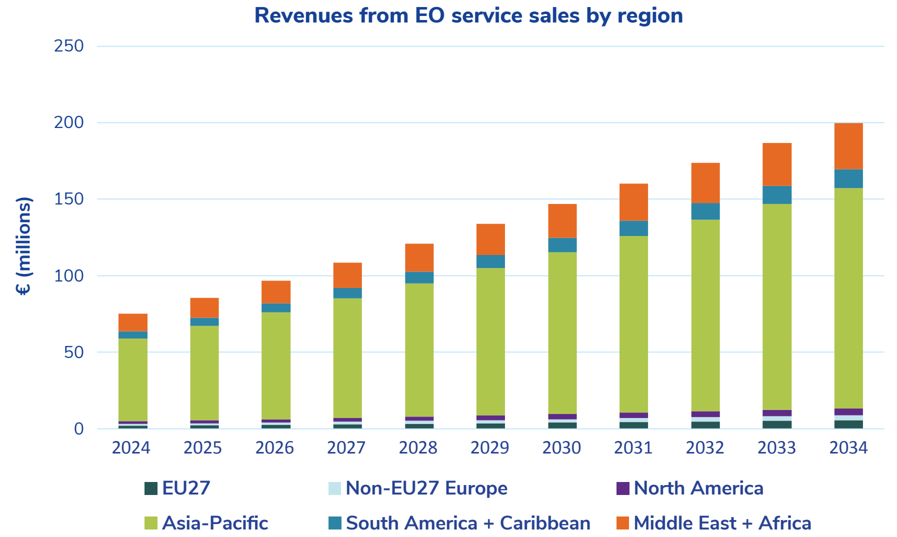
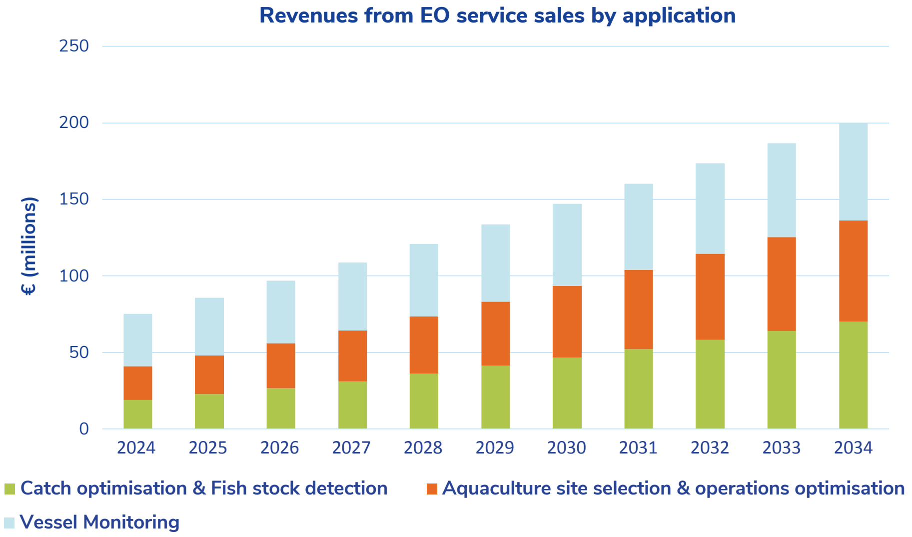
2034
Catch optimisation & Fish stock detection
Aquaculture site selection & operations optimisation
Vessel Monitoring


Revenues from EO service sales by region
€ (millions)
0
50
100
150
200
250
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenues from EO service sales by application
€ (millions)
0
50
100
150
200
250
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Catch optimisation & Fish stock detection
Aquaculture site selection & operations optimisation
Vessel Monitoring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FORESTRY

FORESTRY

This chapter explores the activities involved in the cultivation, maintenance and development of forests, highlighting recent advancements, emerging trends and the key stakeholders within the sector. Because forests are often vast and remote, EO and GNSS technologies are becoming essential tools, enabling forestry managers to carry out operations more efficiently and allowing governmental bodies to monitor environmental impacts linked to forestry activities.

EO supports the remote monitoring of forest inventories and the assessment of forest health, while also enabling the detection of illegal logging and deforestation – issues that are becoming increasingly critical as global forest resources face rising pressures.

GNSS, especially when combined with EO, enhances precision forestry by enabling accurate machinery guidance, supporting the positioning and navigation of drones for hyperspectral or lidar surveys, and facilitating the precise location of on-tree health sensors.

Environmental monitoring

- Biomass monitoring
- Deforestation and illegal logging monitoring

Forest resources monitoring

- Forest inventory monitoring
- Forest vegetation health monitoring

Operations management

- Automatic steering
- Forest asset management
- Forest certification
- Forest machinery guidance

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

What you will find in this chapter

- **Key trends:** EU forests are losing carbon absorption capacity and facing sustainability-driven challenges, making adaptive management and afforestation crucial.
- **Industry:** Forestry value chains.
- **Recent developments:** EO is improving post-wildfire forest recovery and GNSS enabling precise mapping and optimized forestry operations via simultaneous localisation and mapping.
- **Future market evolution:** Virtual forests strengthen remote sensing capabilities, while GNSS technologies will play a key role in improving situational awareness during forest operations.
- **European systems and projects:** The EU Space Programme supports R&D activities in forestry.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

EU forests are losing carbon absorption capacity and facing sustainability-driven challenges, making adaptive management and afforestation crucial

Key market trends

- EU forests are experiencing a 27% decline in carbon absorption capabilities, highlighting the urgent need for timely EO data and standardised monitoring.
- Rising extreme weather and climate impacts are outpacing natural tree adaptation, making adaptive forest management essential to sustain forest resilience, biodiversity and their role in the bio-based economy and climate goals.
- The EU Renewable Energy Directive (RED III) and Land Use, Land-Use Change and Forestry (LULUCF) Regulation are driving wood supply challenges that afforestation – supported by remote sensing for planning and monitoring and GNSS for precise, efficient planting – can help address sustainably.

European forests' carbon sink capacity declining

Forests cover around 40% of EU territory. Between 1990 and 2022, they absorbed around 10% of the EU emissions from human activity. According to the EU greenhouse gas inventory published by the European Environmental Agency (EEA) in 2024, the average forest carbon sink between 2020-2022 decreased by around 27% compared to the average sink in 2010-2014. The decline in carbon absorption has several causes: harvesting of trees has increased; and climate change is making heatwaves and droughts more frequent, which reduces tree growth. Climate change also tends to increase disruptive events such as insect outbreaks, wildfires and tree mortality, which have become more frequent and severe in some areas. However, there are ways in which the decline in carbon sink capacity can be combatted, with EO playing a prominent role. EO data and ground observation networks are essential for monitoring EU forests in a timely manner. Currently, many EU countries rely mostly on periodic forest inventories, which are not sufficient to keep up with the rapid pace of declining forest health. Moreover, existing forest datasets require more transparency and standardisation for their better utilisation, along with technical advances to assess impacts on the environment, biomass stock changes, forest management and tree mortality. Strengthening such monitoring capacities is also critical for meeting the requirements of the EU Deforestation Regulation and the Carbon Removal Certification Framework – which demand robust, harmonised and verifiable forest data to ensure compliance, support climate goals and improve the resilience of European forests.

Climate change impacts drive the need for change in forest management

The frequency of extreme weather events (heat, drought, storms), along with the risk of pests and pathogens, and wildfires are rising. These impact tree growth, mortality and species composition. In Greece, the wildfire season was unusually severe in 2025. Extreme heat, drought and strong winds fuelled a large number of fires, especially across Peloponnese, Attica, Crete, Evia and the islands. In Portugal, 2025 was one of the worst wildfire seasons on record. Over 260,000 hectares were burnt, almost five times the average for this time of year. Moreover, in 2025, Czech forests continued to face serious damage from spruce bark beetle infestations, particularly affecting Norway spruce stands. The present rate and magnitude of climate change exceeds the speed of natural tree species migration. Adaptive forest management is therefore essential to safeguard the future of forests and ensure their sustainable management. It is a flexible, learning-based approach that responds to changing environmental conditions to maintain long-term ecosystem health and resilience. Accordingly, a growing body of research is exploring how adjustments in forest management, such as species composition, rotation length, structural diversity and risk management, can enhance forest resilience. This requires changes in forest management that anticipate impacts and act to minimise negative consequences on forest functioning while maintaining forests' contribution to the bio-based economy and decarbonisation targets, with EO playing a vital role in improved management approaches.

Afforestation – a solution to supply and demand constraints

© pexels

Several ongoing global forces are both driving demand and putting pressure on the supply of wood. Geopolitical instability close to EU borders has directly affected the availability of woody biomass in Europe through the EU's import ban on timber and timber products from Russia and Belarus. By aiming to increase the share of renewable energy in overall energy consumption, the amended EU Renewable Energy Directive (RED III) promotes demand for wood, while the EU's updated LULUCF Regulation sets ambitious, binding national targets for the increase in net greenhouse gas removals that could restrict the supply of wood.

Supply chain transparency in the timber sector has become a critical priority as global demand rises and regulatory scrutiny tightens. Ensuring traceability from forest to end product is essential to verify legality, sustainability and compliance with frameworks such as the EU Deforestation Regulation. In order to tackle this issue, afforestation is one of the approaches that can be used to increase supply within Europe. Remote sensing offers powerful tools to support afforestation by providing large-scale, consistent and cost-effective monitoring of landscapes. One of its key contributions lies in site identification and planning. Using satellite imagery, areas of degraded or marginal land can be mapped with high precision. It is also essential for baseline establishment and progress monitoring. By capturing pre-afforestation land-use conditions, it provides a reference point against which future changes can be measured.

For afforestation efforts, GNSS-guided equipment and handheld receivers can assist in following planned planting layouts with high precision. This is especially useful for large-scale projects, where spacing between trees needs to be consistent for healthy growth and optimal resource use. For mechanised planting, GNSS-enabled tractors or drones can further streamline the process, making it faster and less labour-intensive.

GNSS and EO Forestry Value Chains[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- CONSTELLR*
- GEOSAT*
- ICEYE*
- E-GEOS*
- ORORATECH*
- PLANET
- SATELLOGIC*
- UMBRA
- VAISALA*
- VANTOR

- COPERNICUS SENTINELS*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- RADARSAT (CSA)
- RELEVANT EUROPEAN NATIONAL MISSIONS
- RELEVANT IN-SITU NETWORKS
- NISAR (NASA/ISRO)

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CREODIAS*
- GOOGLE EARTH ENGINE
- PIESAT
- SENTINEL HUB* (PLANET)
- SPACESENSE*
- TERRADUE*
- UP42*
- VITO*

- COPERNICUS DATA SPACE ECOSYSTEM*
- FORESTRY TEP*
- GLOBAL FOREST WATCH
- WEKEO*

EO PRODUCTS AND SERVICES PROVIDERS

- ARBONAUT*
- BEETLEFORTECH**
- CGI INC
- CONSTELLR*
- DAVEY TREE EXPERT COMPANY
- EARTH DAILY
- ECOMETRICA*
- EOS DATA ANALYTICS
- ESRI
- GAF*
- GEOVILLE*
- GMV*
- KAYRROS*
- KERMAP*
- KSAT*

LIVEEO*
METRIA*
ORBIFY*
PRIOT DIGITAL SYSTEMS**
ROSA.IO*
SATELLIGENCE*
SITOWISE*
SPACE4GOOD*
SPACEBEL*
TERRAEYE*
VITO*
XYLENE*

- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*

INFORMATION PROVIDERS

- COLLECTIVE CRUNCH*
- COOLX*
- EARTHPULSE*
- F&W
- FÖRA*
- FORESTRADAR*
- FORLIANCE*
- FORSTIFY*
- KANOP*
- KUVA SPACE*
- NIRAS ALECTIA FONDEN*
- OIKON*
- SYMBIA SOLUTIONS*
- TREEMETRICS*
- WUUDIS*

- EU OBSERVATORY ON DEFORESTATION AND FOREST DEGRADATION*
- FOREST INFORMATION SYSTEM FOR EUROPE (FISE)*

END USERS

- ENVIRONMENTAL AGENCIES
- FORESTRY CONSULTANTS
- FORESTRY MANAGERS
- FORESTRY-INSURERS
- INTERNATIONAL AGENCIES (E.G. FAO, WFP...)
- MACHINE MANUFACTURERS
- PAYING AGENCIES
- FOREST CERTIFICATION BODIES
- FOOD/INDUSTRAL MANUFACTURING COMPANIES CONCERNED WITH DEFORESTATION-FREE PRODUCTS

LEGEND

- Commercial offering
- Public offering
- User segments

GNSS

AUGMENTATION SERVICE PROVIDERS

- CNH INDUSTRIAL* (INCLUDING HEMISPHERE)
- DEERE
- HEXAGON*
- SAPCORDA*
- SWIFT
- TERIA*
- TOPCON
- TRIMBLE

- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS
- GALILEO HIGH ACCURACY SERVICE

COMPONENT AND RECEIVER MANUFACTURERS

- AG LEADER TECHNOLOGY
- AGJUNCTION
- ANALOG DEVICES
- ANTCOM
- ARAG*
- AVMAP*
- BEIJING BDSTAR NAVIGATION
- CAMPBELL SCIENTIFIC
- CHCNAV
- CNH INDUSTRIAL*
- COMNAV TECHNOLOGY
- DEERE
- HARXON
- HEXAGON*
- RAVEN INDUSTRIES
- TOPCON CORPORATION
- TRIMBLE NAVIGATION
- UNISTRONG GNSS
- YAGEO

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

- AGJUNCTION
- AL-GHAZI TRACTORS
- AMAZONEN-WERKE*
- BARKO
- C-ASTRAL
- CATERPILLAR INC
- CLAAS KGAA*
- CHCNAV
- CNH INDUSTRIAL*
- DELAIR*
- DEERE
- DUSITECH
- HEXAGON*
- HITACHI
- JCB*
- KOMATSU
- KUBOTA CORPORATION
- LINDNER TRAKTOREN*
- MILLAT TRACTORS
- QIANXUN SI
- SDF GROUP*
- TEEJET TECHNOLOGIES
- VOLVO*
- YANMAR

END USERS

- ENVIRONMENTAL AGENCIES
- FORESTRY CONSULTANTS
- FORESTRY MANAGERS
- FORESTRY-INSURERS
- INTERNATIONAL AGENCIES (E.G. FAO, WFP...)
- LOGGING COMPANIES
- MACHINE MANUFACTURERS
- PAYING AGENCIES

European[2] EO and GNSS industry in the global arena

Driven by industry leaders such as Airbus and Leonardo (e-GEOS), European firms command over 40% of the worldwide EO analysis, insights & decision support market. European firms account for a quarter of the EO data processing market within the forestry segment. GNSS receivers are used in forestry applications in a similar fashion to those in agriculture, reflecting the substantial overlap between the two industries. European companies such as Hexagon and CNH rank among the world's top 15 manufacturers of GNSS components and receivers, together accounting for nearly one-eighth of the global market share.

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

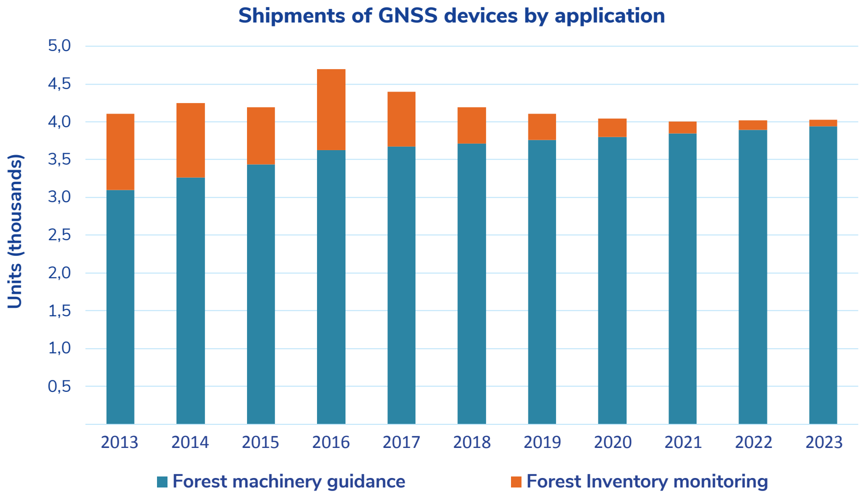
2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

EO is improving post-wildfire forest recovery and GNSS enabling precise mapping and optimised forestry operations via simultaneous localisation and mapping



The shipments of GNSS receivers in the forestry sector over the past decade showed only very modest growth, reflecting the sector's relatively slow pace of technology adoption and the limited scale of equipment fleets compared to other industries.

Forest Machinery Guidance accounted for almost all market share over the past decade. Forest Inventory Monitoring relies on GNSS to precisely locate inventory plots during field operations. While this application was traditionally supported by dedicated handheld devices, there is a continuing shift toward specialised software designed for use on tablets and smartphones. This decline in this application can in part be explained by the growing adoption of EO as an alternative to GNSS-centric workflows. Advances in satellite imagery and aerial data have enabled forest inventory parameters, such as boundaries, tree height, canopy density and biomass, to be derived remotely with increasing accuracy. As a result, fewer field plots are required, and those that remain are often used for calibration and validation rather than primary data collection. EO-driven approaches reduce dependence on precise in-field positioning and can lower operational costs by limiting time-consuming field surveys.

EO providing insights into post-wildfire forest recovery

EO data is being used to evaluate forest regrowth after wildfires, particularly looking at how different land protection categories influence recovery rates. This helps understand effectiveness of land management and conservation strategies. Traditionally, recovery of burnt areas has been assessed by field work, which is time- and labour-intensive. Remote sensing offers a quick, low-cost way to assess burnt areas. When combined with GNSS, ground reference points can be geolocated with high accuracy, improving the calibration and validation of EO-derived datasets.

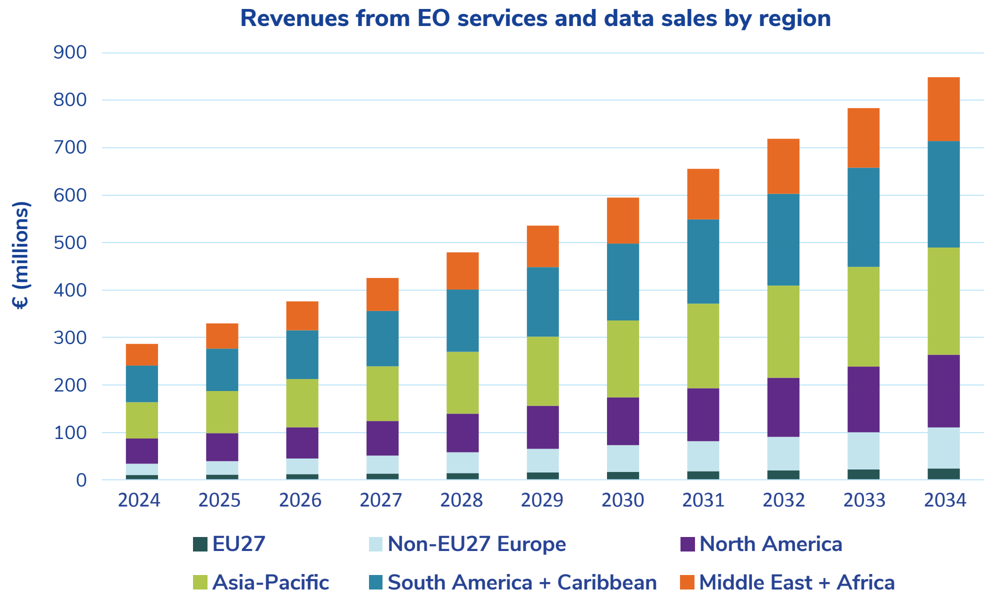
Scientists at the US National Science Foundation National Center for Atmospheric Research have developed a method that cross-references EO imagery with specialised dataset of land areas developed by the USA Geological Survey. This enabled the research team to gain powerful insights into what percentage of forests were recovering from wildfires and assess the speed of recovery of different categories of land protection. These insights help land managers and policymakers to determine which protection practices make a difference, so they can prioritise funding, restoration efforts, fire prevention, etc. A 2025 study used Copernicus data and spectral indices to assess fire severity and vegetation recovery in southern Italy's Bosco Difesa Grande after fires in 2017 and 2021. It found that low-severity areas recovered faster, while repeatedly burned zones showed poor regrowth and signs of long-term ecosystem change. A practical and recent example of the use of Copernicus data in such applications occurred in January 2025, when a series of devastating wildfires swept through Los Angeles County. To respond effectively, Direct Relief worked with Sentinel-1 data to map structural damage across the region. In combination with fire perimeter maps and health facility databases, an interactive model was built that pinpointed likely damage near clinics, care centres and hospices. Beyond playing a role post-wildfires, EO is also applicable for analysis of other extreme events such as storms, floods, droughts etc.

GNSS a key component of Simultaneous Localisation and Mapping - allowing for optimised precision forestry operations

Simultaneous Localisation and Mapping (SLAM) is a technology that is applied in precision forestry which enables the creation of a map of an environment while simultaneously determining the position of a robot or vehicle within it. Positioning data from GNSS signals help establish the robot's absolute location. In addition, sensors such as LiDAR and cameras can be integrated with SLAM to generate detailed maps of the surroundings and the robot's position relative to landmarks. A key application of GNSS-based SLAM in PF is the generation of accurate maps of forests, as well as supporting precise guidance of forestry machinery.

Inertial Measurement Units (IMUs) are commonly integrated into these robots to provide measurements of acceleration and angular rates. The combination of GNSS and IMU data enables the estimation of attitude, velocity and position with higher accuracy and improved robustness. This integration is particularly beneficial for precision forestry applications that involve dynamic machinery operations, such as autonomous vehicles or robotic systems. A recent field case study showed that combining handheld LiDAR with SLAM and GNSS, along with advanced processing software, offers a practical, efficient and accurate approach to forest inventory, especially in GNSS-challenged and areas that are difficult to access.

Virtual forests strengthen remote sensing capabilities, while GNSS technologies will play a key role in improving situational awareness during forest operations



Total revenues from EO data and services sales are expected **to show stable growth over the next 10 years**, reaching almost **€850 million by 2034**.

Demand for EO data and services in forestry is pushed by several drivers, including forests' vital carbon sink capacity, legislation such as the EU Deforestation Regulation and rising forest risks management concerns, all of which can lead to increased relevance of space technologies. Moreover, better data and analytics enable scalable, higher-value services, which also support sustained revenue growth. Many forests are also vast and widely distributed, making them difficult and costly to monitor from the ground, while satellite remote sensing enables efficient, large-scale tracking of forest cover, health, and change through consistent and repeat observations.

South America and the Caribbean is expected to achieve and share the status of market share leader with the Asia-Pacific region. Both are projected to **reach almost €230m by 2034. The emergence of South America and the Caribbean as a market leader is largely due to the continued significance of forestry-related activities in the Amazon.**

North America is forecast to gain the third-largest share of the global forestry market, with revenues projected to reach €153m by 2034, reflecting steady expansion in a relatively mature market. The region's forestry sector benefits from a well-established industrial base, extensive forest resources and strong integration with downstream industries such as construction, paper, packaging and furniture manufacturing

'Virtual forests' is helping improve remote sensing capabilities

Remote sensing is a powerful tool for tracking forest disturbance and recovery, but the signals captured by sensors are influenced not only by changes in the forest itself but also by viewing angles, illumination and canopy structure. Virtual forests offer a controlled way to test these factors, reducing the uncertainties of real-world data collection. Researchers have been building highly realistic 3D forest models that replicate tree architecture, species differences and canopy structures. These models can then be manipulated to simulate disturbances, such as tree loss or damage, and subsequent recovery processes. These virtual forests differ from digital twins. A digital twin is a real-time, data-driven replica of a physical forest, while a virtual forest is a simulated, non–real-time digital model used for visualisation or research.

Through these experiments, the researchers can show how virtual forests can help quantify biases and uncertainties in remote sensing data. For example, shadows, overlapping foliage and canopy density all influence how sensors perceive forest changes, which in turn affects how quickly recovery can be detected and what level of disturbance is noticeable. This approach could lead to improved forest monitoring protocols, better calibration of sensors and more reliable long-term assessments of how forests respond to disturbances.

GNSS will drive personal safety and situational awareness in forest operations

The job of a forest operator is one of the most dangerous in the world and therefore ensuring the safest possible working conditions for forest workers is crucial to achieving full sustainability in forest operations. One application of modern technology in operator safety is the utilisation of Location Sharing (LS) devices. LS systems are often based on GNSS-RF (radio frequency) paired with smartphones.

The use of LS technology could support injury prevention and response while also improving team situational awareness during logging operations. For example, LS devices equipped with help alerts would enable isolated people to warn co-workers or off-site response agencies of a crisis. Automatic location updates may be useful in incapacitating situations to let co-workers know when someone might need assistance. LS devices can offer greater accuracy, reliability and connectivity in remote forest environments, where smartphones often lose signal, can have lower GPS precision and limited battery life.

Geographic coordinates are supplied in both situations to help with response operations. In order to prevent injuries, automatic position updates combined with geofences could improve worker awareness of their whereabouts in relation to equipment or hazardous regions. Moreover, in many forested regions, cellular coverage is absent. SATCOM can help by ensuring that GNSS-based location data and safety alerts are transmitted in real time to supervisors, emergency services and cloud platforms.

The EU Space Programme supports R&D activities in forestry

Current and future use of Copernicus

Forest monitoring applications can benefit greatly from Copernicus data and services.

The programme offers dedicated services for land monitoring (i.e. **the Copernicus Land Monitoring Service**), which includes the **Tree Cover Density, Dominant Leaf Type** and **Forest Type products**. Additional services include the Copernicus Climate Change Service (C3S) and, specifically concerning forest fires, the Copernicus Emergency Management Service.

The programme also supplies satellite data from the Sentinels, which are seamlessly integrated into numerous forest monitoring and management applications, such as in deforestation monitoring.

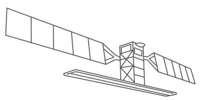
Current and future use of EGNSS

Galileo provides highly accurate real-time positioning and navigation information, which allows forestry professionals to precisely locate and map forest areas, boundaries, roads and trails. The Galileo **High Accuracy Service (HAS)** went live in 2023, offering greater accuracy than 20cm horizontally and 40cm vertically, free of charge. Accurate positioning is essential for tasks such as **machinery guidance, planning tree planting, authenticating plot sizes/positions to track deforestation rates, or identifying specific areas for timber harvesting**. Moreover, the Open Service Navigation Message Authentication provides receivers with the assurance that the received Galileo navigation message is coming from the system itself and has not been modified.

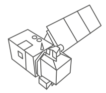
The real-time data allows forestry managers to monitor and track moving assets within the forest, such as vehicles or personnel, **which enhances safety and efficiency**. The combination of precise positioning and real-time data also enables the use of remote sensing to be integrated with the positioning data to create **detailed forest inventory maps**.

Copernicus
Europe's eyes on Earth

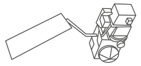
Land (CLMS) | Climate Change (C3S) | Emergency (CEMS)



Sentinel-1

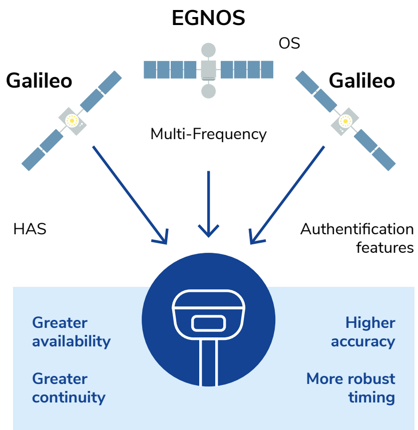


Sentinel-2



Sentinel-3

EGNOS GALILEO



Horizon Europe, a programme of the European Union

FUTUREFOR

FUTUREFOR - Copernicus Applications for Next-Generation Forest Monitoring

Europe's forests face growing pressures from climate change, biodiversity loss, pests and wildfires. At the same time, policymakers, forest managers and businesses need more accurate, harmonized and timely forest information to support sustainable forest management, reporting and decision-making.

The FUTUREFOR project addresses these needs by delivering accurate, timely forest data for Europe. Working with Copernicus entities and national stakeholders, it will assess regulatory and user requirements, support Ukraine's alignment with EU forest legislation and develop innovative EO-based products using AI, big data and advanced aerial platforms.

Building on existing operational services and past Horizon projects, FUTUREFOR will also create a forest digital twin and three commercial applications to showcase business opportunities from Copernicus and complementary forest data, including ecosystem services like carbon removals.

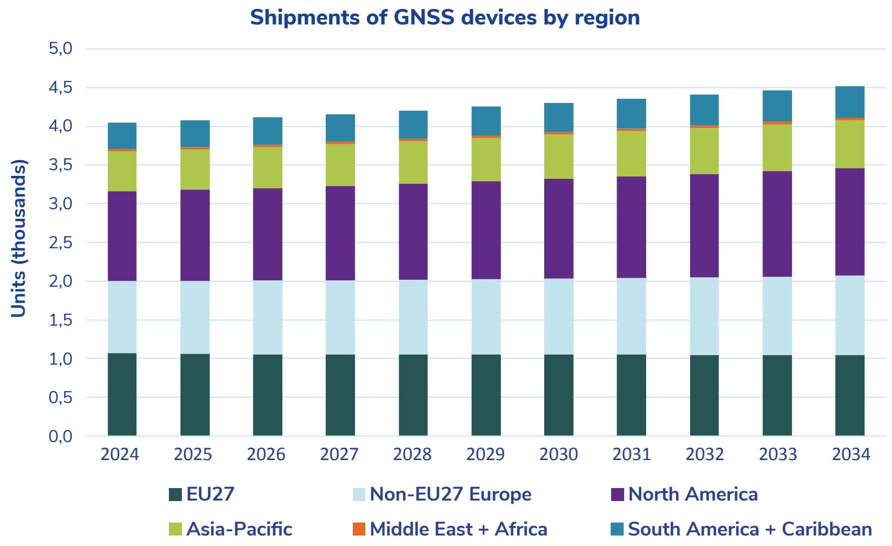
AXA

Unlocking the Power of Copernicus for Parametric Insurance: Advancing Faster Wildfire Recovery

Wildfires are becoming more frequent and severe, creating urgent needs for swift financial recovery. Parametric insurance offers an innovative solution by providing predefined payouts based on measurable event parameters, avoiding lengthy claims processes.

The EU's Copernicus programme underpins this model by delivering rapid, accurate wildfire data. Sentinel-2's high-resolution multispectral imagery enables precise mapping of burned areas, burn severity, and post-fire vegetation regrowth—crucial indicators for insurance triggers. With EUSPA support, AXA Climate has developed workflows that integrate these insights into parametric insurance products, ensuring tailored risk assessments.

Looking ahead, EUSPA and AXA Climate are continuing their collaboration to explore the use of cloud-native Sentinel data in Zarr format, a cutting-edge approach that enhances scalability and accessibility. Zarr enables large amounts of data to be analysed across a long time period, leveraging the power of cloud computing.


Shipments of GNSS devices by region
Units (thousands)
5,0
4,5
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
2024
2025
2026
2027
2028
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2032
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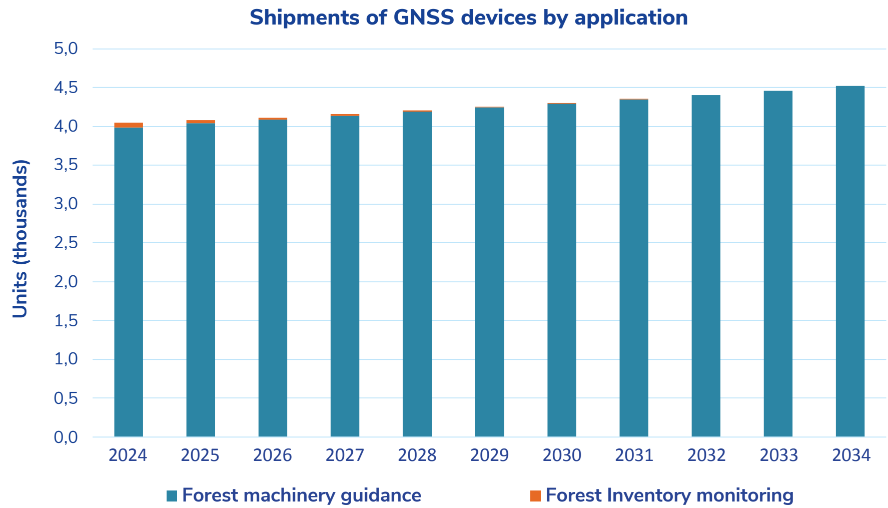
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Shipments of GNSS devices by application
Units (thousands)
5,0
4,5
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
2024
2025
2026
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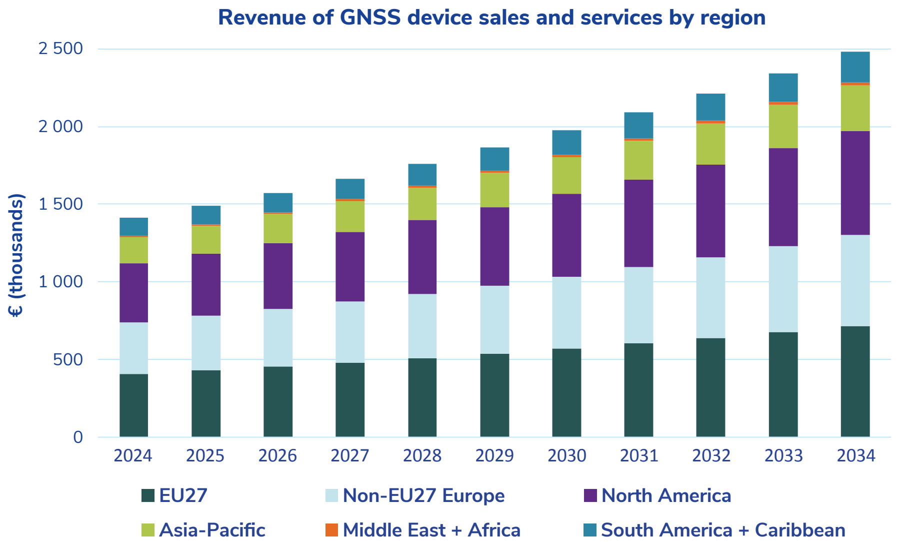
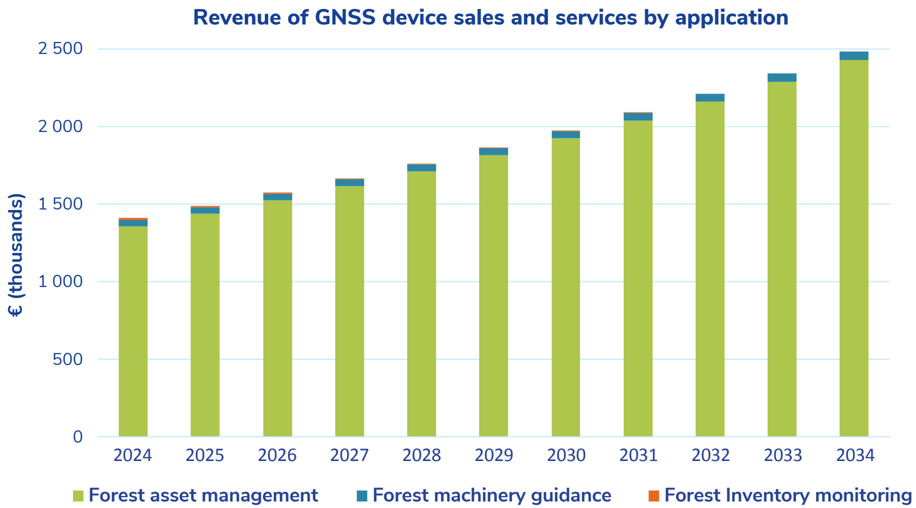
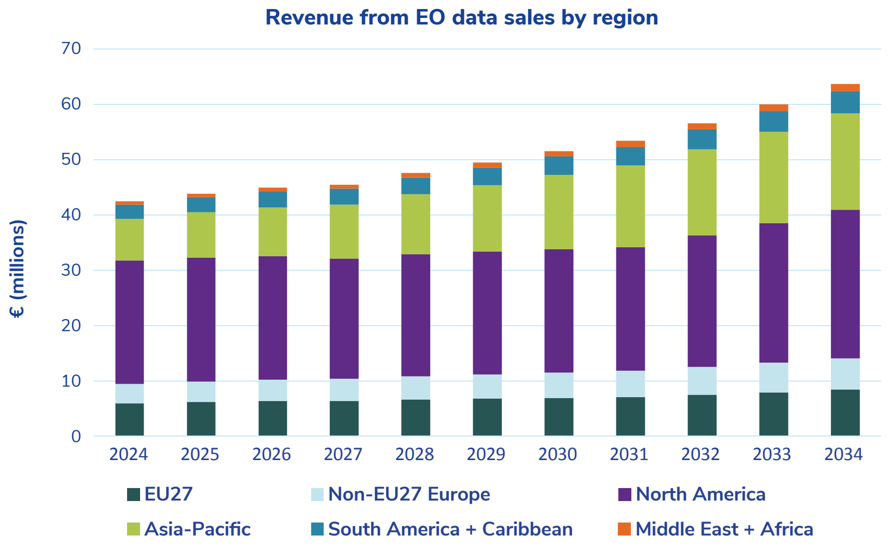
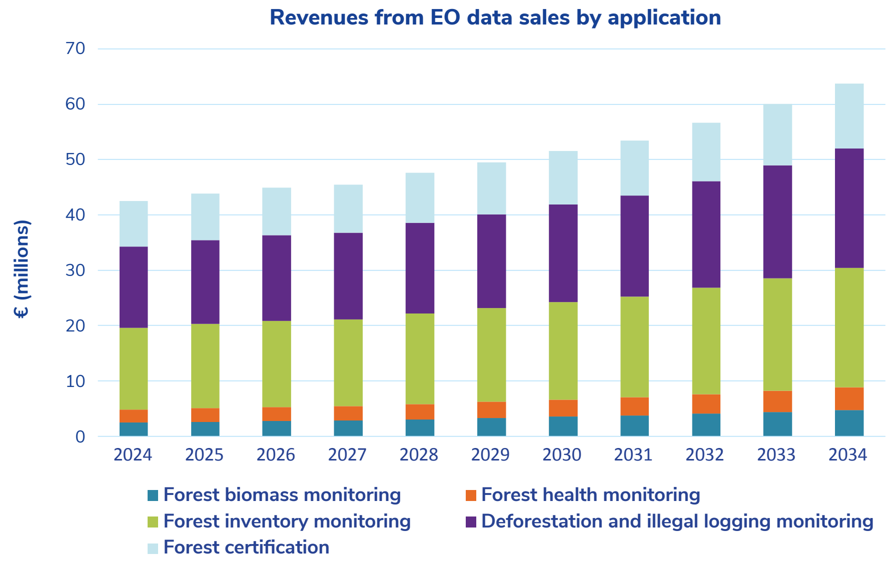
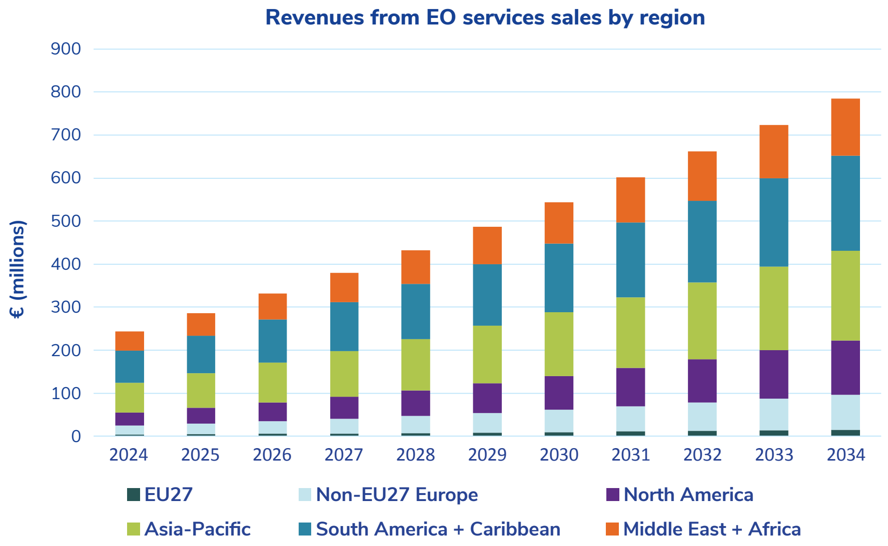
2031
2032
2033
2034
Forest machinery guidance
Forest Inventory monitoring

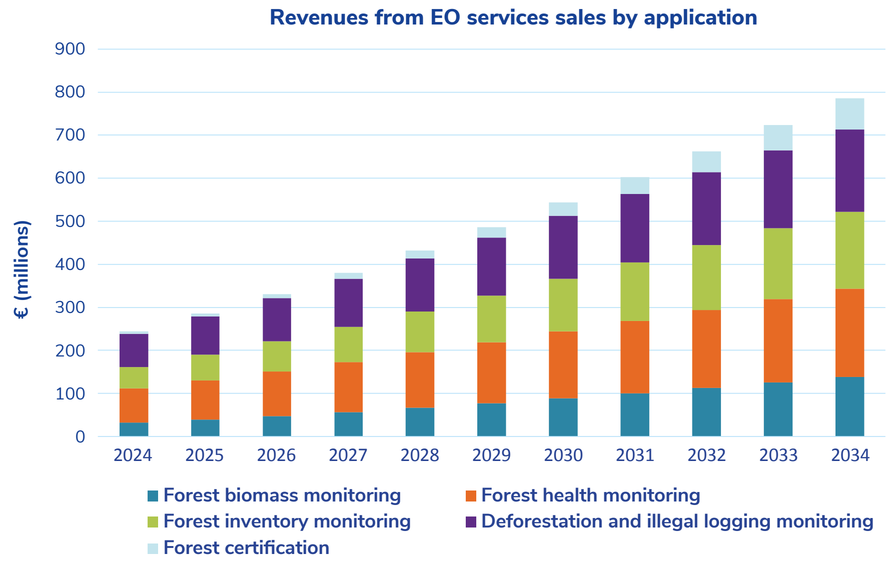

Revenue of GNSS device sales and services by region
€ (thousands)
2 500
2 000
1 500
1 000
500
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales and services by application
€ (thousands)
2 500
2 000
1 500
1 000
500
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Forest asset management
Forest machinery guidance
Forest Inventory monitoring


Revenue from EO data sales by region
70
60
50
40
30
20
10
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenues from EO data sales by application
70
60
50
40
30
20
10
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Forest biomass monitoring
Forest health monitoring
Forest inventory monitoring
Deforestation and illegal logging monitoring
Forest certification


Revenues from EO services sales by region
900
800
700
600
500
400
300
200
100
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenues from EO services sales by application
900
800
700
600
500
400
300
200
100
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
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Forest health monitoring
Forest inventory monitoring
Deforestation and illegal logging monitoring
Forest certification

INFRASTRUCTURE

Environmental impact monitoring

- Environmental impact assessment of infrastructure

Infrastructure construction and monitoring

- Construction monitoring[1]
- Monitoring of impact of human activities on infrastructure
- Pipeline monitoring
- Post-construction monitoring

Infrastructure planning

- Infrastructure site selection and planning[2]
- Vulnerability analysis

Timing & synchronisation of telecommunication networks

- Data centre
- Digital Cellular Network (DCN)
- DTV broadcast
- Professional Mobile Radio (PMR)
- Public Switched Telephone Network (PSTN)
- Satellite Communication (SATCOM)
- Small cells

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

1: Includes Construction surveying and Official Development Assistance (ODA) support monitoring

2: Includes Permitting

INFRASTRUCTURE

GNSS and EO continue to be invaluable assets in the toolbox of construction companies, infrastructure managers, public authorities and utility operators. GNSS receivers integrated into heavy machinery or drones enable the sector to benefit from the high-accuracy services offered by satellite navigation systems, which support the various phases of the infrastructure lifecycle, including construction works and maintenance operations. Recent improvements in terms of signal authentication have enabled GNSS-based timing and synchronisation to further foster the protection and resilience of telecommunication networks, data centres, cloud services and state-of-the-art industrial production systems.

Satellite-based imagery supports the various stages of the infrastructure lifecycle, from initial site selection to post-construction monitoring. It contributes to the characterisation of potential construction sites and to the monitoring of construction operations and of their impacts on the environment. Leveraging cutting-edge technologies, such as artificial intelligence and digital twins, EO improves risk exposure assessment, helps to design more resilient infrastructure and contributes to improved maintenance planning and operations.

Ultimately, GNSS and EO help operators and managers of all types of infrastructure to increase the safety of operations and productivity, while improving infrastructure resilience and limiting negative impacts on the environment.

What you will find in this chapter

- **Key trends:** Space-based services help infrastructure managers to optimise maintenance operations and to improve the reliability and resilience of their assets.
- **Industry:** Infrastructure Value Chains.
- **Recent developments:** GNSS and EO power robust solutions and improve resilience of infrastructure.
- **Future market evolution:** AI-enhanced GNSS analytics and EO data processing together with digital twins are expected to improve predictive infrastructure management.
- **European systems:** Galileo and Copernicus: the space services powering modern infrastructure management.
- **European projects:** Several EU-funded projects explore solutions to improve infrastructure resilience.
- **Reference charts:** Yearly evolution of the installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

Space-based services help infrastructure managers to improve resilience and maintenance operations

Key market trends

- Critical infrastructure operators are seeking to improve predictive maintenance and need solutions that provide a reliable and detailed assessment of the condition of their infrastructure.
- Large-scale infrastructure operators are increasingly using InSAR to assess ground deformation risk, but need solutions combining the advantages of different SAR frequency bands.
- Faced with growing threats, infrastructure requiring timing and synchronisation need solutions that offer greater reliability and resilience.
- Maintenance planning for large-scale infrastructure requires frequent monitoring while optimising the effort and resources dedicated to on-site inspections.

The need for a comprehensive view of infrastructure condition and performance requires multiple source solutions

GNSS data is increasingly being combined with EO data, particularly Synthetic Aperture Radar Interferometry (InSAR), and with complementary data sources such as Light Detection and Ranging (LiDAR) and Internet of Things (IoT) sensors, to create a comprehensive view of infrastructure condition and performance. While EO instruments like InSAR provide broad-area screening for signs of settlement or instability and LiDAR delivers high-resolution surface and structural models, GNSS augments these datasets by supplying precise, real-time ground-truth measurements at selected control points.

Using continuous satellite tracking, real-time kinematic positioning, and differential corrections, GNSS can detect millimetre-scale movements in three dimensions, ensuring accuracy even in challenging environments. This ability makes it possible to monitor structural responses to loads, environmental changes, or progressive ground shifts that broader EO surveys alone might not capture. When fused together, these complementary data streams allow earlier detection of subtle deformations and provide a more reliable basis for risk assessment.

The approach is especially valuable for critical assets such as bridges, dams, tailings storage facilities, and transport corridors, where timely warnings can prevent failures. By integrating these datasets into Digital Twins and asset management systems, operators can strengthen predictive maintenance, improve safety assurance, and support more efficient infrastructure management.

GNSS-based timing and synchronisation solutions for critical infrastructure management gain in reliability

GNSS-based timing and synchronisation improve the reliability of critical infrastructure by providing a precise time reference which keeps operations coordinated and reduces the risk of outages. Galileo and EGNOS play a key role by offering robust, high-integrity timing signals that support demanding telecom functions such as 5G cell-to-cell synchronisation, massive Multiple Input Multiple Output (MIMO) and time-division duplexing. The publication of the Space - Galileo Timing Receiver - Functional and Performance Requirements and associated Tests standard in December 2024 underpins reliability by defining common functional performance and test criteria for Galileo timing receivers. This standardisation improves the trustworthiness and predictability of receiver behaviour, giving regulators, operators and critical infrastructure providers greater confidence when deploying GNSS-based timing as part of their resilience and continuity strategies. The official launch of the Galileo Open Service Navigation Message Authentication in July 2025, which adds data authentication to the navigation message so that receivers can verify that timing information is genuine and not spoofed, also strengthen confidence in GNSS-based timing for critical infrastructure, making it more resilient to deliberate interference.

Risk assessment for large-scale infrastructure increasingly relies on InSAR-based ground deformation monitoring combining several frequency bands

Ground deformation poses a risk to infrastructure, prompting operators to conduct regular on-site inspections. In the specific case of large-scale infrastructure, such as intercity rail lines, highways and pipelines, these inspections are both costly and time-consuming, and operators are looking for automated or semi-automated solutions to minimise the number of on-site inspections. The technique known as InSAR, which uses Synthetic Aperture Radar, is increasingly being used to assess risks related to ground deformation, but each frequency bands has its own advantages and disadvantages. For example, the X-band captures small-scale deformations, making it well suited for monitoring individual assets, while the C-band offers a good balance between sensitivity and coverage, making it suitable for linear infrastructure. The L-band offers lower spatial resolution but is less affected by vegetation. It is also less affected by decorrelation over long intervals, making it well suited for long-term monitoring of unstable or vegetated terrain.

Using different frequency bands maximises the benefits and increases reliability. For example, it helps to better distinguish surface motion from subsurface motion, or vegetation noise from actual deformations. In short, multiband InSAR provides a more complete picture of soil behaviour and, therefore, of the risks to large-scale infrastructure.

Constellations of small EO satellites are playing a growing role in the monitoring of large infrastructure networks

Because they are vast, deteriorating, important to safety and, in general, directly tied to economic stability and public welfare, large infrastructure networks, such as road and rail networks, require frequent monitoring. There are solutions based on IoT sensors or unmanned aerial vehicles (UAVs) that complement on-site inspections carried out by workers, but they remain costly when used to monitor very large infrastructure. Satellite-based solutions are increasingly being used to monitor large infrastructure networks (e.g., to monitor ground deformation or vegetation encroachment along linear infrastructure) but when high-revisit frequencies are required, satellite missions offering revisit times of several days may not be entirely suitable. However, small satellite (Smallsat) constellations provide high-resolution optical and radar imagery with a very high revisit frequency. Smallsat constellations can cover large geographic areas consistently and deliver very frequent observations (even multiple revisits per day in some cases), enabling the detection of sudden changes or damages. They are therefore highly suited to monitoring linear infrastructure stretching hundreds of kilometres.

Infrastructure GNSS Value Chain[1]

GNSS

AUGMENTATION SERVICE PROVIDERS

- GEODNET
- CNH INDUSTRIAL* (INCLUDING HEMISPHERE)
- HEXAGON (LEICA GEOSYSTEMS, NOVATEL)*
- POINT ONE NAVIGATION
- SPACEOPAL*
- SWIFT NAVIGATION
- TERIA*
- TOPCON
- TRIMBLE NAVIGATION
- U-BLOX*

- GALILEO HIGH ACCURACY SERVICE
- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS
- REGIONAL SBAS PROVIDERS

COMPONENT MANUFACTURERS

Construction
- BEIJING BDSTAR NAVIGATION
- COMNAV TECHNOLOGY
- FURUNO
- HEXAGON*
- QUALCOMM
- SONY SEMICONDUCTOR SOLUTIONS
- STMICROELECTRONICS*
- TAI-SAW TECHNOLOGY
- TRIMBLE NAVIGATION
- U-BLOX*
- YAGEO CORPORATION

Timing & Synchronisation
- BROADCOM
- FURUNO
- HEXAGON*
- MICROCHIP TECHNOLOGY
- NIHON DENGYO KOSAKU
- QORVO
- QUECTEL
- SEIKO EPSON
- STMICROELECTRONICS*
- UNICORE COMMUNICATIONS

RECEIVER MANUFACTURERS

Construction
- BEIJING UNISTRONG SCIENCE &TECHNOLOGY
- CHCNAV
- EMLID*
- HEXAGON*
- KONGSBERG MARITIME*
- STONEX*
- TOPCON CORPORATION
- TRIMBLE NAVIGATION

Timing & Synchronisation
- CHRONOS TECHNOLOGY*
- ELPROMA ELECTRONICS*
- GORGY TIMING*
- HEXAGON*
- HOPF ELEKTRONIK*
- MEINBERG*
- MICROCHIP TECHNOLOGY
- OMICRON*
- OSCILLOQUARTZ*
- SAFRAN TRUSTED 4D*
- SEIKO SOLUTIONS INC.
- STMICROELECTRONICS*
- TIMEBEAT
- TIMELINK*
- TRIMBLE NAVIGATION
- U-BLOX*

SYSTEM INTEGRATORS DESIGN CONSULTANCIES TESTING & MAINTENANCE

Construction
- AB VOLVO*
- CATERPILLAR
- CNH INDUSTRIAL*
- DEERE
- HEXAGON*
- HYUNDAI INFRACORE
- J.C.B. SERVICE*
- KOMATSU

Timing & Synchronisation
- ABB*
- ACCENTURE
- CHRONOS TECHNOLOGY*
- EATON*
- ERICSSON*
- HUAWEI
- JUNIPER
- KERLINK*
- NOKIA*
- SAFRAN*
- SCHNEIDER ELECTRIC*
- SIEMENS
- SICE*
- SPIRENT
- ZTE

USERS

- CONSTRUCTION COMPANIES
- ENGINEERS
- PIPELINE OPERATORS
- PUBLIC AUTHORITIES (REGULATION, TRANSPORTATION)
- REGULATING AUTHORITIES
- TELECOM OPERATORS

LEGEND

- Commercial offering
- Public offering
- User segments

European[2] GNSS industry in the global arena

The use of GNSS for infrastructure can be split into two different use cases: receivers related to construction applications, and receivers for the timing and synchronisation for critical infrastructure. In construction, one of the leading companies in Europe is Hexagon, which provides GNSS-based surveying and machine-control solutions relevant for civil infrastructure projects.

Regarding timing and synchronisation, notable European receiver manufacturers include STMicroelectronics, Safran Trusted 4D, u-blox, Oscilloquartz and Meinberg, all of which supply GNSS-based timing technologies for critical infrastructure sectors.

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

Infrastructure EO Value Chain[1]

EO

DATA PROVIDERS

- 21AT
- AIRBUS*
- AXELSPACE
- BLACKSKY
- CAPELLA SPACE
- CGSTL
- EARTHDAILY
- E-GEOS*
- GEOCENTO*
- GEOIMAGE
- ICEYE*
- ORBITA AEROSPACE
- ORBITAL SIDEKICK
- PLANET
- SATELLOGIC
- UMBRA
- VANTOR

- ALOS-2 (JAXA)
- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- LANDSAT (USCG)
- NISAR (NASA / ISRO)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G., GAIA-X)*
- COPERNICUS COLLABORATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CREODIAS*
- EARTH-I*
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- OPEN DATA CUBE

- COPERNICUS DATA SPACE ECOSYSTEM*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

- CLS*
- DETEKTIA* **
- E-GEOS*
- GAF*
- GEOFEM*
- GEOVILLE*
- INSAR.SK*
- KSAT*
- ORBITAL EYE*
- PLANETEK*
- SKYGEO
- SPOTLITE*
- TERRASIGNA*
- TRE ALTAMIRA*
- URSA SPACE
- VITO*

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS EUROPEAN GROUND MONITORING SERVICE (EGMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*

INFORMATION PROVIDERS

- ARCHER GEOGRAPHIC
- ARUP*
- AVINEON*
- DARES TECHNOLOGY*
- DEWBERRY
- DHI*
- FUGRO*
- GEOCONCEP T*
- INFRASPACE* **
- KORRAI
- LIVEEO*
- RINA*
- SENSAR*
- SIXENSE*
- SWECO
- SYNSPECTIVE
- SUPERVISION*

END USERS

- CONSTRUCTION COMPANIES
- FINANCIAL INSTITUTIONS
- INFRASTRUCTURE MANAGERS
- INTERNATIONAL DEVELOPMENT ORGANISATIONs
- LOCAL, REGIONAL & NATIONAL AUTHORITIES
- PUBLIC WORKS COMPANIES
- PIPELINE OPERATORS
- OIL & GAS PRODUCERS
- UTILITY COMPANIES

LEGEND

Commercial offering
Public offering
User segments

NOTES

1: The value chain considers the key global and European companies involved in EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 for a comprehensive description of the EO value chain and how to interpret them at segment level.

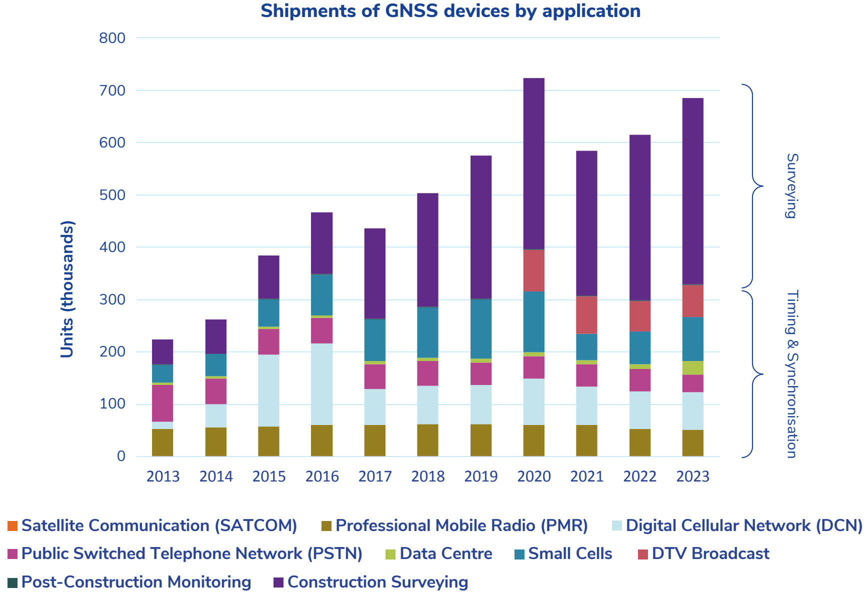
* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

European[2] EO industry in the global arena

North American and European companies dominate the market thanks to their strong position at all levels of the value chain, from data acquisition and distribution to the provision of analytics and insights to support decision-making. Thanks to companies like Airbus, e-GEOS (Leonardo Group), Fugro or ICEYE, Europe is on a par with North America. With five companies in the top 10, Europe is a key actor in the Infrastructure market segment.

GNSS and EO power robust solutions and improve resilience of infrastructure



Modern infrastructure increasingly depends on precise positioning and resilient timing, driving sustained demand for high-end GNSS solutions across the segment. This growth is shaped by broader technological shifts: **densifying** 5G networks and **early 6G preparations**; expanding cloud and edge-computing facilities that require **assured synchronisation**; and the **digitalisation of construction and asset-management processes**.

Within timing and synchronisation, small cells and DCN remain the main growth engines. Small-cell shipments have nearly doubled over the past decade as operators improve indoor coverage and **timing robustness**, while DCN continued its steady rise as networks **upgraded for 5G-Advanced**. Data-centre receivers, though smaller in volume, grew quickly as distributed cloud architectures depend more heavily on GNSS-based timing. PMR remained stable at around 50,000 units per year, mainly **substituting ageing equipment**.

In geomatics, construction surveying shows strong, sustained expansion driven by **Building Information Modelling (BIM)-integrated workflows**, machine guidance and **increased automation** on construction sites. Post-construction monitoring is continuing to grow as GNSS is adopted for structural health monitoring. Smaller categories such as SATCOM, PSTN and DTV broadcast have either gradually declined or remained stable as legacy systems have been phased out or replaced by integrated connectivity solutions.

GNSS supports condition-based maintenance for ESG compliance

GNSS-enabled monitoring, enhanced by AI analytics, is becoming a cornerstone of condition-based maintenance, helping infrastructure owners align with environmental, social and governance (ESG) standards through transparent, data-driven decision-making.

Traditional schedule-based maintenance often leads to premature replacements, unnecessary site visits and excess emissions. By contrast, GNSS provides precise, continuous tracking of structural behaviour, while AI algorithms, such as anomaly detection, predictive modelling and pattern recognition, interpret this data in real-time to trigger interventions only when genuinely required. This synergy minimises travel, fuel use and material waste, directly reducing the asset's carbon footprint and ecological impact.

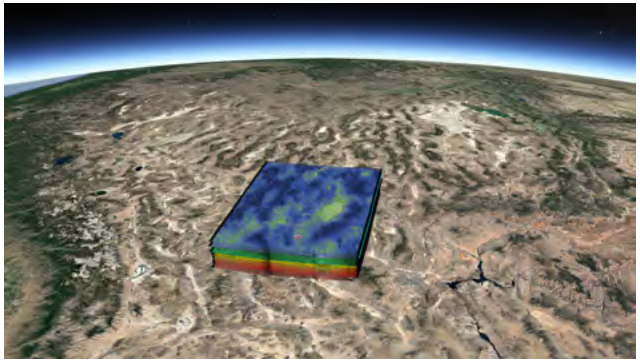
AI also enhances ESG reporting value by transforming GNSS data into verifiable sustainability metrics. Machine Learning models can quantify avoided emissions, estimate extended component lifetimes and generate predictive risk indicators, all traceable through time-stamped GNSS datasets. These insights strengthen governance by providing auditable, tamper-proof evidence that assets such as bridges, dams and transport corridors remain within regulatory thresholds. When movements approach critical limits, AI-driven alerts demonstrate early detection and proactive management, improving accountability and audit readiness.

Combined with Galileo's High Accuracy Service (HAS) and Open Service Navigation Message Authentication (OSNMA), AI-processed GNSS data delivers both precision and integrity. Integrated into digital twins and asset management platforms, these intelligent monitoring systems connect operational efficiency with measurable ESG outcomes, reinforcing stakeholder trust, sustainability credentials and long-term resilience across the infrastructure lifecycle.

Hyperspectral imagery serves various aspects of infrastructure management

Satellite hyperspectral imagery has been used for several years in domains such as agriculture, geology, energy and mining. Its scope of application now extends to infrastructure management. Thanks to its ability to detect early signs of deterioration such as structural fatigue, surface oxidation and chemical changes resulting from water ingress or the presence of salt, hyperspectral imagery can help monitor infrastructure assets (e.g., bridge decks) as well as transport infrastructure (e.g., monitoring of asphalt and pavement conditions).

Satellite hyperspectral imagery can also play a key role in water management infrastructure: combined with in-situ measurements and other satellite data, hyperspectral imagery is highly promising for monitoring and safeguarding drinking water supplies, especially for detecting water quality degradation and harmful algal blooms.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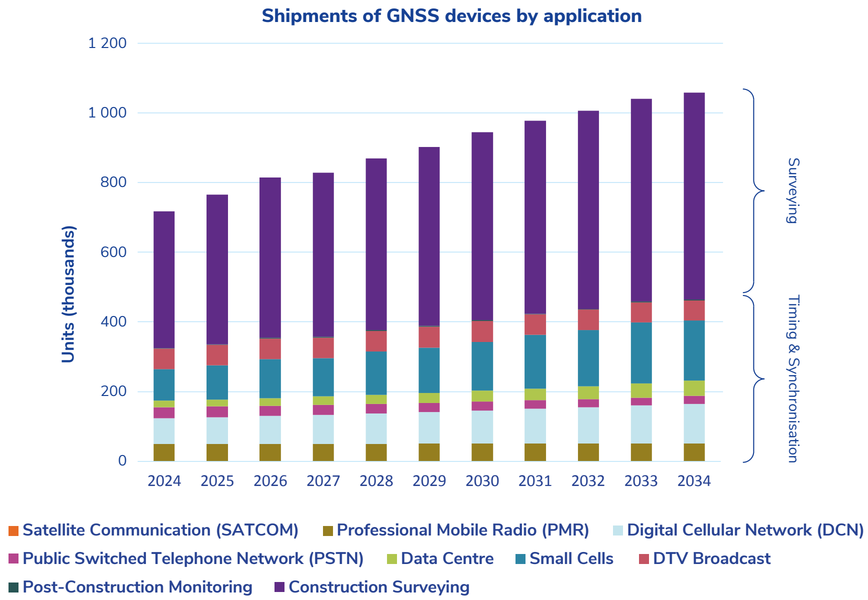
In addition, satellite hyperspectral imagery is extremely useful for assessing the impact of infrastructure on its environment. By analysing spectral signatures, it can detect subtle changes in vegetation health, water quality, soil degradation and land cover changes, all of which can result from the construction or presence of infrastructure.

AI-enhanced GNSS analytics and dynamic digital twins enable predictive infrastructure management



GNSS-powered digital twins will offer reliable decision tools to infrastructure operators

GNSS is emerging as a powerful enabler for digital twins in infrastructure management, especially when combined with other geospatial data and tools such as LiDAR and Building Information Modelling (BIM). While LiDAR and BIM provide detailed 3D geometry, GNSS anchors reference points of the twin to universally referenced coordinates, streaming continuous displacement and attitude data into the model. This transforms digital twins from static design records into dynamic systems that mirror real asset behaviour. High-precision, multi-frequency signals from Galileo's High Accuracy Service (HAS) enhance trust in these models, detecting subtle shifts and structural deformations in real time.

Fused with local sensors such as strain gauges or accelerometers, GNSS delivers both global positioning and local responses, filling the gap between periodic inspection campaigns. Through this pipeline – receivers installed on structures, real-time processing, data fusion to combine input from other sensors, and dynamic models – operators gain 'living' twins that support simulations, trigger alarms on threshold exceedance and optimise maintenance based on observed trends. The result is a reliable decision tool that improves safety, extends asset life and reduces costs.

GNSS infrastructure demand is increasingly driven by construction, telecommunications and data-centric applications. **Construction surveying** represents the largest and fastest-growing segment, with shipments rising from around 393,000 units in 2024 to nearly 594,000 by 2034, as GNSS becomes embedded in machine guidance, BIM-enabled workflows and large-scale infrastructure programmes. Post-construction monitoring grows steadily from a low base, supported by increasing use of GNSS for deformation monitoring, structural-health assessment and long-term asset management.

In telecommunications, demand is shaped by **network densification** and **tighter synchronisation requirements**. Digital cellular networks and small cells expand over the period as operators prepare for 5G-Advanced and enhance indoor and high-capacity environments. **Data-centre timing** shows strong growth as cloud, edge and colocation facilities increasingly require resilient, GNSS-anchored timing solutions.

The more mature segments show limited growth or decline. **Professional Mobile Radio** remains broadly stable, reflecting **steady but constrained investment**, while PSTN, DTV broadcast and dedicated SATCOM receivers gradually decrease as **legacy systems are phased out**, and timing functionality is consolidated into multi-purpose network equipment. Despite rising shipment volumes in key applications, revenue growth remains moderated by **declining unit prices, longer equipment lifetimes** and an overall maturing GNSS infrastructure market.

AI-enhanced analytics will bring the exploitation of GNSS datasets for infrastructure management to the next level

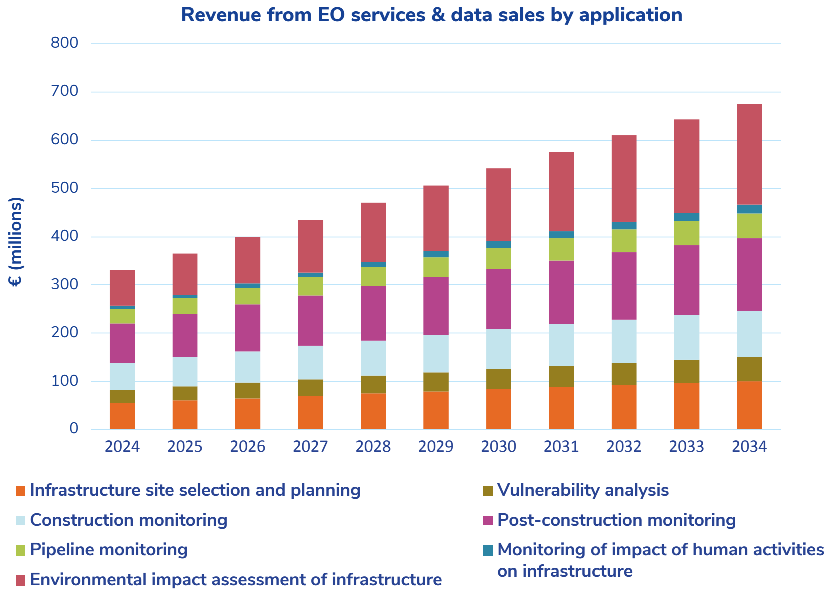
AI is revolutionising how vast GNSS datasets are exploited for infrastructure management by transforming raw positioning signals into predictive, decision-ready intelligence. Machine Learning (ML) models, particularly Deep Learning (DL) and time-series analysis networks, detect subtle patterns in GNSS data that indicate stress, deformation or instability long before they become critical. These algorithms enable early anomaly detection, trend forecasting and predictive maintenance, reducing safety risks and extending asset lifecycles through timely interventions.

By training models on multi-constellation inputs from Galileo, GPS, BeiDou and GLONASS, AI improves robustness against multipath effects, signal blockages and systematic errors, delivering more reliable results even in dense urban or mountainous environments. This supports safety-critical applications such as bridge, dam and transport corridor monitoring.

Cloud-based AI platforms allow large-scale data fusion, combining GNSS inputs with other sensor modalities (e.g., accelerometers, strain gauges and weather data) to provide holistic situational awareness. In parallel, edge AI algorithms bring intelligence directly to the sensor, enabling local, low-latency anomaly detection even in remote or bandwidth-limited sites. This distributed approach ensures both scalability and resilience, allowing continuous monitoring and autonomous decision support across entire infrastructure portfolios.

Together, these AI segments (ML, DL, edge analytics) turn GNSS monitoring from a reactive tool into a proactive, predictive system. The result is earlier warnings, optimised maintenance scheduling, reduced operational costs and a solid foundation for compliant, data-driven infrastructure governance.

Artificial intelligence and digital twins are expected to improve risk assessment and maintenance planning



In the infrastructure sector, the **total revenue** generated by the sale of EO data and EO-based services **is expected to increase** steadily over the coming years, driven by key applications. This general evolution is supported by underlying trends in the infrastructure management sector, which include the **increasing adoption of interferometric SAR techniques** for ground deformation monitoring, the **growing number of commercial constellations and governmental satellite missions** (enabling a general improvement of revisit frequencies, spatial coverage and spatial resolution), **the use of machine learning** (enabling a reduction of human intervention and the production of actionable information), and the **increasing integration of EO data in digital twins and Building Information Modelling** (BIM).

In this general context, site selection and planning, construction monitoring, post-construction monitoring (maintenance phase) and environmental impact assessment of infrastructure should remain the dominant EO-based applications over the coming years, generating around 80% of revenues from EO data and service sales. Among these key applications, the **environmental impact assessment of infrastructure** application should benefit from the growing willingness of public authorities to improve assessment of the impact of large infrastructure on its surroundings (e.g., pollution, impact on ecosystems and biodiversity). It is therefore expected to increase its relative share over the next decade.

AI/ML-based processing techniques will enable automated risk assessment to be ingrained into infrastructure asset management workflows

Processing techniques based on Artificial Intelligence and machine learning (AI/ML) algorithms support the detection of structural anomalies and damage assessment, including for large-scale infrastructure such as road and rail transport networks and pipelines.

AI/ML can help classify materials and detect temporal trends, thus helping to enhance infrastructure management workflows. For example, thanks to their ability to classify land cover from satellite imagery, machine learning algorithms enable vegetation growing too close to infrastructure, such as railways and pipelines, to be detected and the risk for vegetation encroachment to be quantified. Still in relation to vegetation, the analysis of multispectral/hyperspectral satellite data using machine learning algorithms can detect anomalies such as vegetation stress near pipelines, helping to identify leaks.

Another example is the processing of InSAR data using machine learning, which helps to identify patterns of ground deformation and building settlement that are important for assessing the risk for structural health or rail deformation.

Powered, frequently-updated EO imagery, infrastructure digital twins and AI models enable improved predictive maintenance helping, for example, to identify at-risk assets and prioritise on-site inspections through other means.

Predictive maintenance will be optimised thanks to 3D living models

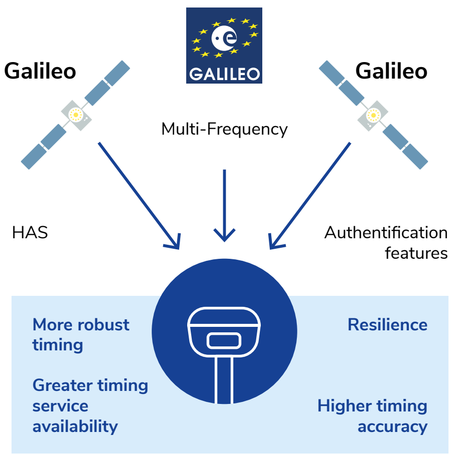
Digital twins are already being used in many sectors and enable data from different sources to be merged into 3D-models. In the infrastructure sector, they enable satellite-based observation data to be fused, allowing for wide-area monitoring and the use of data from on-site sensors.

These models show the current state but also make it possible to predict how this state will evolve based on factors such as ground deformation trends or the effects of climate change. These projections facilitate the identification of future risks and improve predictive maintenance planning.

For example, a digital twin can be used to simulate flow disruptions in an underground pipeline and to combine satellite thermal infrared imagery showing unusual soil temperature patterns, InSAR data showing ground deformation and pressure sensors to localise probable leak points. Digital twins can also be used to combine InSAR-based ground deformation data along a rail track with data from accelerometers on board trains to identify sections most likely to fail under stress, and to plan targeted maintenance accordingly.

Ultimately, improving predictive maintenance facilitates the development of long-term maintenance schedules and helps reduce infrastructure maintenance costs as well as interruptions and downtime in transportation networks.

Galileo and Copernicus: the space services powering modern infrastructure management



Galileo provides infrastructure managers with reliable positioning and timing solutions

Galileo is increasingly used across the infrastructure market for reliable positioning, timing and monitoring applications. Its **multi-frequency Open Service** supports asset localisation and deformation tracking, while the **High Accuracy Service (HAS)** enhances precision for structural monitoring, surveying and geospatial data integration. The operational rollout of **the Open Service Navigation Message Authentication (OSNMA)** in 2025 strengthens signal trust for safety-relevant use cases, providing protection against spoofing in critical infrastructure environments.

In parallel, the **Timing Service Message (TSM)**, which was introduced in December 2024, adds integrity information for Galileo System Time and its alignment to UTC, marking an important step towards a dedicated **high-integrity timing service** for infrastructure assets such as smart electricity grids and telecommunications networks.

These evolutions reinforce Galileo as a robust and trusted component for infrastructure management, monitoring and resilience planning.

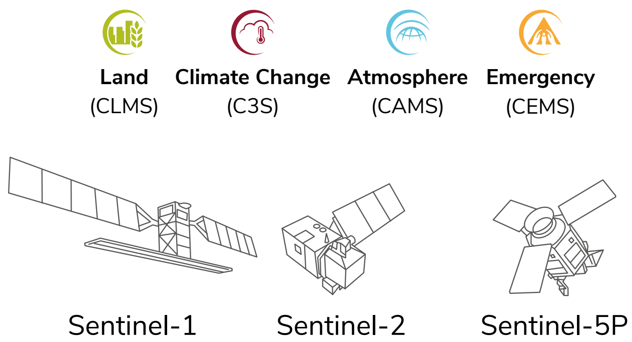
EGNSS services and features to be explored

Studies and research continue to explore how **authenticated SBAS signals** could complement the now-operational **Galileo OSNMA**, providing an **additional layer of security and resilience** for critical infrastructure, such as telecommunications networks and data centres. EGNOS offers strong performance in time accuracy and stability, and ongoing work on EGNOS Network Time reinforces its potential as an independent, integrity-protected reference for future **certified timing services**. The introduction of the **Galileo Timing Service Message** marks a key step toward high-integrity timing at system level, supporting sectors that require trusted synchronisation. Galileo's **High Accuracy Service** is also evolving, positioning the system as the first GNSS to provide **global PPP corrections** directly through the Signal-in-Space, with further enhancements under study for demanding infrastructure planning, construction and monitoring tasks. These developments together with planned **second-generation Galileo features**, such as improved signal robustness, dual-frequency authentication and enhanced integrity, are shaping a new generation of precise, secure and resilient EGNSS services for critical infrastructure applications.

Copernicus data and services power infrastructure management applications

With its Full, Free and Open (FFO) data policy, **Copernicus** continues to provide infrastructure management market players with a **one-of-a-kind access to data and services** that support the development, monitoring and maintenance of **safe, sustainable and resilient** infrastructure. The data delivered by the **Sentinel missions** offer a **spatial coverage** which goes **beyond any other in situ-only monitoring solution**, allowing the provision of valuable information over large and/or remote areas, which can be followed-up with Very High Resolution (VHR) imagery when necessary. In addition, the processing of **long-time series** also enables the detection of **subtle changes** and the identification of **evolution trends**.

The diversity and amount of data and products offered by the Sentinels and the Copernicus services enable the development of a wealth of applications that address the various phases of the infrastructure life cycle. In the **planning phase** for instance, the **Copernicus Land Monitoring Service (CLMS)** and the **Copernicus Climate Change Service (C3S)** can help to assess possible construction sites while on the longer-term, **CLMS** and the **Copernicus Atmosphere Monitoring Service (CAMS)** can deliver land cover and air quality information that can **help to better identify the impacts of infrastructure** on its environment **and reciprocally**. The Copernicus **European Ground Motion Service (EGMS)** is of particular interest to the infrastructure sector as it provides **millimetre-accuracy ground deformation maps** at European scale, updated on a yearly basis. Thus, EGMS supports the identification of the areas where ground movements put infrastructure **at risk**. Through its **Early Warning & Monitoring component**, the **Copernicus Emergency Management Service (CEMS)** also **supports the protection of infrastructure** through the delivery of critical geospatial information for flood, fire and drought risk, at both European and global levels.



Several EU-funded projects explore solutions to improve infrastructure resilience

Horizon Europe, a programme of the European Union

IIMEO - Instantaneous infrastructure monitoring by Earth Observation

IIMEO is a three-year EU-funded project aiming to develop and demonstrate key technologies for the global monitoring of **critical infrastructure** (e.g., energy supply, communication networks, transport networks) from space in **near real time**.

The IIMEO system consists of three complementary parts: an on-board platform, an on-ground platform, and user services. The on-board platform combines **advanced sensors** (Synthetic Aperture Radar and high-resolution RGB cameras) and innovative **AI-based processing technologies** to handle critical monitoring tasks, such as the automated detection of obstacles on railway tracks.

The project's final goal is to set up a system that is able to automatically detect infrastructure malfunctions, whether caused by natural disasters, extreme weather events or malicious actions, across large areas and in near real time, regardless of local weather and lighting conditions. The last phase of the project includes a demonstration campaign based on an airborne prototype, which will enable the system to be tested in real conditions for a railway infrastructure.

Horizon Europe, a programme of the European Union

RESIST - Resilience enhancement of essential infrastructure safety and telecommunications

RESIST is a 30-month EU-funded project that aims to enhance the **resilience** of **large-scale interconnected critical infrastructure**, thanks to the combination of a solar-based Unmanned Aerial Vehicle equipped with high-end performing sensors and Copernicus optical and radar satellite imagery. The solution developed by the project will support critical infrastructure operators and crisis managers across EU territories **before, during and after disasters**.

RESIST will offer multi-mission capacity and will enable a persistent and/or aleatory monitoring of critical infrastructure. It will provide relevant data for the actualisation of **emergency plans** and **climate adaptation plans**. In case of a disaster, the developed solution will improve the coordination and response capacity of infrastructure operators and crisis managers.

The resilience enhancement of large-scale interconnected critical infrastructure will be approached through three particular use cases dealing respectively with transmission lines monitoring, electricity production and distribution infrastructure monitoring, and surveillance of a strategic hydrocarbon site.

CLEPSYDRA / STARGATE / Gal4TSync - Development of standard Galileo timing receivers

With the publication of the Space - Galileo Timing Receiver - Functional and Performance Requirements and associated Tests CEN/CENELEC standard (EN 16605:2024) on 4 December 2024, the European Commission and EUSPA made a significant step forward in the adoption of a Galileo Timing Service.

To follow-up this important milestone, three new EU-funded projects were launched in September 2025 by EUSPA through the R&D funding mechanism known as the Fundamental Elements initiative, which supports the development of EGNSS-enabled chipsets, receivers and antennas.

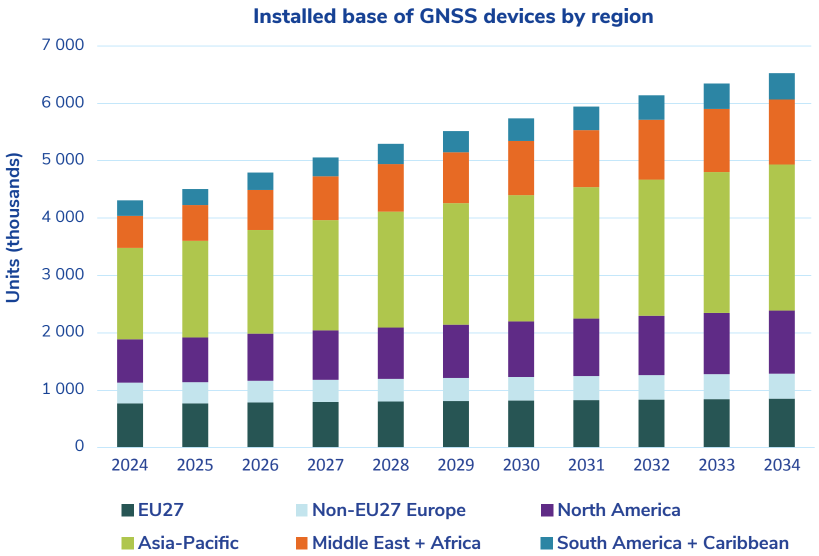
These projects, respectively named CLEPSYDRA, STARGATE and Gal4TSync, aim to develop **Galileo dual-frequency timing receivers** in full compliance with the functional and performance requirements defined in the standard. The projects focus on critical infrastructure, such as telecommunication networks, for which user requirements include the need for resilient, robust and accurate timing services.

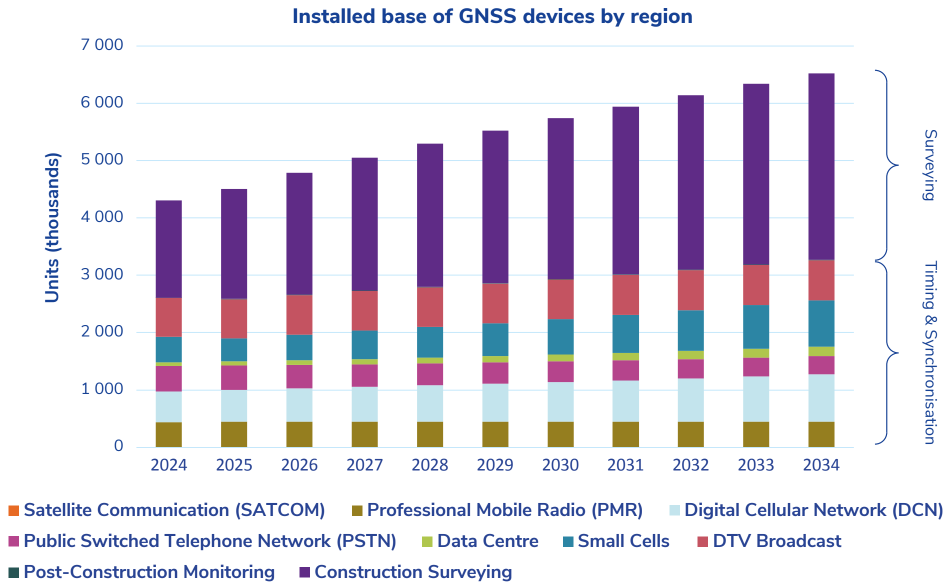
AIS - Autonomous infrastructure surveillance

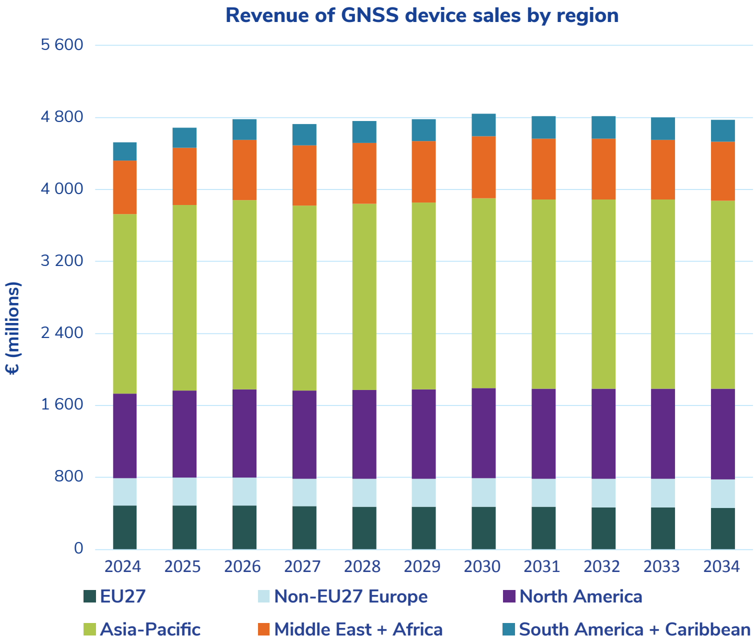
AIS is a 'kick-start' activity funded by ESA and aimed at addressing the challenge of **critical infrastructure surveillance** in remote areas. The concept is to provide continuous aerial surveillance through a **tethered autonomous drone** capable of highly accurate navigation even in regions where local ground stations are not available.

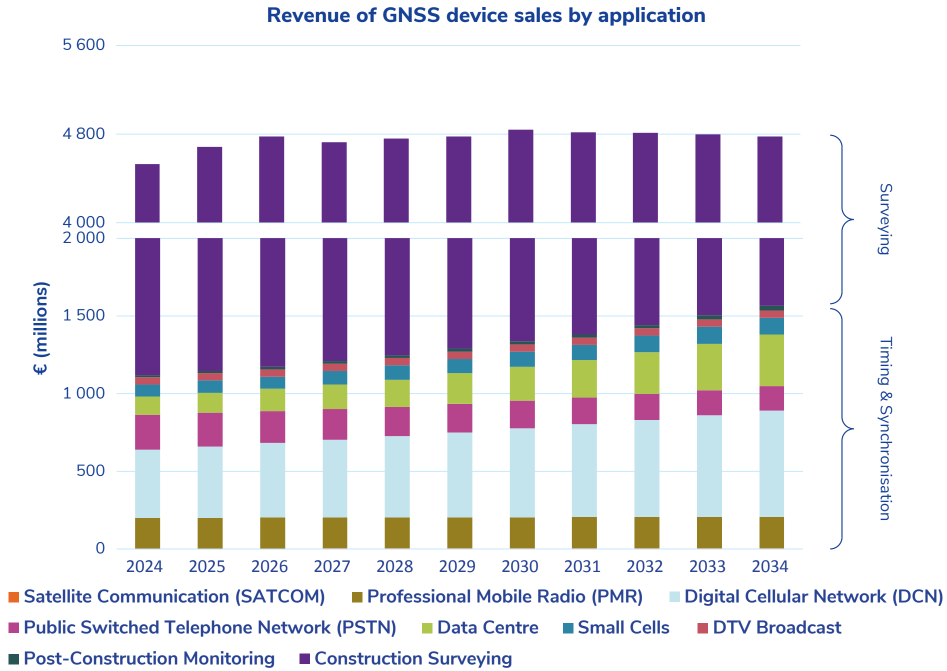
The project successfully validated that the **Galileo High-Accuracy Service** provides sufficient accuracy for autonomous navigation in the absence of local Real-Time Kinematic stations, while the tether ensures continuous power and data connectivity, operational safety and regulatory acceptance.

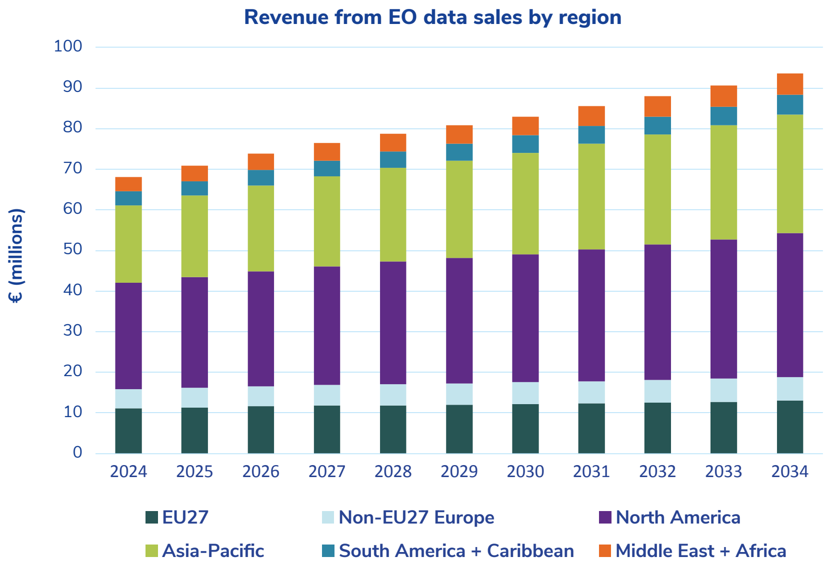
Follow-on activities carried out in the context of a demonstration project, will aim to industrialise the system, expanding environmental testing and deploying the first units with early adopters.

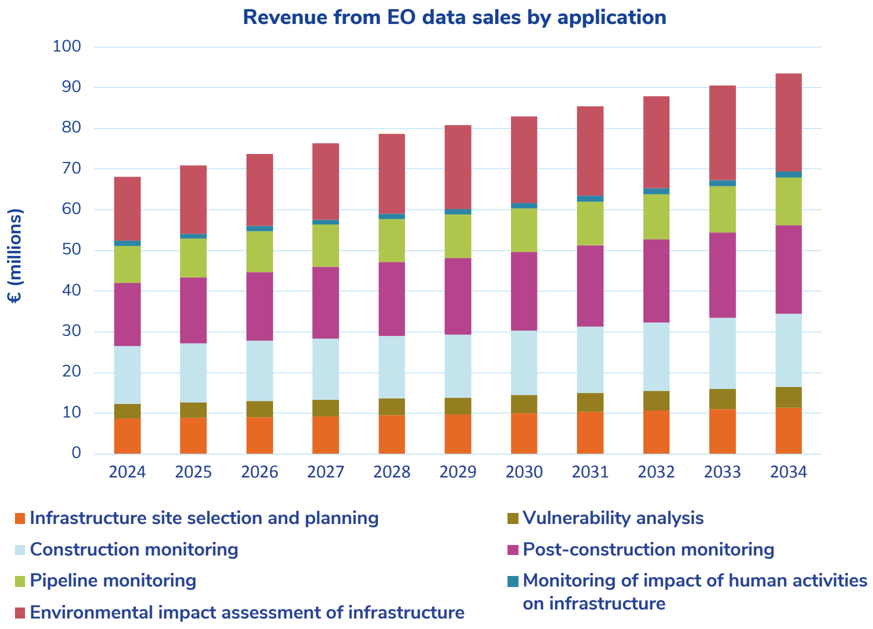

Installed base of GNSS devices by region
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean

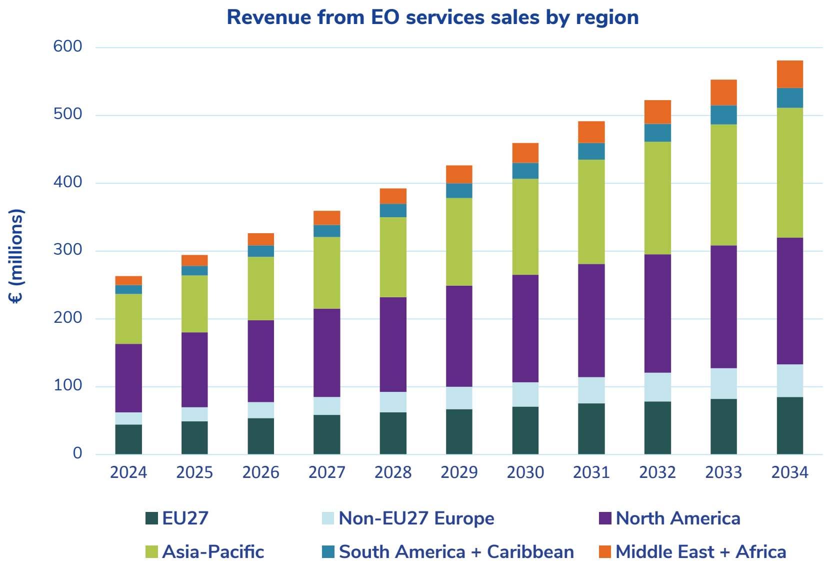

Installed base of GNSS devices by region
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Surveying
Timing & Synchronisation
Satellite Communication (SATCOM)
Professional Mobile Radio (PMR)
Digital Cellular Network (DCN)
Public Switched Telephone Network (PSTN)
Data Centre
Small Cells
DTV Broadcast
Post-Construction Monitoring
Construction Surveying

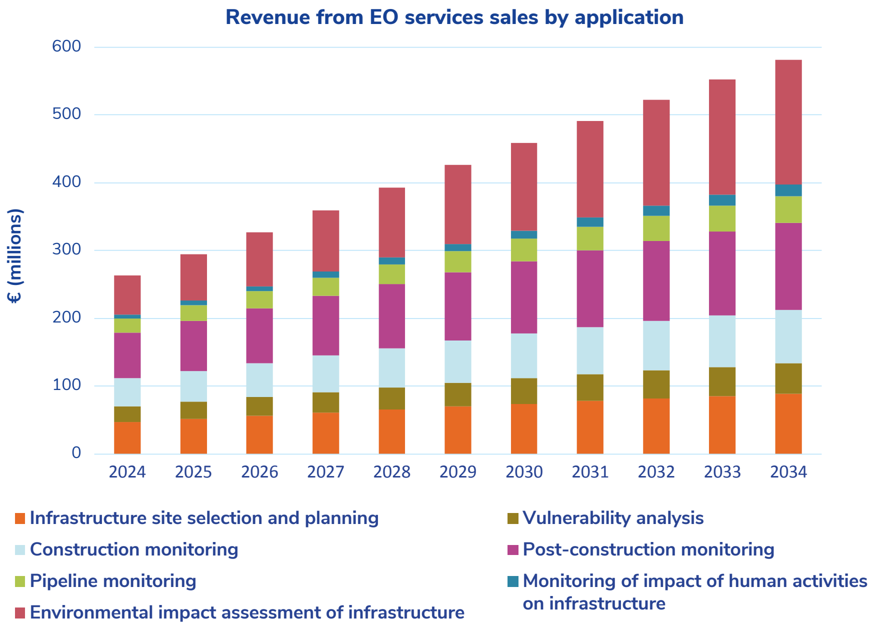

Revenue of GNSS device sales by region
5 600
4 800
4 000
3 200
2 400
1 600
800
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
5 600
4 800
4 000
2 000
1 500
1 000
500
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Surveying
Timing & Synchronisation
Satellite Communication (SATCOM)
Professional Mobile Radio (PMR)
Digital Cellular Network (DCN)
Public Switched Telephone Network (PSTN)
Data Centre
Small Cells
DTV Broadcast
Post-Construction Monitoring
Construction Surveying


Revenue from EO data sales by region
€ (millions)
100
90
80
70
60
50
40
30
20
10
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
100
90
80
70
60
50
40
30
20
10
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Infrastructure site selection and planning
Vulnerability analysis
Construction monitoring
Post-construction monitoring
Pipeline monitoring
Monitoring of impact of human activities on infrastructure
Environmental impact assessment of infrastructure


Revenue from EO services sales by region
€ (millions)
600
500
400
300
200
100
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO services sales by application
€ (millions)
600
500
400
300
200
100
0
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Infrastructure site selection and planning
Vulnerability analysis
Construction monitoring
Post-construction monitoring
Pipeline monitoring
Monitoring of impact of human activities on infrastructure
Environmental impact assessment of infrastructure

INSURANCE AND FINANCE

Finance

- Commodities trading
- Stock exchange transactions
- ESG reporting
- Bank transactions
- Risk assessment

Insurance for natural disasters

- Event footprint
- Risk modelling
- Index production

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

INSURANCE AND FINANCE

The **insurance and finance** market segment encompasses services and products provided and consumed by institutions and organisations in these domains, including insurers and reinsurers, as well as international and local financial institutions such as private and commercial banks, stock exchanges and trading entities.

Earth Observation (EO) plays an increasingly critical role in supporting insurance companies and financial institutions. In insurance, EO data is used for damage assessment and claims management (event footprint), calculation of indices for parametric products (index production) and modelling the likelihood and severity of weather events (risk modelling). In finance, EO supports risk screening for investments, monitoring production and shipping at key locations, and providing traders with insights to anticipate supply and demand for commodity markets. EO also underpins sustainable finance by delivering indicators for environmental, social and governance (ESG) reporting, helping assess both financial returns and broader impact.

In parallel, GNSS has become essential for operational integrity in financial markets. Secure timing solutions are critical for time-stamping transactions in banking and stock exchange environments, ensuring compliance with stringent regulations and supporting high-frequency trading. In insurance, GNSS is becoming increasingly relevant for the usage-based insurance (UBI) market, where insurers leverage advanced telematics and AI-powered data analytics platforms to shift from static actuarial models to dynamic,

Note: the sub-segment **insurance** is showcased with a **shield icon**, while the sub-segment **finance** is showcased with a **money bill icon**. . behaviour-driven risk frameworks.

What you will find in this chapter

- **Key trends:** Space technologies as strategic enablers for financial and insurance resilience.
- **Industry:** Insurance and finance value chains.
- **Recent developments:** Space technologies secure financial timing and drive the expansion of agro-insurance.
- **Future market evolution:** Satellite data enables smarter insurance pricing and commodity market decisions.
- **European systems and projects:** Satellite data enabling agile and transparent insurance and finance solutions.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

Space technologies as strategic enablers for financial and insurance resilience

Key market trends

- ESG risk management is transforming finance through space technologies, which enable objective data collection, precise asset geolocation and scenario-based risk assessments aligned with EBA guidelines.
- Insurance is undergoing a significant transformation driven by climate change, technological innovation, evolving customer expectations and shifting regulatory landscapes. Insurers are adapting to a more volatile and complex environment by rethinking traditional models.
- Financial institutions increasingly demand secure applications built on zero-trust, strengthened by OSNMA-authenticated GNSS timing and QKD-secured SATCOM channels.

EO technology becomes central to EU banks' ESG compliance strategies ahead of 2026 EBA Guidelines

Environmental, social and governance (ESG) reporting and risk management is reshaping financial decision-making by **integrating the identification, measurement and management of ESG risks into prudential processes**, regulatory frameworks and practices aimed at ensuring the stability of financial institutions.

The **European Banking Authority (EBA)** has issued final guidelines, effective January 2026 for large institutions and January 2027 for smaller ones, to set **minimum standards and methodologies for managing ESG risks within the prudential risk framework**. These requirements establish clear operational standards for institutions, requiring reliable, objective and auditable data sources to accurately assess and report risks.

EO can play a key role in helping financial institutions meet these guidelines by supporting several core application areas, including **materiality assessments, physical risk assessments, environmental indicators and monitoring, portfolio and scenario analysis**, and the development of **risk metrics and proxies**. EO supports objective environmental data collection enabling forward-looking, scenario-based risk analysis aligned with prudential requirements.

Concrete applications already demonstrate this potential. For materiality assessments, EO can support a range of applications; for example, it enables infrastructure vulnerability analysis through ground-motion monitoring, using Sentinel-1 InSAR data and the Copernicus Land Monitoring Service (CLMS) Ground Motion products. For physical risk assessment, EO contributes also to a wide range of applications,such as enabling flood monitoring through all-weather soil-moisture and flood-extent mapping based on Sentinel-1 data, complemented by flood-risk assessment capabilities provided by the Copernicus Emergency Management Service (CEMS) Global Flood Awareness System.

Overall, the integration of EO into ESG risk management is increasingly supporting the progress of banks towards compliance with the EBA ESG risk guidelines. By providing consistent, objective and auditable environmental information across multiple risk dimensions, EO strengthens the ability of institutions to identify, measure and manage ESG risks within prudential frameworks, while improving transparency, comparability and resilience in supervisory reporting.

Rising exposure to extreme weather events fuels demand for EO-enabled insurance risk modelling

The natural **catastrophe insurance market** is entering a period of significant expansion, projected to grow from over **€202 billion in 2025 to nearly €253 billion by 2030**. This growth is linked to both heightened exposure to natural hazards and the introduction of evolving regulatory requirements, notably under the **Solvency II framework** and related initiatives, which demand greater financial resilience and transparency. Underpinning this market shift is a fundamental change in risk modelling. Traditional insurance risk models relied heavily on historical data. However, accelerating climate change is increasingly altering these patterns, rendering past data increasingly unreliable. This is leading to a **shift towards EO technologies** to modernise natural catastrophe risk assessment. EO can enhance risk modelling by offering **consistent measurements of floods, wildfires, storms, land-use change and vegetation conditions**. In the context of **flood-risk modelling**, insurers increasingly combine climate data and projections from the Copernicus Climate Change Service (C3S), hydrological and flood-monitoring outputs from the Copernicus Emergency Management Service (CEMS), including EFAS and GloFAS, Copernicus flood-hazard maps, Sentinel satellite imagery, and Copernicus land-monitoring datasets. Integrating these datasets allows insurers to **refine hazard intensity, vulnerability and exposure assumptions**, improving underwriting, pricing and capital allocation for insurers. Insurance companies are increasingly adopting **EO-based solutions for** natural **catastrophe risk modelling**, enhancing hazard-assessment accuracy and strengthening underwriting, capital allocation and Solvency II reporting in an evolving climate-risk landscape.

Financial sector eyes space-based quantum communications to boost system resilience

The finance sector is experiencing a rapidly **increasing demand** for **secure applications** as the need for **robust, trustworthy digital infrastructures** continues to grow. In this context, **GNSS** combined with **OSNMA** provide authenticated timing data (see page 156 for further details on OSNMA implementation). At the same time, **long-term confidentiality requirements** imposed by regulations such as **GDPR** and **Solvency II** are becoming more stringent, driving the **adoption of advanced security solutions**. In response to these challenges, SATCOM integrated with **Quantum Key Distribution (QKD)** is emerging as a promising application for enabling quantum-safe key exchange in highly sensitive financial communications.QKD provides **physics-based security** with **forward secrecy**, supporting compliance with emerging EU quantum-safe actions such as the transition to post-quantum cryptography. Pairing QKD with SATCOM can further enhance resilience in financial operations, by enabling **ultra-secure, long-distance key distribution** via free-space optical links, crucial for protecting cross-border financial communications. Examples of the implementation of QKD include the **JPMorgan Chase research project**, conducted in partnership with Toshiba and Ciena, which demonstrated a **800 Gbps quantum-secured optical channel**, and proved it could securely support real-world applications such as blockchain transactions. While there are currently no full-scale commercial implementations on **QKD-SATCOM**, high-profile pilots and projects such as ESA's QKD/SAT trials show accelerating momentum toward deployment.

Insurance and Finance GNSS Value Chain[1]

GNSS

COMPONENT AND RECEIVER MANUFACTURERS

- ALBEDO TELECOM*
- BODET*
- ELPROMA*
- ENDRUN TECHNOLOGIES
- FURUNO
- GMV*
- GORGY TIMING*
- GUIDETECH
- HEXAGON AB
- VIAVI SOLUTIONS
- MASMEINBERG*
- MICROCHIP TECHNOLOGY
- OSCILLOQUARTZ*
- SAFRAN*
- STMICROELECTRONICS*
- TALLYSMAN WIRELESS
- TRIMBLE
- U-BLOX*
- TERCLOCK

DEVICE MANUFACTURERS

- ARBITER
- CHRONOS TECHNOLOGY*
- ELPROMA*
- ENDRUN
- GORGY TIMING*
- JACKSON LABS
- MASTERCLOCK
- MEINBERG*
- MICROCHIP
- OSCILLOQUARTZ*
- SAFRAN*

SYSTEM INTEGRATORS
DESIGN CONSULTANCIES
TESTING & MAINTENANCE

- CHRONOS TECHNOLOGY*
- COMTECH DATA
- IBM
- SAFRAN*

NETWORK OPERATORS

- BANKS AND STOCK EXCHANGES

LEGEND

Commercial offering
Public offering / entities
User segments

European[2] GNSS industry in the global arena

GNSS receivers in insurance and finance are used for T&S applications, including networks using GNSS time and NTP and PTP servers. Europe holds the largest share of GNSS components/receivers in T&S due to stringent regulations and dense financial hubs like Frankfurt.

NOTES

1 The value chain considers the key global and European companies involved in GNSS downstream activities.

2 In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider

Insurance and Finance EO Value Chain[1]

EO

DATA PROVIDERS

- ACCUWEATHER INC
- AIRBUS*
- ATOS*
- BLACKSKY
- CAPELLA SPACE
- GEOSAT*
- E-GEOS*
- ICEYE*
- PLANET
- SPIRE GLOBAL
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- NISAR (NASA/ISRO)
- NOAA and GOES (NOAA)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- ATOS*
- CLEOS*
- CREODIAS*
- GOOGLE EARTH ENGINE
- ICEYE*
- SENTINEL HUB (PLANET)
- TERRADUE*
- UP42*
- VERISK ANALYTICS
- VITO*

- COPERNICUS DATA SPACE ECOSYSTEM (CDSE)*
- GEOHAZARDS TEP*
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

Insurance & Finance:
- EARTH DAILY ANALYTICS
- GEOVILLE*
- VITO*

Insurance:
- GAF*
- LUXCARTA*
- SKYTEK*

Finance:
- AGTUALL*
- KAYRROS*
- SATELLIGENCE*
- SPACEKNOW

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*

INFORMATION PROVIDERS

Insurance & Finance:
- ACCLIMATISE*
- ACCUWEATHER
- EARTHLAB AI SYSTEMS*
- ECOMETRICA*
- STORMGEO*
- VERISK ANALYTICS

Insurance:
- GREEN TRIANGLE*
- VERISK ANALYTICS
- DESCARTES LABS
- **Finance:**
- ASSET RESOLUTION*
- CHAI*
- FLINTPRO
- GEOSPATIAL FINANCIAL HUB*

Financial information providers:
- BLOOMBERG
- LONDON STOCK EXCHANGE GROUP
- MOODY
- REUTERS
- S&P GLOBAL

END USERS

COMMERCIAL/INVESTMENT

BANKS
- RE/INSURANCE SECTOR
- AIG
- ALLIANZ*
- AXA*
- GENERALI*
- GUY CARPENTER
- MUNICH RE*
- SWISS RE*
- WILLIS TOWERS WATSON*

FINANCIAL INSTITUTIONS
- BANKS
- INVESTMENT FUNDS & ASSET
- MANAGERS
- PRIVATE EQUITY FIRMS

INTERNATIONAL DEVELOPMENT ORGANISATIONS
- AFRICAN DEVELOPMENT BANK
- ASIAN DEVELOPMENT BANK
- EUROPEAN BANK OF
- RECONSTRUCTION AND
- DEVELOPMENT*
- EUROPEAN INVESTMENT BANK*
- INTER-AMERICAN DEVELOPMENT
- BANK
- WORLD BANK

TRADING COMPANIES

NOTES

1: The value chain considers the key global and European companies involved in EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the EO value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

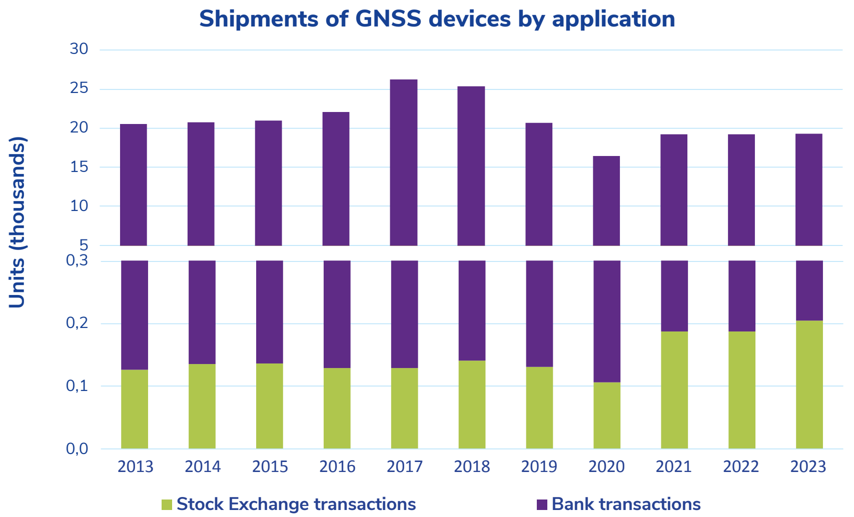
European[2] EO industry in the global arena

Europe holds a dominant position in the EO market for insurance and finance, capturing a significant share of the segment's total value. In comparison, North American companies represent roughly a quarter of the market. Among Europe's leading players, Airbus stands out as the primary frontrunner, followed by ICEYE and Kayrros.

LEGEND

- Commercial offering
- Public offering
- User segments

Space technologies secure financial timing and drive the expansion of agro-insurance



Shipments of GNSS-enabled devices in the finance and insurance segment show a **shift in application trends** between 2013 and 2023. Bank transaction applications have historically dominated shipment volumes, peaking at around 26,000 units in 2017 before declining and stabilising at nearly 20,000 units. This pattern reflects a **transition to a mature replacement-driven market** in which most major financial institutions already operate advanced, GNSS-based timing infrastructures for critical functions.

While traditional banking remains the largest application, a **shift in growth dynamics** has taken place in recent years with regards to shipments related to **stock exchange operations**. Following a temporary dip in 2020, exchange-related deployments accelerated significantly from 2021 onward, reaching their highest levels in 2023. This growth has been driven by more stringent regulatory requirements for precise time-stamping and synchronisation under frameworks such as **MiFID II**, together with the rising need for resilience and timing accuracy in high-frequency trading.

As a result, stock exchanges increasingly invest in advanced GNSS-based timing infrastructures to secure-deterministic time sources, minimise latency and enhance overall operational integrity.

Over the full period, **stock exchange-related shipments achieved an estimated CAGR of around 7.9%**, highlighting their strong upward trajectory.

Securing financial timing

In the finance sector, **highly accurate timing is not merely a utility but a competitive advantage**. This is especially true for high-frequency trading (HFT), where software processes streams of market data to execute buy/sell decisions in milliseconds, meaning precise timing can translate directly into financial gains. Beyond competition, precise timing is also a **regulatory obligation**. **Accurate timestamps** are required to ensure market integrity and transparency. Regulatory bodies impose fines for non-compliance, or evidence of timing-related fraud, under EU frameworks such **as MiFID II/MiFIR*, CSDR*** and **EMIR***.

Financial institutions and banking systems rely heavily on GNSS for highly accurate timing and synchronisation (T&S), which underpins core functions such as **transaction timestamping, electronic trading, network synchronisation and payment clearing**. False or spoofed GNSS signals can disrupt these time-dependent processes, causing financial losses, regulatory risks and operational instability.

Galileo OSNMA, the first global civil GNSS authentication service, embeds a cryptographic digital signature in the Galileo navigation messages, enabling GNSS receivers to verify that the positioning and timing data come from Galileo satellites and have not been tampered with or spoofed. This provides a crucial layer of data authentication, protecting financial systems from the risk of spoofed timing signals, reinforcing trust in GNSS-based T&S.

Leading GNSS timing solution providers are integrating this technology. Companies like Furuno and Meinberg, alongside Adtran's Oscilloquartz division, are among the first to support OSNMA. Adoption of authenticated GNSS timing solutions is accelerating, as financial institutions integrate OSNMA-enabled architectures to strengthen resilience and regulatory compliance in systemically important market infrastructures.

* MiFID/R – Markets in Financial Instruments Directive/Regulation
**CSDR – Central Securities Depositories Regulation
***EMIR – European Market Infrastructure Regulation

Agro-insurance uncovers new needs

The **global agricultural insurance market** was valued at **around €39.5 billion**, with Europe accounting for over 30%, or around €11.85bn in 2024. The market is projected to grow at a **4.5% CAGR up to 2031**, a trend driven by a convergence of factors, including rising awareness of climate-related risks, increased government support such as the EU's Common Agricultural Policy (CAP), which encompasses a wide range of measures for farmers and rural areas, and the growing financial strain on farmers. The market reflects a **shift towards risk mitigation and resilience in the face of environmental uncertainty**.

Increasing **frequency and severity of adverse events**, greater **yield volatility**, and **geopolitical shocks** affecting input and output of prices are significantly increasing the demand for robust insurance products. To meet this demand and manage risk effectively, insurers are leveraging **space data to specialise agro-insurance products**, enabling accurate, real-time monitoring of crop health, soil moisture and environmental conditions. These technologies enable precise risk assessment and the design **of customised insurance solutions, which is a major driver of market expansion**.

EO data provides verifiable triggers for parametric insurance, moving away from complexity indemnity-based claim processes. For example, AXA Climate developed parametric insurance solutions for wildfires, responding to the increasing frequency and severity of such events (see page 138). These solutions use satellite imagery to map burned areas and assess fire impact, automatically triggering payouts based on pre-defined parameters. This approach enables more timely, transparent compensation and supports rapid financial recovery.

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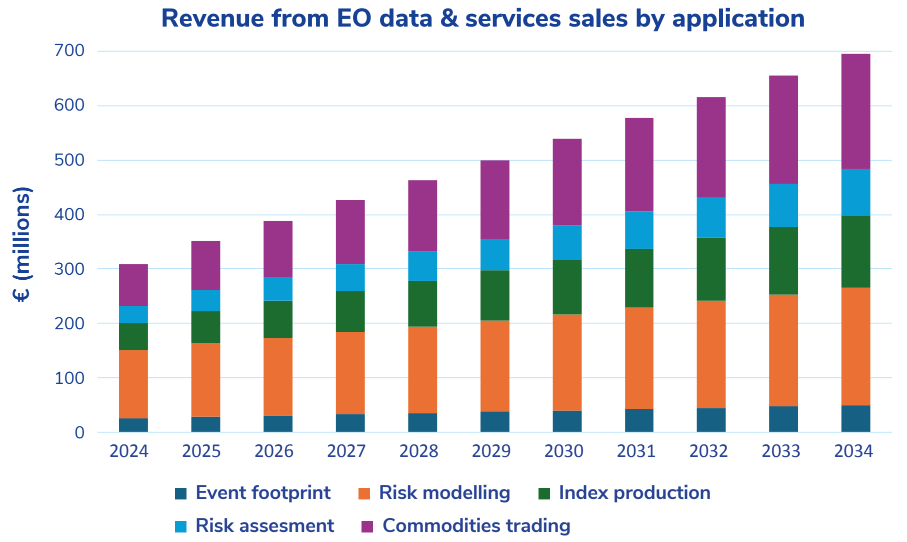
Satellite data will enable smarter insurance pricing and commodity market decisions



Eyes on the economy: How Earth Observation is reshaping commodity trading

EO data is increasingly integrated into commodity trading algorithms to provide real-time insights into environmental factors that directly influence commodity supply and prices. This capability moves market analysis beyond traditional data streams, offering enhanced clarity and competitive advantage.

Satellite imagery and derived analytics, such as NDVI for crop health and yield estimation, change detection of harvest progress, object counting for stockpiles at ports or silos, and SAR for oil storage levels or refinery activity, provide independent confirmation of commodity data. This information can be integrated into models to forecast supply surpluses or shortages. Examples of this operational intelligence include agricultural yield forecasting, supply chain resilience and inventory quantification through 3D models.

Beyond climate risk assessment EO can be used to **monitor economic activity and detect changes** in specific regions. This broader use of EO involves tracking physical indicators of economic development (e.g. infrastructure development, mining extraction activities). These serve as **economic indicators**, providing an earlier and more granular view of fundamental supply-side shifts than conventional reports. In addition, EO can also be used for **change detection**, which identifies landscape alterations that signal new economic developments (e.g. new factories, expanded farmland). These changes serve as **early warnings of economic shifts** that can impact commodity prices.

The utility of EO for economic activity monitoring has been validated at the institutional level, as demonstrated by the **European Central Bank (ECB)**, The ECB project successfully showcased how EO data could substantially improve commodity trading models by providing enhanced, timely, and granular insights into the regional economic activities that directly influence market dynamics (see more information on page 158).

The **insurance and finance segment is projected to experience strong growth**. An important driver of this growth is the increasing demand for risk modelling solutions. Risk modelling is the dominant application, accounting for the largest share of revenues. This application relies heavily on EO data. The ability to integrate high-resolution satellite data and advanced analytics into predictive models enhances decision-making and supports regulatory compliance, making EO-based risk tools, including **risk assessment**, essential for the sector's digital transformation and resilience planning.

When analysing closely the applications in scope within the segment, **commodities trading** is foreseen to yield the greatest CAGR of more than 13% between 2024 and 2034, reaching a total revenue of around €212 million. This growth is driven by the increasing reliance on EO-based analytics in commodities trading, as market participants progressively depend on timely insights into weather, production conditions and logistics to enhance risk management strategies and optimise hedging decisions.

Finally, **event footprint** and index production EO-enabled insurance applications are also growing progressively in both breadth and volume, driven by climate-related risk evolution.

GNSS-powered telematics transforming insurance pricing

The usage-based insurance (UBI) market is expanding rapidly, reaching €30.31 billion in 2025 as GNSS and telematics shift insurers from static actuarial models towards **real-time behavioural analytics**. Recent EU regulations (**Data Act, EDR, Solvency II** updates) accelerate this transition by widening access to vehicle data and reinforcing the move toward data-driven pricing.

GNSS-embedded telematics systems provide precise position and timing data, allowing insurers to analyse speed, acceleration and driving patterns. By combining these insights with AI-driven analytics, insurers can move towards **behaviour-driven risk frameworks**. With **UBI expanding into new sectors**, insurers can create **personalised products**.

While the use of UBI originated in automotive insurance, (see the Road and Automotive segment) its principles now extend to other sectors, such as robotics and health insurance, through wearables. Europe holds a **strong market share of more than 26%** due to regulatory mandates like the EU's event-data recorder requirement (UN Regulation No 169).

Beyond the farm: satellite-driven parametric insurance for a changing climate

The global parametric insurance market, which was valued at **€16.2 billion in 2024**, is set to grow as **parametric products expand beyond agriculture** to broader natural catastrophe and emerging risks. Space-derived analytics have the potential to **power new finance instruments directly tied to measurable indices** for natural disaster severity, agricultural productivity and infrastructure health. Technology-based risk evaluation is accelerating this shift. Insurers increasingly use satellite imagery, IoT and AI to improve payout accuracy, meaning that insurance payouts more closely reflect actual losses experienced by policyholders, and monitor hazard parameters such as rainfall, wind intensity or vegetation stress to design index triggers with greater precision and lower basis risk.

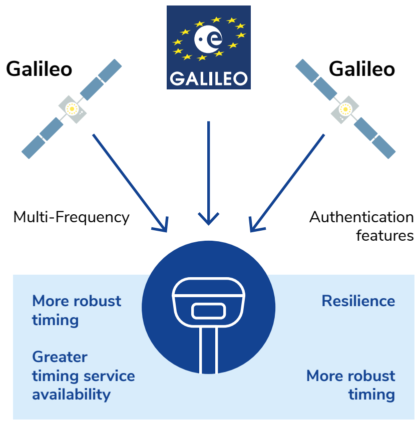
The integration of space data can also enhance **automation and transparency** across the insurance lifecycle. For instance, **AXA Climate** enables quick payouts for climate change and natural disaster risks, with automated claims processing often triggered by third parties using space-based information. Similarly, **Swiss Re** provides advanced parametric solutions for weather and catastrophe risks, relying not only on satellite monitoring support but also blockchain technology to secure and automate the execution of smart insurance contracts.

Satellite data enabling agile and transparent insurance and finance solutions

Current and future use of Copernicus

Copernicus EO data is increasingly embedded in insurance and finance workflows, with **Sentinel** imagery and the **Copernicus Data Space Ecosystem** enabling rapid damage assessment after floods, wildfires and storms for claims processing and parametric insurance products, while the **Climate Change Service (C3S)** and **ERA5 reanalysis** support long-term risk modelling, crop yield forecasting and ESG compliance under Solvency II and EU Green Deal requirements.

Looking ahead, Copernicus could enable more automated applications, such as portfolio stress-testing for banks and reinsurers, and geospatial indices for commodity trading and mortgage valuation, with seamless integration of high-resolution data into operational decision-support systems via the Data Space Ecosystem.

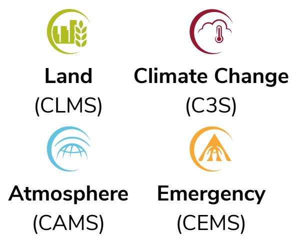


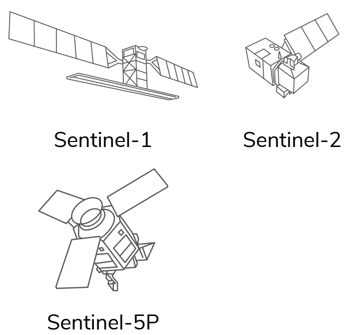
Enhancing climate risk assessment with Copernicus data

To meet **new Italian requirements*** mandating insurance coverage for natural disasters, **Vittoria Assicurazioni** partnered with **EUSPA** and **Eoliann** to enhance its climate-risk underwriting. The proof of concept (PoC) explored how **Copernicus climate data**, accessed via the **Copernicus Climate Data** Store and combined with **AI-based analytics**, could provide more accurate, asset-level insights into flood exposure, strengthening the insurer's risk assessment capabilities.

The PoC delivered a user-friendly tool that combines Copernicus climate data, historical flood events and forward-looking scenarios to generate a **0–10 flood risk index** for each property. Its three modules - **location exposure, vulnerability assessment and projections to 2050** - offer both high granularity and frequent updates. Compared to existing tools, the PoC solution achieved **broader coverage, finer resolution, more frequent map updates** and **higher accuracy** in identifying past flood events (**78% vs 67%**).

With these improvements, the PoC demonstrated clear benefits in **underwriting speed, precision and regulatory compliance**.





Horizon Europe, a programme of the European Union

Leveraging Copernicus data for ESG reporting and environmental risk assessment

As companies face **growing regulatory pressure** to demonstrate sustainability and resilience, **ESG reporting** has become essential for maintaining competitiveness and attracting investment. New frameworks now require organsations to disclose **consistent, detailed information** on environmental risks and performance, creating both challenges for compliance and opportunities for improved transparency and long-term value.

To support these needs, **Copernicus** provides high-quality satellite and in-situ data that help organisations assess environmental conditions with objectivity and precision. Building on these capabilities, **EUSPA** and **CGI IT Czech Republic** jointly developed the **ESG Zoning Tool**, which uses **Copernicus data** to evaluate **double materiality**, assessing both environmental risks affecting an area of interest and the impacts that area has on its surroundings.

Designed to align with **European Sustainability Reporting Standards (ESRS) requirements**, the tool is particularly relevant for financial institutions, which face increasing obligations under ESG and sustainability reporting frameworks. The ESG Zoning Tool was demonstrated with Czech banks acting as end users, including Raiffeisenbank, **Komerční banka, ČSOB** and **MONETA Money Bank**.

By supporting applications, such as natural hazard exposure analysis, impact monitoring and ESRS-aligned corporate reporting, the tool helps banks identify and manage environmental risks within their portfolios, strengthen risk management practices and respond to investor and regulatory expectations. With both granular indicator views and broader zone-level assessments, it equips organisations with **actionable insights** for environmental oversight and to meet emerging sustainability expectations.

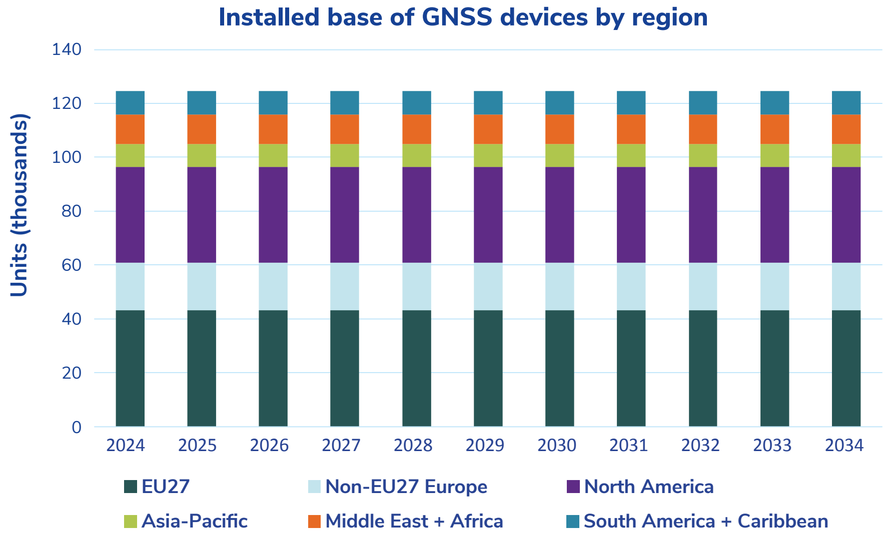
Demonstrating the value of EO data for monitoring economic development

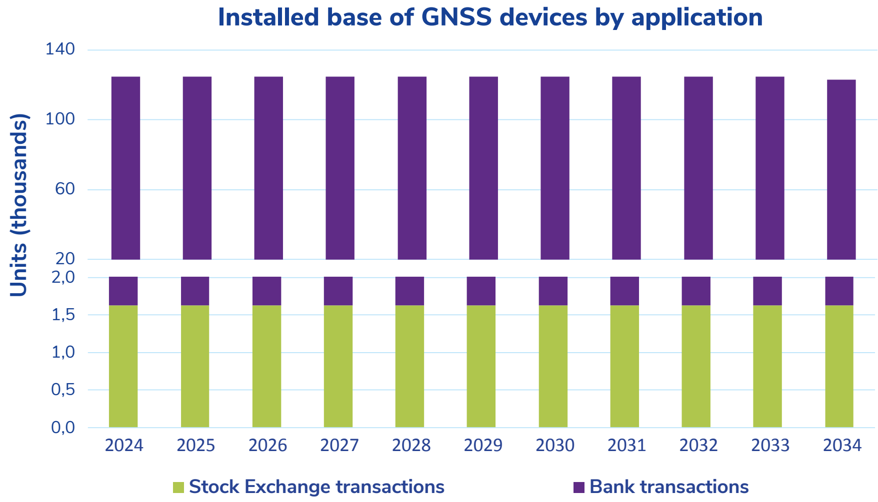
The European Central Bank (ECB) closely tracks economic developments to maintain price stability and safeguard financial stability across the euro area. Traditional indicators, such as inflation, GDP, employment and financial market trends, help the ECB assess whether the economy is expanding, cooling or facing emerging risks. However, these indicators often rely on surveys or national accounts that can be subject to reporting delays. To complement these sources, the ECB explored whether EO and Copernicus satellite data could provide faster, objective insights into economic activity.

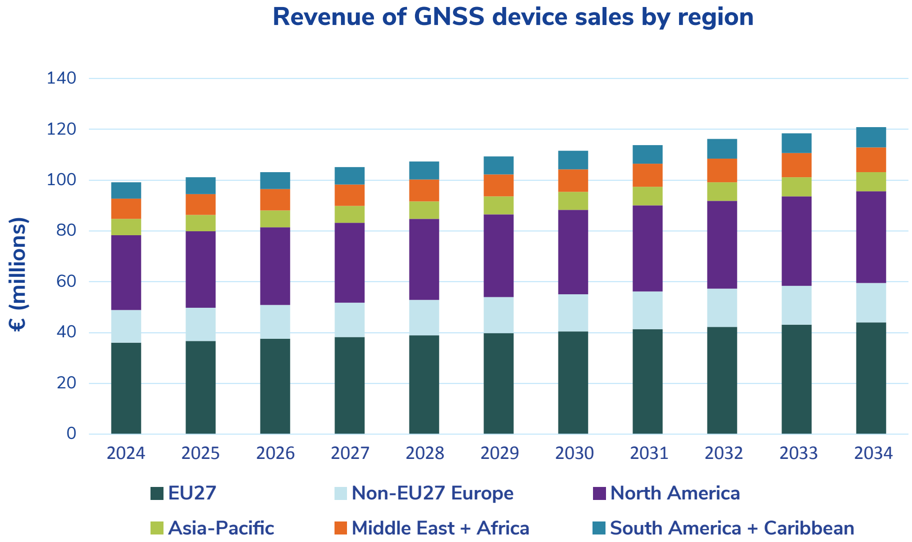
Within an EUSPA-supported proof of concept (PoC), the ECB tested the use of EO data for tracking economic development. The initiative focused on construction activity, an early signal of investment and growth, by analysing satellite imagery around Iasi, Romania. Using Sentinel-2 data and vegetation indices, areas where land changed from vegetated to persistent bare ground were identified, indicating potential construction activity.

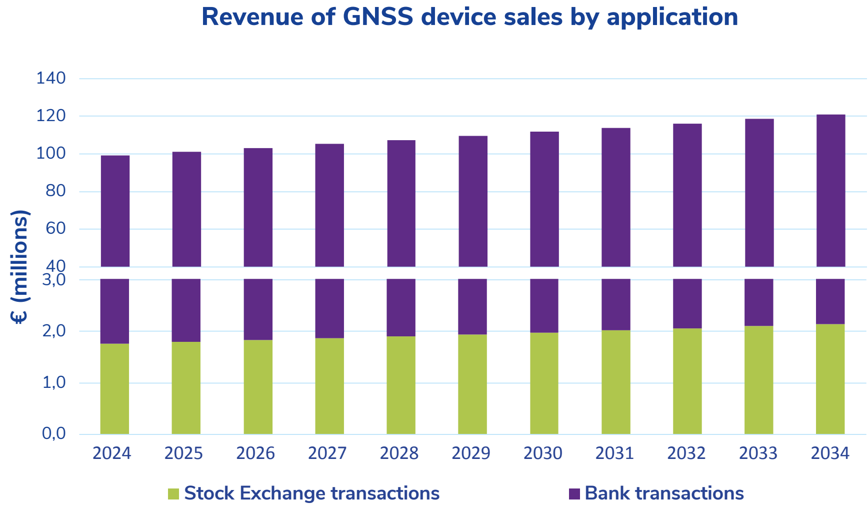
The PoC demonstrated that EO data can reveal economic patterns earlier than many traditional statistics. The results showed how satellite-based monitoring can serve as a complementary and independent data source, helping validate official reports. The ECB now plans to further refine these methods and assess their application across larger regions.

*Italian Budget Law 2024 (law n.213/2023)
Terminology used on this page is explained in Annex 2 for both GNSS and EO performance parameters.

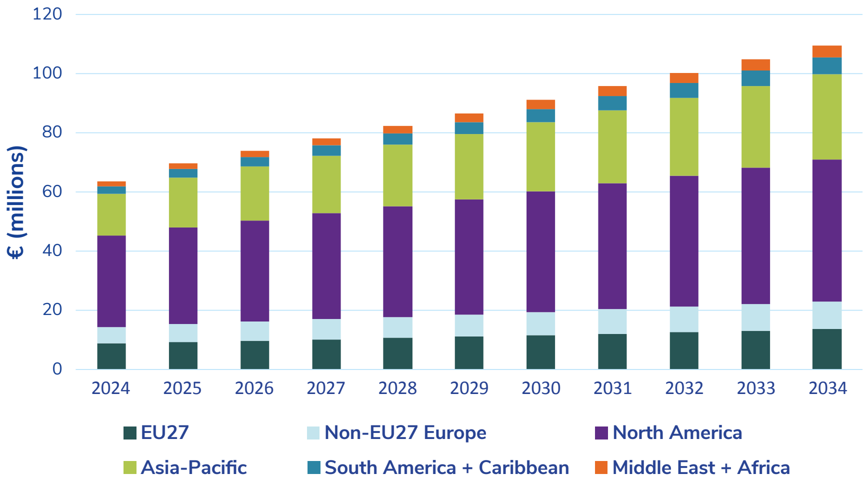

Installed base of GNSS devices by region
Units (thousands)
0
20
40
60
80
100
120
140
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Installed base of GNSS devices by application
Units (thousands)
0,0
0,5
1,0
1,5
2,0
20
60
100
140
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Stock Exchange transactions
Bank transactions

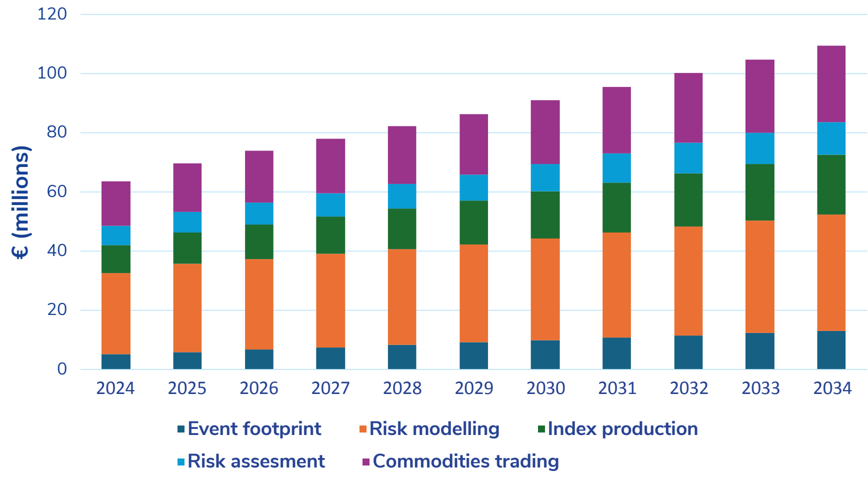

Revenue of GNSS device sales by region
€ (millions)
0
20
40
60
80
100
120
140
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
€ (millions)
0,0
1,0
2,0
3,0
40
60
80
100
120
140
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Stock Exchange transactions
Bank transactions

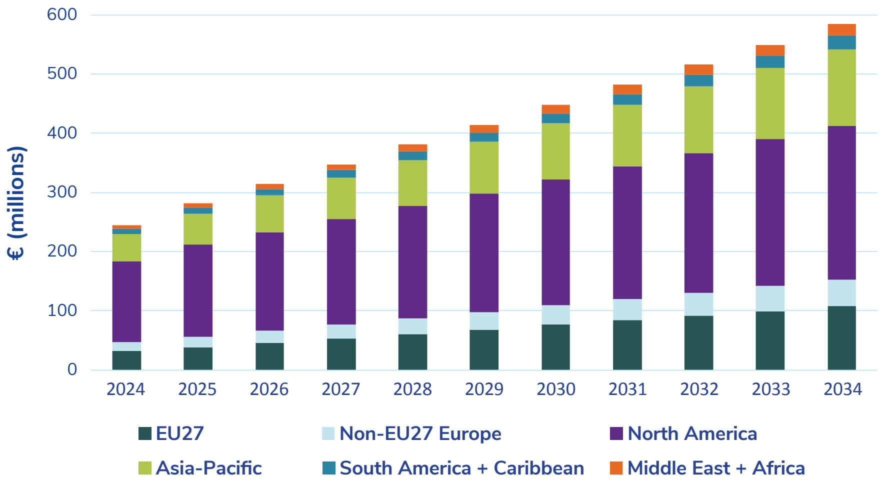
Revenue from EO data sales by region



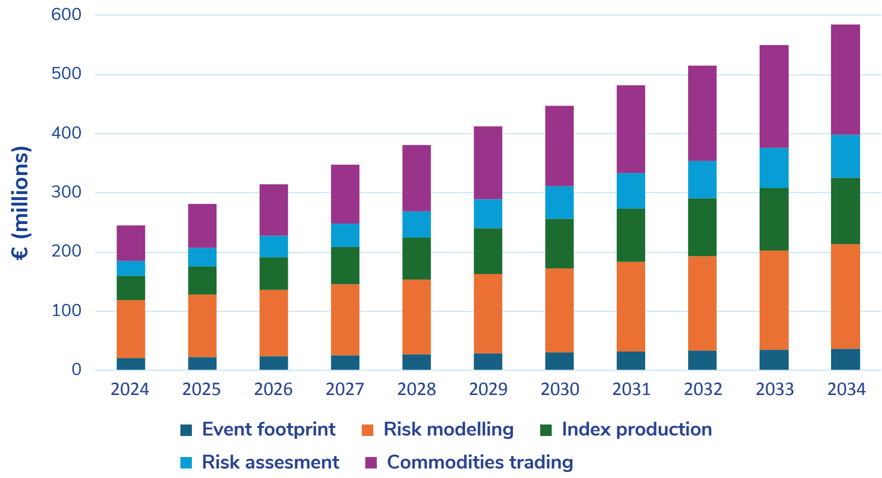
Revenue from EO data sales by application



Revenue from EO services sales by region



Revenue from EO services sales by application



MARITIME AND INLAND WATERWAYS

Inland waterways
- Autonomous surface vessels
- GNSS vessel engine management system
- Inland waterways navigation
- Traffic management (AIS, VDES)

Maritime engineering
- Dredging
- Marine surveying and mapping

Merchant vessels
- GNSS vessel engine management system
- Maritime autonomous surface ships
- Merchant navigation
- Ship route optimisation including Navigation through sea ice
- Traffic management (AIS, VDES)

1: (incl. Port-based Port navigation devices, PPUs and Vessel docking).

Application descriptions can be found in Annex 3.

Ocean and environmental monitoring
- Marine pollution monitoring
- Ocean monitoring buoys

Port
- Automated port operations
- Pilotage and docking[1]
- Port safety
- Port security

Recreational craft
- Recreational navigation

Vessel tracking
- Vessel monitoring

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

MARITIME AND INLAND WATERWAYS

Maritime transport is increasingly steered from space. GNSS, EO and Secure SATCOM are part of everyday infrastructure for ships, ports and coastal authorities. They guide vessels along more efficient routes, cut fuel burn and emissions, and help protect sensitive ecosystems by steering traffic away from high-risk areas. The same data feed into surveillance and monitoring systems that strengthen port security and raise safety standards for crews and passengers.

These space-based services are also the foundation for the next wave of innovation at sea. High-accuracy GNSS, authenticated navigation signals, EO-driven corridor awareness and Secure SATCOM links are key building blocks for autonomous and semi-autonomous vessels, advanced collision-avoidance systems, maritime digital twins and just-in-time operations. Together, they make it possible to maintain – and progressively enhance – the safety and reliability of today's fully manned, instrument-heavy bridges.

A wide range of users benefit from this shift: vessel operators optimising routes and maintenance; port authorities managing traffic and emissions; environmental agencies monitoring pollution and ecosystems; and recreational boaters navigating more safely. Across all these communities, satellite-based information improves situational awareness and decision-making, while enabling more efficient, secure and financially sustainable maritime operations.

Cross-reference: *GNSS-enabled search and rescue beacons, while used in this market segment, are presented and quantified in the Emergency Management and Humanitarian Aid market segment.*

What you will find in this chapter

- **Key trends:** Maritime tech revolution driven by sustainability and autonomous operations.
- **Industry:** Maritime and inland waterways value chains.
- **Recent developments:** Scaling GNSS for safer seas: strong GNSS growth led by leisure and inland applications.
- **Future market evolution:** Earth Observation is steering the future of maritime transport.
- **European systems and projects:** European space systems and services supporting modern maritime operations.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now features the estimation of the market for Ocean Monitoring Buoys. It also relies on an improved methodology for the estimation of EO service revenues.

The maritime tech revolution is driven by sustainability and autonomous operations

Key market trends

- Space-based monitoring is a key tool for maritime pollution control to comply with the latest maritime regulations and policies.
- The recent update of the EU River Information Services Directive recommends using GNSS and EO technologies.
- GNSS, Secure SATCOM and EO play an essential role in preparation of the MASS Code, becoming key enablers.
- The VHF Data Exchange System (VDES) becomes a backbone of e-Navigation, addressing limits of AIS and opens the door for authenticated positioning information.

Space-based monitoring is a key tool for maritime decarbonisation

Maritime transport is under growing pressure to decarbonise, cutting both fuel consumption and greenhouse gas emissions. Space-based solutions have become key enablers of this shift, providing the data backbone for smarter and cleaner operations.

The IMO 2023 **GHG Strategy targets net-zero emissions for international shipping by 2050, with a 40% reduction in carbon intensity by 2030** and a 70–80% cut in absolute GHG emissions by 2040. As alternative fuels and new propulsion technologies will take time to scale, shipowners and operators must act now, relying on operational efficiency measures that can be rolled out quickly and across entire fleets.

In this context, **EO-based routing systems** combine information on currents, wind, waves and sea ice with AI-driven analytics on EO and metocean data to enable least-CO_2 routing and dynamic speed optimisation for just-in-time arrivals.

In practice, such tools already deliver **fuel savings of around 5–15%, cutting emissions and operating costs**. EO also supports monitoring and verification for green corridors and alternative fuel deployment, increasing transparency and credibility along decarbonisation pathways.

Concrete examples include the Copernicus Marine Service providing ocean and ice data for routing tools, such as OCEANiCS, the Pacific Green Corridor initiative led by CMCC using Copernicus data for least-CO_2 routing in the North Pacific, or ESA's OCEAN-BULLETIN-GDSC offering high-resolution current forecasts for the Singapore–Rotterdam green corridor. These are just a few examples that show how satellite-based services are becoming key to support low-carbon maritime operations.

Robust space technologies support the RIS Directive update for inland waterways

Inland waterways (IWW) are a key part of Europe's transport network, and their safe, efficient and sustainable operation increasingly relies on robust digital and space-based solutions. River Information Services (RIS) provide harmonised information for traffic and transport management, including navigation data, voyage planning, traffic information, lock and bridge status, and electronic reporting between vessels and authorities.

To support this, the **EU amended the Directive on harmonised RIS in 2025** (Directive (EU) 2025/2482). It mandates core technologies and services such as vessel tracking and tracing or electronic reporting, to improve safety, efficiency, environmental performance and interoperability. The Directive's aim is to accelerate and harmonise RIS deployment across Member States and to better integrate with wider logistics systems for multimodal transport. A key innovation in the **Directive is a new Article 6 on "satellite positioning"**, which recommends using satellite positioning by Galileo (incl. the High Accuracy Service and Open Service Navigation Message Authentication) and the EGNOS for applications requiring exact positioning. It also **recommends Copernicus data, information and services for RIS applications relying on EO**. While not explicitly named, SATCOM are expected to enable RIS data flows, vessel–shore connectivity, real-time infrastructure monitoring and integration in the wider digital transport ecosystem.

Essential role of GNSS, SATCOM and EO in market preparations for the MASS Code

Maritime transport is entering a new phase of automation as the IMO Maritime Safety Committee advances the **Maritime Autonomous Surface Ships (MASS)** Code, with a non-mandatory version expected in 2026 and **mandatory adoption by 1 July 2030**. The industry is shifting from pilots to concepts that can be certified and deployed at scale. It is focusing on 'corridor-first' services such as short-sea shuttles, ferries and inland routes, where traffic is predictable and procedures repeat. Operators are investing in remote operations centres, new roles (remote watchkeepers, autonomy engineers) and upgraded port and traffic systems so that MASS can integrate into existing flows. In parallel, shipyards and technology providers are developing **safety cases for different automation levels**. The MASS Code will also lead to **new business models** in the industry.

Space-based technologies are key enablers for reliable and scalable autonomous operations. **High-integrity GNSS** is the reference for position, speed and timing, and is being placed at the core of navigation architectures in newbuilds and retrofits. Secure SATCOM provides the main communications channel beyond coastal coverage, carrying remote control, telemetry and high-volume data, with growing capacity and cyber-secure services complemented by coastal and port connectivity. EO adds corridor- and port-scale intelligence, providing long-term insights on traffic patterns, hazards and environmental constraints that can be built into MASS route planning, simulation and safety cases. Together, these space-based services are not just generic tools for maritime users, but core enablers of certifiable, scalable MASS operations under the new Code.

VDES as the digital backbone of e-Navigation

The VHF Data Exchange System (VDES) is emerging as the digital backbone of e-Navigation, **addressing the bandwidth and security limits of the Automatic Identification System (AIS)**. Unlike AIS, VDES integrates terrestrial and satellite channels in a single standardised framework, enabling higher-capacity, authenticated ship-to-ship and ship-to-shore communications. This supports real-time route sharing, maritime safety information, weather and water-level updates, and just-in-time port coordination, including beyond coastal coverage. **The regulatory and technical basis is advancing fast**: ITU-R M.2092 defines the spectrum and system structure and IALA has issued guidance on architecture and authentication. In parallel, IMO is advancing SOLAS amendments that could make VDES carriage mandatory by 2028, alongside the development of performance and test standards. Together, these steps position VDES as a core enabler of the IMO e-Navigation strategy, providing cyber-secure, resilient links for safety-critical operations.

Space technologies are essential for these developments. Operators such as Sternula and the AOS consortium have demonstrated two-way VDES-SAT services, extending coverage globally and enabling secure messaging beyond coastal zones. Trials in the Baltic and North Sea have shown VDES for route exchange and digital ship reporting, In parallel, integration with **Galileo OSNMA** can add **authentication** to increase robustness of **vessel navigation** and **position reporting**. Overall, VDES underpins smarter traffic management, reduced congestion and more predictable port calls.

GNSS and EO Maritime and Inland Waterways Value Chains[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- E-GEOS*
- GEOSAT*
- HAWKEYE 360
- ICEYE*
- KLEOS SPACE*
- PLANET
- SPIRE GLOBAL
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- COSMO-SkyMed (ASI)*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- NISAR (NASA/ISRO)
- NOAA and GOES (NOAA)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- CREODIAS*
- EDS CEODE
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- NORTH.IO*
- OPEN DATA CUBE
- OPENEO*
- SENTINEL-HUB* (PLANET)
- UP42*

- EMODnet*
- COASTAL TEP
- CODE DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- NOAA ONESTOP (NOAA)
- WEKEO*

EO PRODUCTS AND SERVICE PROVIDERS

- ACRI*
- AIRBUS SE*
- BMT ARGOSS*
- BERRING DATA COLLECTIVE*
- CLS*
- DESCARTES LABS
- E-GEOS*
- EODC
- EOMAP*
- GMV*
- INDRA SISTEMAS*
- KSAT*
- PIESAT
- RHETICUS (PLANETEK)*
- STORMGEO*
- VANTOR
- VITO*

- COPERNICUS MARINE SERVICE (CMEMS)*
- COPERNICUS SECURITY SERVICE (CSS)*

INFORMATION PROVIDERS

COASTAL AND MARITIME EXPLOITATION AND PRESERVATION:
- BROCKMANN CONSULT*
- EOMAP*
- GEOOPTICS

SHIPPING AND MARITIME TRANSPORT:
- C-MAP
- DNV*
- EOMAP*
- ESRI UK*
- GLOBAL MARITIME*
- OCEANROUTE
- SAT-OCEAN
- STORMGEO

DATA ANALYTICS COMPANIES

END USERS

- PORT AUTHORITIES
- SHIP OPERATORS
- SURVEILLANCE AUTHORITIES (both national and international)

GNSS

MARITIME ORGANISATIONS

- **CIRM** (International Association for Marine Electronics Companies)
- **EMSA** (European Maritime Safety Agency)
- **IALA** (International Association of Marine Aids to Navigation and Lighthouse Authorities)
- **IAPH** (International Association of Ports and Harbors) and ESPO (European Sea Ports Organisation)
- **ICS** (International Chamber of Shipping) and BIMCO (Baltic and International Maritime Council)
- **IMO** (International Maritime Organisation)
- **IMPA** (International Maritime Pilots' Association) **and EMPA** (European Maritime Pilots' Association)
- Mercator Ocean Internation

COMPONENT AND RECEIVER MANUFACTURERS

- ANALOG DEVICES
- BEIJER ELECTRONICS*
- BEIJING BDSTAR NAVIGATION
- BEIJING UNISTRONG SCIENCE &TECHNOLOGY
- CHCNAV
- COBHAM*
- COBRA ELECTRONICS
- FURUNO ELECTRIC
- GARMIN
- GMT CO.
- HEXAGON*
- INTELLIAN TECHNOLOGIES
- JAPAN RADIO CO
- KONGSBERG MARITIME*
- NAVICO*
- SCOUT*
- SEAS OF SOLUTIONS
- TRIMBLE
- U-BLOX*
- WARTSILA*

SYSTEM INTEGRATORS

- AB VOLVO*
- GUANGXI BEIBU GULF INTERNATIONAL PORT GROUP
- COBHAM*
- BEIJING UNISTRONG SCIENCE &TECHNOLOGY
- CYBERNETICA*
- DAMEN SHIPYARDS GORINCHEM*
- FURUNO ELECTRIC
- HYUNDAI
- INMARSAT*
- JAPAN RADIO CO
- JOHNSON OUTDOORS
- KONGSBERG MARITIME*
- LOCKHEED MARTIN
- MITSUBISHI HEAVY INDUSTRIES
- PRAXIS AUTOMATION TECHNOLOGY*
- SAAB*
- SAMYUNG ENC
- VIASAT
- WARTSILA*
- XIAMEN YAXON NETWORK

DATA ANALYTICS COMPANIES

- MARINETRAFFIC*
- MYSHIPTRACKING*
- VESSELTRACKER*
- FLEETMON*
- VESSELFINDER*
- LLOYD'S LIST INTELLIGENCE*
- KPLER*
- VORTEXA*
- WINDWARD
- SPIRE GLOBAL
- ORBCOMM
- S&P GLOBAL

END USERS

- **COMMERCIAL SHIP OPERATORS:** Container, Tanker, Bulk, Cruise, Ferry, Fishing Vessels, Workboats
- **PORT AUTHORITIES**
- **SURVEILLANCE/PUBLIC AUTHORITIES:** Coast Guards, Navy, Fisheries and Boarder Agencies
- **OFF-SHORE/MARINE CONSTRUCTION OPERATORS**
- **LEISURE & SMALL CRAFT:** Recreational Boats, Yachts

LEGEND

- Commercial offering
- Public offering / entities
- User segments

NOTES

1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers' step of the value chain often provide platforms as a service. For simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

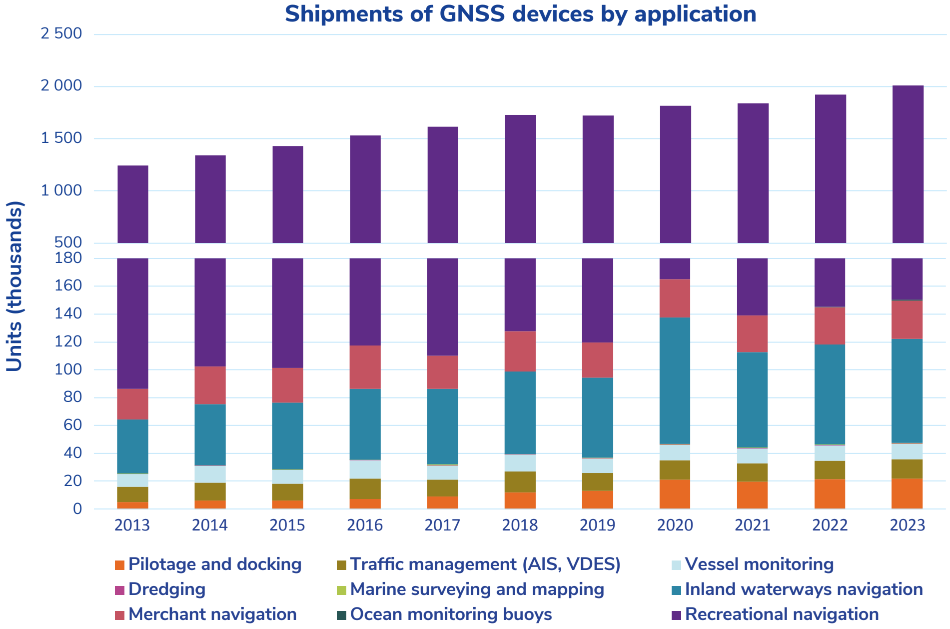
**Company awarded a prize by the EU CASSINI initiative.

European[2] GNSS and EO industry in the global arena

Europe has the largest share of the overall market for Earth Observation at close to 60%, followed by North America with a quarter of the market. The biggest EU players are Leonardo (e-GEOS), Airbus, Acri, and CLS.

Europe has several **globally leading** players across the GNSS maritime stack: **Kongsberg Maritime and Wartsila** are the top system integrators, as well as component and receiver manufacturers, whereas **u-blox** as a GNSS chip/module supplier and **NAVICO and HEXAGON** are well-established high-precision GNSS receiver manufacturers.

Scaling GNSS for safer seas: strong GNSS growth led by leisure and inland application



Global GNSS shipments in maritime have almost doubled over the past decade, reaching more than 2 million in 2023 and reflecting the digital shift in the segment. The growth is driven by Asia Pacific, Europe and North America, with expanding leisure-boating markets, dense coastal traffic and active inland waterway programmes.

Recreational navigation is still the largest application, as chart plotters and multifunction displays become standard on smaller craft. Inland waterways navigation is the second major growth engine as RIS and fairway digitalisation spread, especially across Europe.

Traffic management (AIS, VDES) and pilotage & docking devices are expanding as traffic becomes more tightly managed and ports digitalise tugs, pilot boats, and workboats. Merchant navigation volumes stay stable, tracking slow fleet growth but with increasingly sophisticated installed systems.

Smaller yet strategic niches, such as dredging, marine surveying and mapping, as well as vessel monitoring, use high-precision GNSS to support coastal engineering, seabed knowledge, and maritime security, rounding out a maritime application range, where satellite-based information ensures efficiency, safety, and financially viable performance.

The rise of smart surveillance in maritime traffic management

Maritime traffic management today relies on two established systems: the **Automatic Identification System (AIS)** and **Long-Range Identification and Tracking (LRIT)**. AIS was introduced to improve traffic management in busy sea lanes and ports by sharing a ship's identity, position and course with nearby vessels and shore stations, with collision avoidance becoming one of the major additional benefits. LRIT, operational since around 2008, adds a secure, long-range view of SOLAS ships: vessels report at least every six hours, with the option of more frequent polling by flag, coastal, and port states.

In Europe, **EMSA's LRIT Cooperative Data Centre** fuses LRIT with coastal and satellite AIS and Copernicus imagery, giving authorities a richer operational picture. Globally, it supports surveillance, fisheries control and search and rescue. GNSS, with increasingly multi-constellation capability, provides the common positional reference, with services like Galileo OSNMA set to strengthen confidence that reported positions are based on authentic signals.

Moreover, **traffic management is becoming more predictive and risk-aware**. Shore centres and bridge systems are starting to apply analytics and AI to AIS, radar and GNSS data to flag close-encounter situations or vessels behaving atypically. Modern solid-state radars and richer electronic charts further improve local awareness in constrained waters and port approaches. Together, AIS, LRIT, GNSS, Secure SATCOM and EO data are turning basic "where are the ships?" plots into integrated traffic management and surveillance services that help authorities and operators manage safety and efficiency in real time.

* MiFID/R – Markets in Financial Instruments Directive/Regulation
**CSDR – Central Securities Depositories Regulation
***EMIR – European Market Infrastructure Regulation

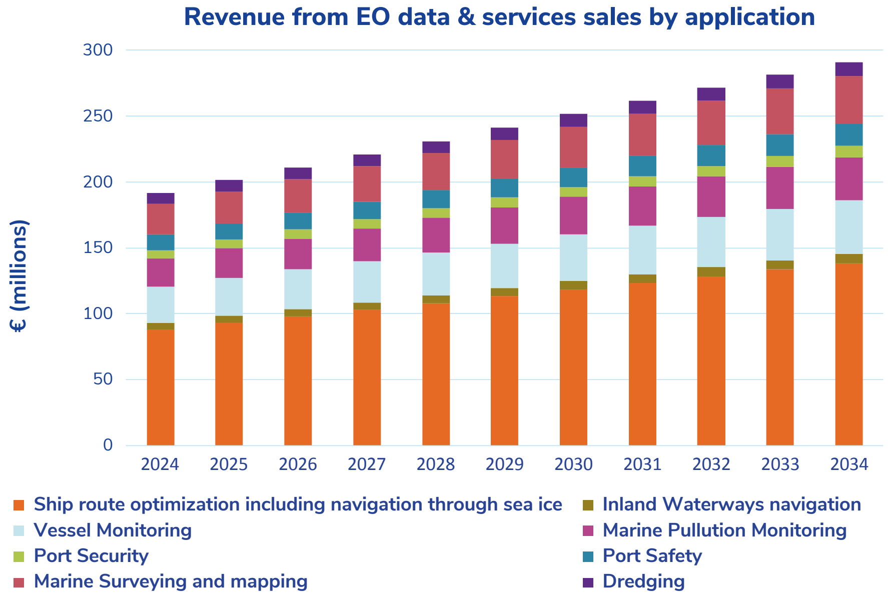
Radar and AIS working together thanks to Sentinel satellites

With Sentinel-1C (launched in 2024) and Sentinel-1D (launched in 2025), Europe's flagship C-band radar mission now flies with an AIS "ear" on board. Each satellite carries an AIS payload to capture the same VHF messages ships send at sea, while the radar keeps imaging the ocean surface in all weather, day and night. Fusing these streams means users no longer just see radar targets – they can also identify most of them and, crucially, spot ships visible in radar but missing in AIS, a potential sign of non-compliant or unauthorised activity.

For maritime users, this strengthens both operations and surveillance. Satellite AIS on Sentinel-1C/D helps build a global traffic picture, especially in remote oceans and the Arctic, supporting traffic management, routing, ice navigation and search-and-rescue planning. Combined with radar ship detection and Copernicus services, it improves maritime domain awareness: authorities can monitor key lanes and protected zones, track ships of interest and cross-check reported positions against actual radar returns.

The satellites also carry Galileo-compatible GNSS receivers, sharpening the geolocation of radar images and AIS tracks. The result is a more accurate, frequent and trusted view of who is at sea and where they are going, delivered as free Copernicus data into EU maritime services and commercial analytics.

EO is steering the future of maritime transport



Revenue from EO applications in the maritime sector is set to grow steadily, reflecting the rising strategic value of EO across maritime operations. Total EO revenues in this segment are estimated at around €200 million and are projected to reach approximately €280 million by 2034, corresponding to a CAGR of over 4%.

Ship route optimisation and navigation through sea ice remain the dominant applications, with revenues forecast to increase from nearly €88 million in 2024 to over €132 million by 2034. This use case accounts for around 45% of total EO revenues in the maritime segment and plays a key role in improving safety, efficiency, and fuel optimisation. Marine surveying and mapping is currently the second-largest application. Revenues from EO-based services in this area are expected to grow from more than €23 million in 2024 to over €32 million by 2034, supported by demand for accurate seabed and coastal data.

Maritime pollution monitoring is gaining importance as environmental regulation and sustainability pressures intensify. By 2034, this application is expected to reach a level of market significance comparable to marine surveying and mapping. EO data supporting vessel monitoring represent approximately 15% of total revenues, while smaller applications such as port safety and security also benefit from EO capabilities, albeit to a lesser extent.

GNSS precision meets EO corridor awareness and SATCOM security for autonomous shipping

Autonomous shipping is not starting on the high seas but on **fixed corridors**: short-sea shuttles, ferry routes and inland waterways where vessels repeat the same journeys every day. These controlled environments, with clear traffic rules and port systems already in place, are ideal “first lanes” for autonomy. This is already visible in practice. Ships like **Yara Birkeland** sail fixed legs with automated docking and crossing, supervised from a shore-based control centre and still supported by crew. European trials have brought short-sea and inland automation close to market readiness, building the safety cases needed for the first commercial services.

Behind this shift are a few essential space-enabled ingredients. **Satellite navigation** gives precise, reliable positioning so the vessel knows exactly where it is along the route. **Earth observation data** help design and manage corridors by highlighting shallow areas, currents or recurring hazards. **Secure communications** link ship and shore, allowing remote operators to monitor several vessels, receive alerts and intervene when needed. In the near term, this leads to human-supervised, corridor-based autonomy, highly automated but repeatable operations watched from land. In the next phase, experience and clearer standards will allow these corridors to be extended and linked, with higher levels of automation and fewer interventions from shore. In the longer run, corridor-based services can evolve into a network of connected routes where autonomous ships operate routinely alongside conventional traffic, forming the backbone of a safer, cleaner and more predictable maritime transport system.

Maritime digital twins enable predictive operations and optimisation

Operators increasingly want to manage ships, ports and logistics as one connected system. Maritime digital twins make this possible by providing **high-fidelity digital replicas of vessels, terminals or fleets that are updated with real-world data**, including satellite inputs. By mirroring the status and environment of an asset in near real time, digital twins give operators a clever tool to manage operations. Crews and planners can simulate routes and operating modes and see the impact on fuel use, arrival times and safety margins. This supports **predictive maintenance**, more efficient route planning and just-in-time arrivals, **reducing downtime and operating costs, as well as environmental impact**.

Space data are central to the creation of digital twins. **GNSS and AIS** provide accurate positioning and route tracking, while **EO** satellites supply information on sea state, weather, winds, currents and coastal change for performance and risk models. **Secure SATCOM** keeps the digital twin synchronised with ships at sea, ensuring reliable data flows well beyond coastal coverage.

What began as a research concept is now entering operations. The emerging **European Digital Twin of the Ocean** provides a large-scale framework for ocean and coastal modelling. Kongsberg Digital’s solutions already link ships and shore through shared twins, while ports, such as **Bremen and Antwerp, are building port-scale twins to analyse traffic, infrastructure and emissions**.

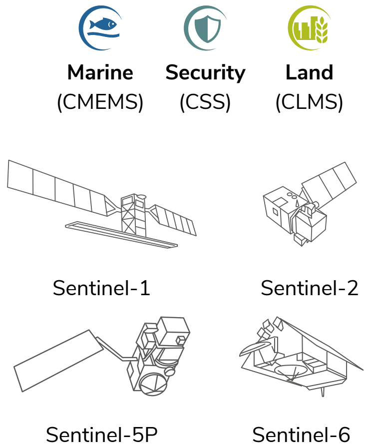
These developments suggest that satellite-enabled digital twins are on track to become standard tools for running modern maritime operations that are safer, efficient and more sustainable.

European space systems and services supporting modern maritime operations

Current and future use of Copernicus

The **Copernicus Marine Service (CMEMS)** provides free and open, scientifically assessed ocean data worldwide. Regular product updates, such as AI-enabled features and higher-resolution forecasting, support users in maritime safety, environmental management and research. CMEMS also underpins route optimisation by supplying near-real-time ocean data that can feed digital twins and automated navigation systems. Services, such as SIMROUTE and the Pacific Green Corridor, use Copernicus marine data for weather routing, emissions reduction and adaptive responses to changing sea and weather conditions.

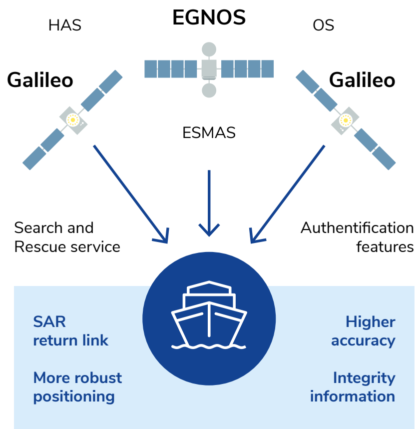
The recently launched **Copernicus SAR Sentinel satellites 1B and 1C** improve revisit time and coverage for maritime users. They carry **AIS payloads** to detect vessel signals for improved maritime domain awareness and include Galileo receivers that support higher-quality downstream products for navigation and coastal surveillance.



EGNSS for Maritime Operations

Galileo's key differentiators for maritime users include the High Accuracy Service (HAS), Open Service Navigation Message Authentication (OSNMA), and the Search and Rescue (SAR) functions. EGNOS Safety of Life assisted Service for Maritime Users (ESMAS) is also free and open for users in the EGNOS coverage area:

- **HAS** delivers global, free-of-charge, decimetre-level positioning accuracy using PPP corrections directly via Galileo satellites, benefiting navigation and operational safety in maritime scenarios.
- **OSNMA** adds a layer of robust security by authenticating navigation messages, making it possible to detect and exclude spoofed or manipulated signals. **This service transitioned to full operational status in 2025.**
- **SAR** offers rapid, accurate distress detection and relay via Cospas-Sarsat, with return-link capabilities, sending confirmation to those in need.
- **ESMAS** extends EGNOS Safety of Life capabilities, improving the accuracy and integrity of GNSS signals for navigation in ocean, coastal and harbour waters. It offers a dedicated broadcast channel for maritime safety information.

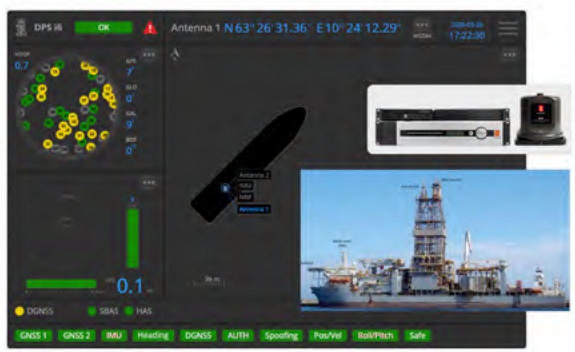


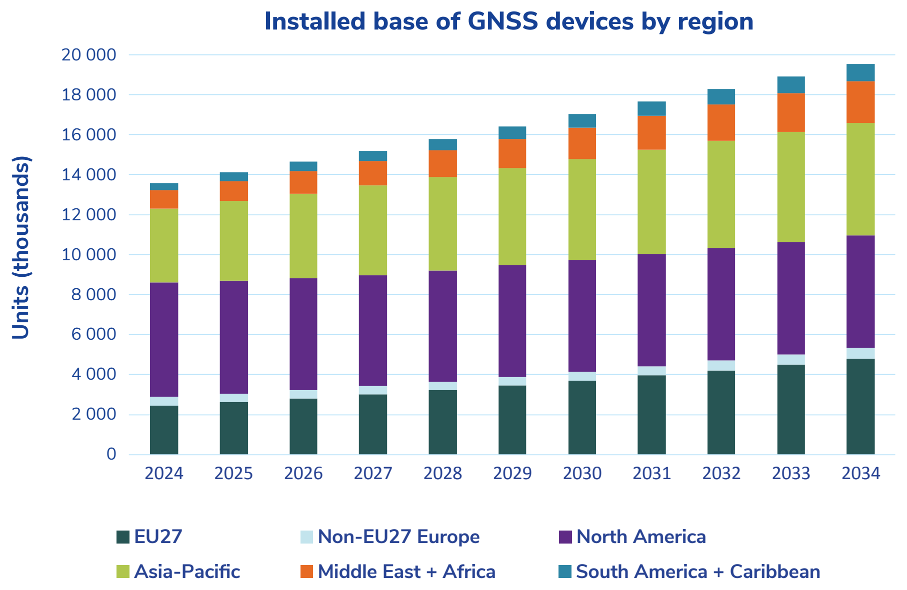
AVIS Project - Automated Vessels on Inland Waterways

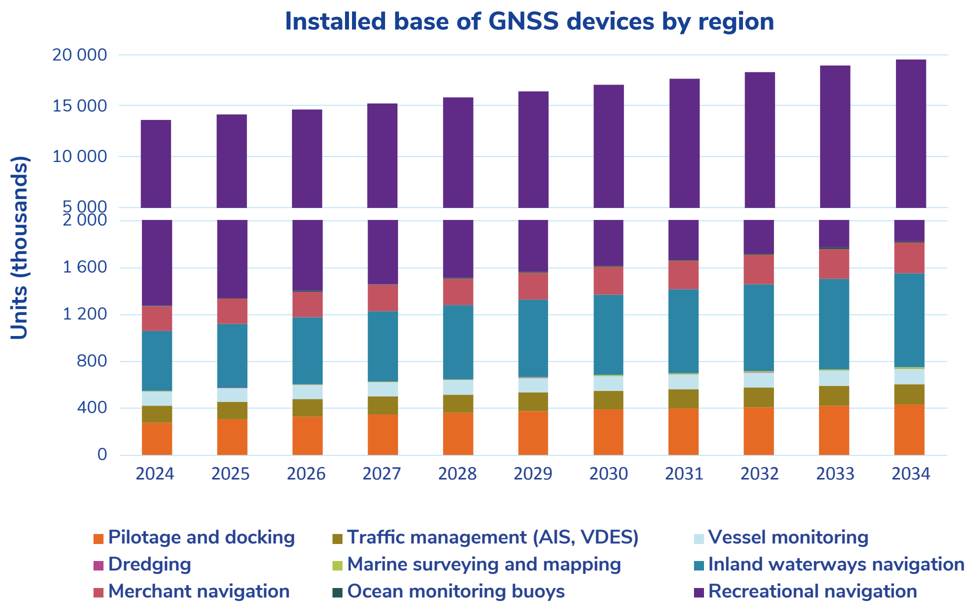
The AVIS project is a testbed for how EU Space services can enable **automated navigation on Europe's inland waterways**. It combines **EGNSS** for precise, reliable positioning with **Copernicus EO** for environmental awareness, aiming to give automated vessels the situational awareness needed to operate safely alongside conventional traffic. AVIS focuses first on defining **requirements and safety needs** for automated inland vessels (feeding into future standards and regulations), and secondly on developing a **prototype navigation solution** that fuses EGNSS and Copernicus (including accuracy maps for different waterways). Thirdly, it takes this solution out of the lab and into **real pilot corridors on major European inland waterways**, testing how well it supports route optimisation, collision-risk reduction and safe operation in constrained, complex environments. In doing so, it helps write the "playbook" for using EU Space to support safer, more efficient and cleaner inland shipping over the coming years. The intended users are ship owners, port administrators, coastal and inland waterway administrators and other maritime stakeholders.

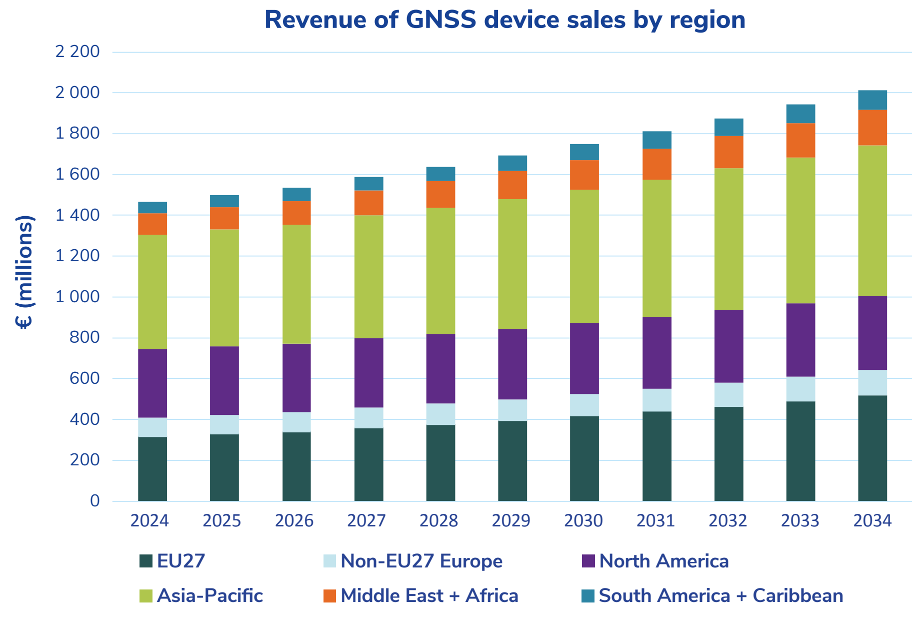
EUSPA Fundamental Elements Projects fill the gaps for maritime receivers

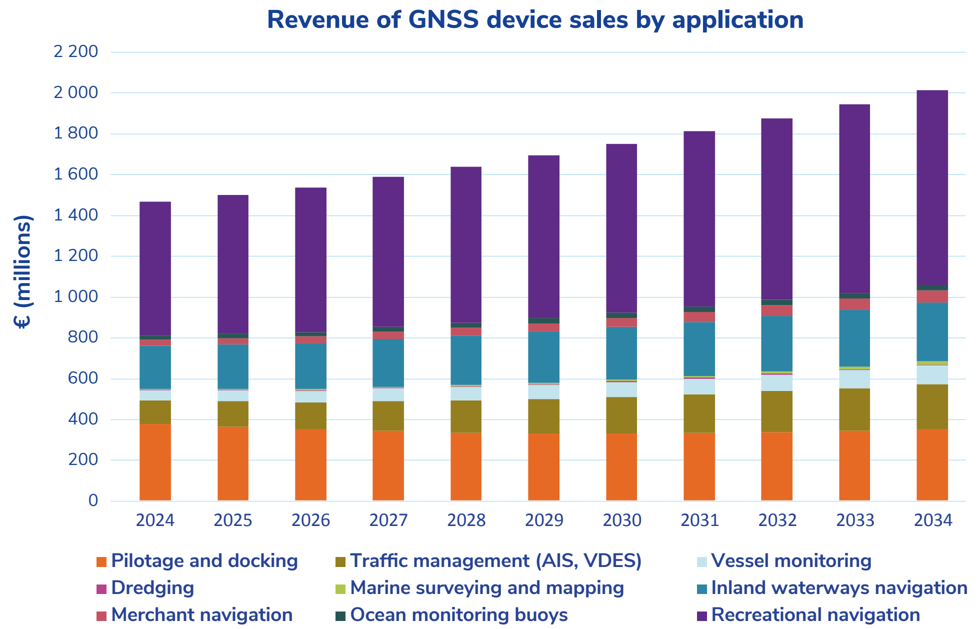
HASMAR and ISLET projects bring Galileo's HAS and OSNMA into next-generation maritime GNSS receivers. **HASMAR** integrates Galileo HAS and OSNMA into **dynamic positioning systems** used offshore and trials advanced **Controlled Reception Pattern Antenna (CRPA)** technology to make positioning more robust in challenging radio-frequency environments. **ISLET** is developing a shipborne receiver that combines Galileo HAS with multi-frequency, multi-constellation GNSS and OSNMA, delivering sub-metre accuracy from Galileo corrections, while allowing users to check that the signal is authentic and not spoofed. Both projects focus on **demanding situations such as auto-docking, dynamic positioning, passing through locks and under bridges, and navigating narrow inland waterways**, in which ships need more precise and trustworthy positioning than traditional DGPS beacons can deliver.



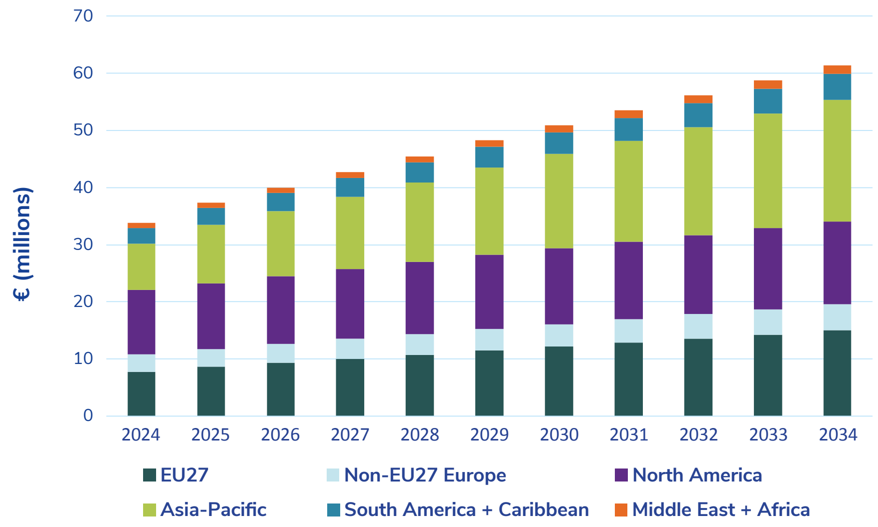

Installed base of GNSS devices by region
Units (thousands)
20 000
18 000
16 000
14 000
12 000
10 000
8 000
6 000
4 000
2 000
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Installed base of GNSS devices by region
Units (thousands)
20 000
15 000
10 000
5 000
2 000
1 600
1 200
800
400
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Pilotage and docking
Traffic management (AIS, VDES)
Vessel monitoring
Dredging
Marine surveying and mapping
Inland waterways navigation
Merchant navigation
Ocean monitoring buoys
Recreational navigation

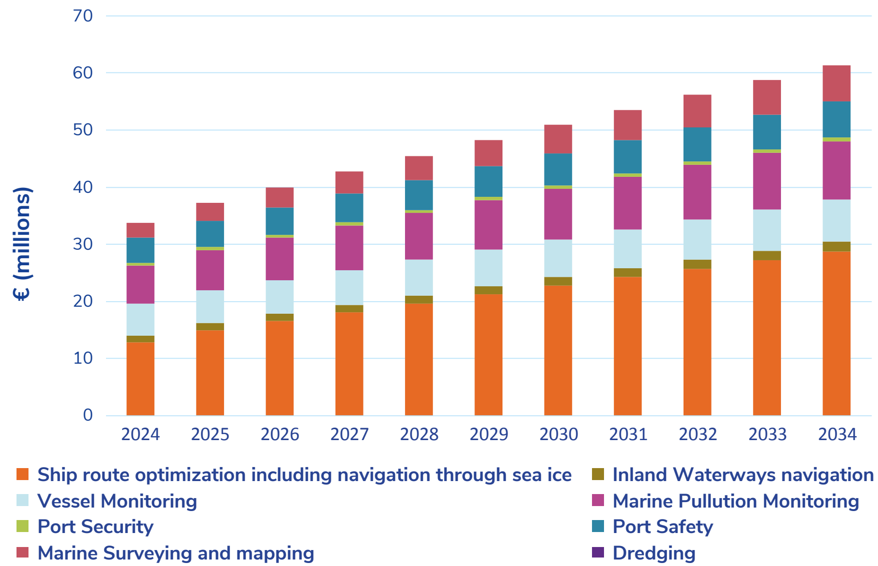

Revenue of GNSS device sales by region
€ (millions)
2 200
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by application
€ (millions)
2 200
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Pilotage and docking
Traffic management (AIS, VDES)
Vessel monitoring
Dredging
Marine surveying and mapping
Inland waterways navigation
Merchant navigation
Ocean monitoring buoys
Recreational navigation

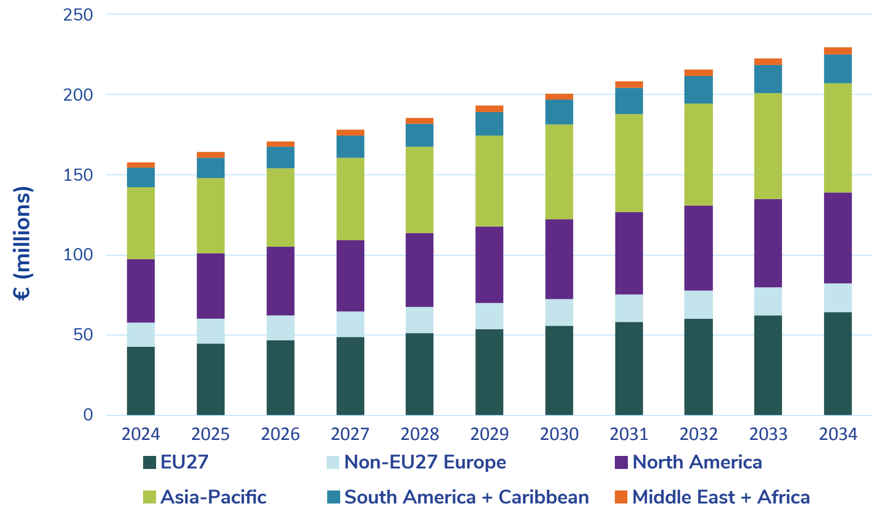
Revenue from EO data sales by region



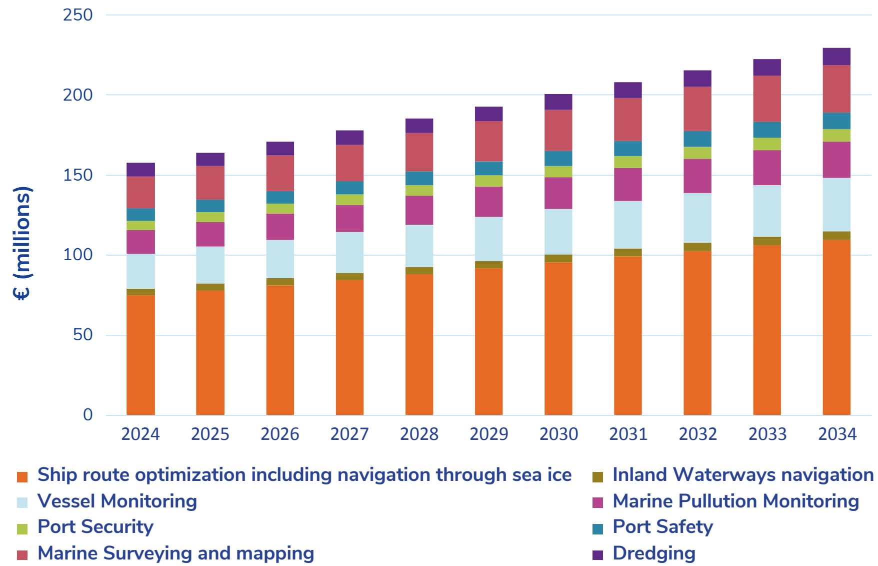
Revenue from EO data sales by application



Revenue from EO services sales by region



Revenue from EO services sales by application



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RAIL

Attractiveness enhancement

- Passenger information systems
- Public transport – tram and light rail

Maintenance improvement

- Condition-based maintenance[1]
- Infrastructure monitoring[2]
- Predictive maintenance[1]

Safety related

- Enhanced Command & Control Systems (CCS)
- Trackside personnel protection systems

Train driving optimisation

- Driver Advisory Systems (DAS)
- Asset management1

- EO application
- GNSS application
- Synergetic application (combined use of EO and GNSS)

1: Asset management, condition-based maintenance and predictive maintenance are non-safety related applications relying on the posi-tionof fixed and moving elements of the railway environment (from the infrastructure to the track-side equipment, and also rolling stock, wagons…). On the charts, these applications are grouped under the name 'asset management'.

2: Used to monitor trackside vegetation, landslide and track defor-mation.

Application descriptions can be found in Annex 3.

RAIL

The rail sector is a key component of modern transportation, enabling efficient movement of goods and passengers, connecting regions and supporting sustainable mobility. Stakeholders include public authorities responsible for transport and infrastructure, as well as private railway operators and man-ufacturers.

GNSS is central to rail digitalisation. It is widely used in non-safety-critical applications such as as-set management, infrastructure monitoring and passenger information services. In addition, several initiatives are advancing GNSS integration into high- and low-density command & control systems, supporting new operational models for train control.

GNSS and satellite EO solutions can contribute to improving infrastructure safety by enabling large-scale monitoring of track deformation and assessing natural hazard risks. These technologies also help reduce costs associated with on-site inspections.

Continuous satellite-based monitoring at network level supports the shift towards predictive mainte-nance. Multi-temporal Interferometric Synthetic Aperture Radar (MT InSAR) ground motion monitoring and vegetation monitoring is increasingly being integrated into operational infrastructure management processes.

Looking ahead, improvements in sensor performance, revisit rates and analytical methods will expand the role of satellite EO in digital rail operations and climate resilient asset management.

What you will find in this chapter

- **Key trends:** Reinventing rail with space: lower costs, higher reliability, greater reach.
- **Industry:** Rail GNSS & EO value chains.
- **Recent developments:** GNSS growth drives advancements in rail safety and automation.
- **Future market evolutions:** GNSS expansion strengthens rail safety, energy efficiency and operations.
- **European systems and projects:** Driving rail digitalisation: EGNSS integration across key innovation projects.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues by application and region.

Reinventing rail with space: lower costs, higher reliability, greater reach

Key market trends

- GNSS-based signalling cuts infrastructure costs and enables scalable deployment for regional rail networks.
- Climate resilience and satellite-based environmental monitoring are becoming essential to protect rail infrastructure from climate hazards and ensure a more adaptive, sustainable transport network.
- European rail is advancing toward automation and autonomy to boost efficiency and safety, leveraging GNSS and complementary technologies to enable semi- and fully autonomous train operations.
- Predictive, data-driven maintenance using satellites, IoT and AI is making rail operations safer, more efficient and cost-effective.

GNSS-based signalling reduces costs, improves reliability, and is easier to scale for regional rail

Many secondary and mixed-traffic rail lines need signalling upgrades but cannot justify **major trackside investment. Satellite-based train localisation is emerging as a cost-effective solution**, reducing **hardware requirements and improving headway times**. Within the EU's planning for future ERTMS/ETCS evolutions, GNSS is considered a candidate technology that could lower signalling CAPEX/OPEX and improve deployment flexibility for low-density lines.

Space-based and multi-sensor technologies reduce reliance on physical electronic transponders (balises) while maintaining safety. **Position integrity remains critical**, with European programmes adapting aviation concepts like EGNOS for rail and advancing sensor fusion **for all-weather availability**. These innovations support the transition **toward digital and automated operations**.

Recent initiatives highlight this progress. Horizon Europe's VICE4RAIL project developed a virtual testing environment for GNSS-based ETCS, cutting on-site trials and enabling virtual balise certification. The R2DATO project is validating GNSS and complementary technologies through eight real-world demonstrators. Combined with ongoing EU-Rail cooperation, **these efforts mark GNSS's shift from research to operational reality, delivering safer and more efficient signalling across Europe**.

Towards more autonomy and automation in rail and train operations

European rail is moving toward **automation** to address **labour shortages**, **rising costs** and **ambitious safety targets**. **Semi-autonomous solutions, driver-assist systems, and ATO GoA2 operations** are already **being deployed**, improving efficiency and safety while laying **the foundation for fully autonomous trains**. **GNSS** plays a critical supporting role, **providing accurate localisation** that complements ETCS, odometry, and trackside systems. Combined with onboard sensors and EO data, it enhances **hazard awareness for conditions such as heat, flooding and low adhesion**. As **satellite constellations** improve in **accuracy and integrity**, GNSS will increasingly contribute to safety cases, enabling **advanced autonomy while meeting regulatory requirements**.

Practical examples illustrate this trend. In Germany, the Digital S-Bahn Hamburg operates automated trains using ATO over ETCS at GoA2, where driving tasks are automated under driver supervision. France's SNCF has tested GNSS-enabled autonomous freight locomotives, while the Czech Republic's AŽD Edita delivered the first autonomous passenger train on an open line (GoA3). Industry initiatives such as R2DATO are accelerating progress, demonstrating **how GNSS and complementary technologies are enabling safer, more autonomous rail operations across Europe.**

Climate Resilience and environmental risk monitoring becoming critical

Rail transport is widely recognised as a climate-friendly mode of mobility, offering a low-carbon alternative to road and air travel. However, it faces **growing exposure to climate-related hazards such as floods, heatwaves and landslides**, which **disrupt operations and cause major economic losses**; Germany alone incurred €1.5 billion in damages during the 2021 floods. As these risks intensify, **climate resilience has become a strategic priority for rail infrastructure managers worldwide**.

Space-based technologies, particularly EO, **are central to strengthening resilience**. **InSAR imagery enables precise monitoring of ground deformation and slope stability**, optical **EO supports vegetation monitoring and broader environmental-risk assessment**, and services like Copernicus Emergency Management provide timely flood mapping. By integrating these tools, **operators can shift from reactive maintenance to proactive risk management**, mitigating hazards before they escalate.

Practical implementations confirm this trend. Network Rail in the UK uses satellite monitoring operationally to track ground movement along key corridors. Swiss Federal Railways (SBB) and Italy's RFI have so far carried out mainly trials and proof-of-concept activities rather than sustained operational deployment. In Germany, DB InfraGO employs EO operationally for vegetation management, primarily to prevent interference with rail assets such as tracks, trains and catenaries, with secondary benefits for fire- and landslide-risk reduction. Together, **these developments show how trial and demonstration activities are steadily evolving into operational use, with space-enabled monitoring transforming rail infrastructure into a more resilient, climate-adaptive backbone**.

Predictive and condition-based maintenance

European rail networks are shifting from **reactive and condition-based maintenance to predictive strategies** to address **aging infrastructure, climate risks and cost pressures**. This transformation combines **EO** for detecting **ground instability, soil moisture and vegetation hazards with GNSS-equipped trains** that monitor **track geometry and vibrations during normal operations**. These data streams feed **AI-driven digital twins**, enabling infrastructure managers to **anticipate failures, optimise interventions, and reduce unplanned disruptions**.
Satellite-based technologies are transforming maintenance. **Galileo HAS offers free, decimetre-level positioning for inspections**, while Copernicus provides EO data for large-scale risk monitoring. Combined with IoT sensors and analytics, these tools enable the adoption of **proactive strategies that improve safety, extend asset life and cut costs**.

Actual examples show the concept is market-ready: SBB uses GNSS for predictive models; ADIF applies EO for vegetation control; DB InfraGO integrates GNSS into digital twins; and SNCF monitors over 1,100 trains with IoT sensors. Beyond Europe, China employs BeiDou for track geometry, and Australia pilots GNSS and InSAR. **Predictive maintenance is now a strategic enabler for efficiency and resilience in global rail operations**.

Rail GNSS Value Chain[1]

GNSS

COMPONENT AND RECEIVER MANUFACTURERS

- ALSTOM TRANSPORT*
- AZD PRAHA*
- CAF*
- CATERPILLAR
- CRRC CORPORATION
- HITACHI
- HUPAC*
- JAPAN RADIO CO.
- KAWASAKI
- KINTETSU RAILCAR ENGINEERING
- MERCITALIA RAIL*
- MITSUBISHI
- SICE*
- SIEMENS*
- THALES*
- TRANSWAGGON*
- VTG*
- WABTEC
- XIAMEN YAXON NETWORK

SYSTEM INTEGRATORS

- ANALOG DEVICES
- ANTCOM
- BEIJING BDSTAR NAVIGATION
- BROADCOM
- COMNAV TECHNOLOGY
- CORE CORPORATION
- GLARUN TECHNOLOGY
- GMV*
- HEXAGON*
- HITACHI
- INTERMODAL TELEMATICS*
- LANNER ELECTRONICS
- MERMEC*
- PANORAMA ANTENNAS*
- SATEL*
- SIERRA WIRELESS
- SYNTONY GNSS*
- TE CONNECTIVITY*
- TRIMBLE NAVIGATION
- U-BLOX*
- YAGEO

TRAIN MANUFACTURERS

- ALSTOM TRANSPORT*
- CAF*
- CRRC CORPORATION
- HITACHI
- SIEMENS*
- STADLER RAIL*
- WABTEC

RAILWAY UNDERTAKINGS

TRAIN AND FREIGHT OPERATING COMPANIES:

- ARRIVA*
- COLAS*
- DB*
- RENFE*
- SBB*
- SNCF*
- STAGECOACH*
- TRENITALIA*
- URBAN TRANSPORT
- OPERATORS

- **ROLLING STOCK OPERATING COMPANIES:**
- CONSORTIA
- INVESTMENT BANKS
- NATIONAL COMPANIES

INFRASTRUCTURE MANAGERS

- ADIF*
- DB INFRAGO*
- INFRAESTRUTURAS DE PORTUGAL*
- NETWORK RAIL*
- RFI*
- SBB BAHNINFRASTRUKTUR*
- SNCF RÉSEAU*
- URBAN TRANSPORT OPERATORS

LEGEND

- Commercial offering
- Public offering
- User segments

European[2] GNSS industry in the global arena

As of 2024, the competitive landscape for GNSS component and receiver manufacturers and system integrators in the rail sector continues to be dominated by Europe, North America and Asia-Pacific. The latest available data show that European companies account for roughly one quarter of global GNSS revenues across all application domains.

In rail-specific system integration, market shares remain more evenly balanced among these leading regions, with Europe retaining around one third of global activity, supported by its strong base in rolling stock, signalling and digital rail solutions. Key European players in this segment include Alstom, Siemens Mobility and Thales, which deliver both GNSS-enabled components and integrated signalling and automation systems for rail applications.

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret it at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

Rail EO Value Chain[1]

EO

DATA PROVIDERS ▷ INFRASTRUCTURE PROVIDERS ▷ PLATFORM PROVIDERS ▷ EO PRODUCT, SERVICE AND INFORMATION PROVIDERS ▷ END USERS

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- CGSTL
- E-GEOS*
- GEOSAT*
- ICEYE*
- PLANET
- SATELLOGIC
- UMBRA
- VANTOR

- ALOS (JAXA)
- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- IRIDE (ASI)*
- NISAR (NASA/ISRO)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- AWS
- CHINA RSGS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- IBM CLOUD
- MICROSOFT AZURE
- OVHCLOUD*
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*

PLATFORM PROVIDERS

- CREODIAS*
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- OPEN DATA CUBE
- OPENEO*
- SENTINEL-HUB (PLANET)
- UP42*

- WEKEO*
- COPERNICUS DATA SPACE ECOSYSTEM (CDSE)*

EO PRODUCT, SERVICE AND INFORMATION PROVIDERS

- ALTAMETRIS*
- ARUP*
- BEIJING SUPERMAP SOFTWARE
- CBC GEOSPATIAL
- E-GEOS*
- DARES TECHNOLOGY*
- DETEKTIA*
- GAF*
- GEOFEM*
- INTERMAP TECHNOLOGIES
- LIVEEO*
- PLANETEK*
- RAMBOLL*
- SATSENSE*
- SIXENSE*
- SKYGEO*
- SPOTLITE*
- TRE ALTAMIRA*

- COPERNICUS EUROPEAN GROUND MONITORING SYSTEM (EGMS)*

END USERS

- ADIF*
- DB INFRAGO*
- INFRAESTRUTURAS DE PORTUGAL*
- NETWORK RAIL*
- RFI*
- SBB BAHNINFRASTRUKTUR*
- SNCF RÉSEAU*
- URBAN TRANSPORT OPERATORS

LEGEND

Commercial offering
Public offering
User segments

European[2] EO industry in the global arena

In 2024, the global EO rail market is still largely shaped by Asia-Pacific, which represents over half of worldwide demand for EO-based services in transport and infrastructure. Europe remains the second-largest region, with players such as Leonardo (e-GEOS) and other Copernicus-enabled providers contributing significantly to rail risk assessment, asset monitoring and operational safety.

Although rail generates relatively limited direct EO revenues, EO solutions developed for broader infrastructure surveillance, disaster response and climate adaptation are increasingly being leveraged within the rail sector. As a result, rail infrastructure managers are progressively integrating EO capabilities into their planning and maintenance activities, expanding the sector's effective use of EO beyond its narrow market size.

NOTES

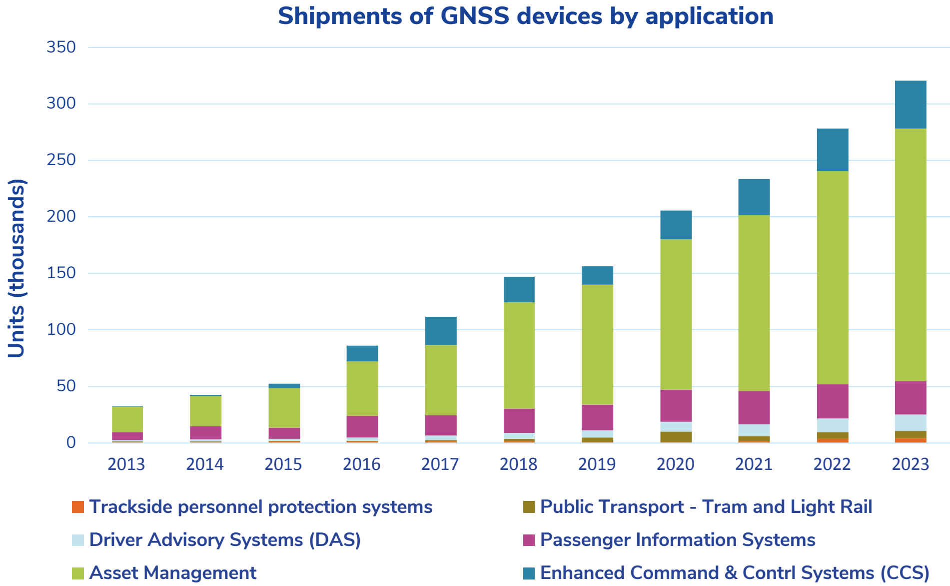
1 The value chain considers the key global and European companies involved in EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

2 In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 for a comprehensive description of the EO value chain and how to interpret it at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

GNSS growth drives advancements in rail safety and automation



GNSS device shipments for rail grew **tenfold in a decade**, from about **30,000 units in 2013 to over 300,000 in 2023**, driven by the **digitalisation of railway assets** and demand for **cost efficiency and reliability. Asset management dominates**, enabling fleet optimisation and lifecycle cost reduction, while **Enhanced Command and Control Systems** became the second-largest application after 2016, supported by the overall evolution of ERTMS and by ongoing developments in GNSS-based train localisation.

Smaller applications include **Passenger Information Systems** for real-time travel data and **Driver Advisory Systems** for energy efficiency and timetable adherence. **Public transport and trackside personnel** protection systems remain niche but underscore GNSS's role in safety.

Overall, the chart shows GNSS's shift from early adoption to a critical enabler of modern rail operations, paving the way for automation and predictive maintenance.

GNSS-based protection systems for trackside workers

Worker safety near active railway tracks remains a **critical challenge**, and recent innovations increasingly rely on **GNSS-enabled wearables and geofencing**. These systems create **virtual safety zones** and deliver **real-time alerts** to both workers and train drivers, complementing traditional signalling and significantly **reducing accidents during maintenance operations**.

Several initiatives illustrate this progress. **Tended**, a UK-based startup specialising in geofencing technology for worker safety in high-risk environments, has deployed **wearable devices with decimetre-level GNSS accuracy for Network Rail**. In France, Hitachi's ERAS, co-developed with SNCF Réseau, **uses AI and GNSS-enabled wearables to detect potential lone-worker safety incidents and trigger geolocated alerts for rapid assistance**. Infrabel in Belgium is implementing **GNSS-based geofencing to prevent track incursions**, while Italy's ESA NAVISP-supported SEMOR project integrates GNSS into automatic track warning systems. At a broader level, EUSPA-backed programmes such as **EGNSS-R** and projects like **CLUG** and **CLUG2** advance certifiable train positioning and multi-sensor GNSS integration. ESA-funded efforts, such as CertiPro in Germany, are developing certifiable warning equipment and localisation units, strengthening both worker safety and railway operations.

Digital Twins with GNSS, EO, and Drones

Digital twins are transforming rail asset management by combining GNSS for precise positioning, EO for environmental insights and drone-based 3D mapping. This integration enables **predictive maintenance**, accelerates inspections and enhances safety while minimising disruptions to rail traffic.

Examples include Altametris in France, which developed **digital twins of track and catenary sections for SNCF using GNSS and drone LiDAR**. The IN2SMART2 project, funded by the European Union and industry partners, incorporates **EO, GNSS, and drone data into predictive maintenance workflows**. Building on these advances, the **Altametris Suite** provides a dedicated **platform for managing and visualizing digital twins** across SNCF's network.

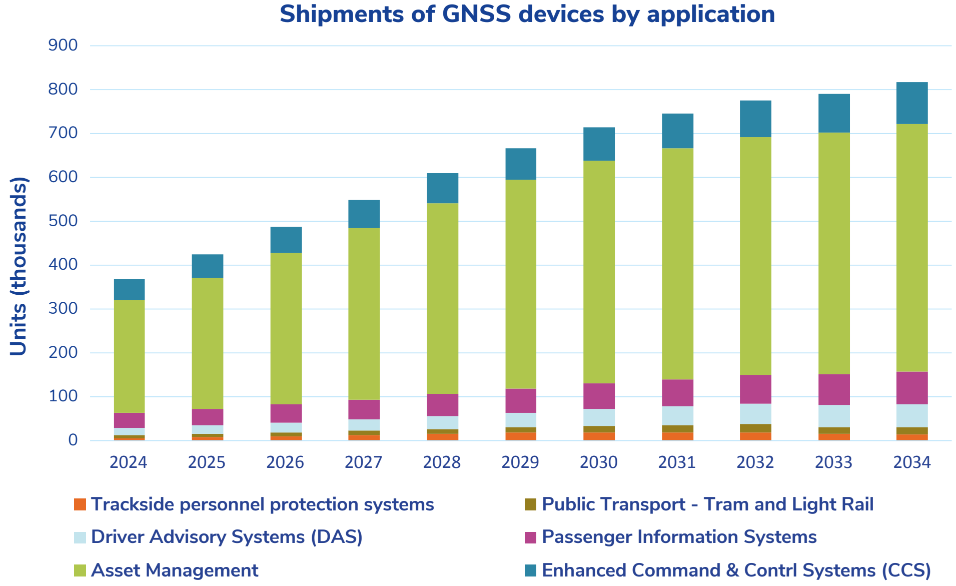
Drone-satellite synergy for inspections

A recent innovation in rail infrastructure management is **the combined use of drones, GNSS and satellite EO to make inspections more efficient and less disruptive**. Drones equipped with GNSS deliver **high-resolution imagery of catenary lines, track geometry and vegetation**, while satellite EO imagery provides **wide-area monitoring of slopes, soil stability and corridor conditions**.

The benefits depend on the business case and technology applied. Drones offer **precise local insights** but face **weather and operational constraints**, whereas satellite EO delivers broader environmental context. **EO** often supports **decision-making**, where thresholds and indexes derived from satellite data trigger **targeted inspections or maintenance**.

Examples include RFI in Italy, which integrates **drones and GNSS** for **monitoring catenary and track geometry**; Network Rail in the UK, combining drone inspections of bridges and tunnels with satellite EO-based corridor risk assessments; and Altametris in France which **enhances predictive maintenance and safety**.

GNSS can strengthen rail safety, energy efficiency and operations



GNSS device shipments for rail are **projected to more than double**, rising from almost 400,000 units in 2024 to over 800,000 by 2034. This growth reflects the **ongoing digitalisation of rail operations**, where GNSS supports asset monitoring, automation and safety. The trend is driven by operators seeking **cost efficiency, predictive maintenance and improved reliability**.

Asset management remains the dominant application, accounting for most shipments as operators optimise **fleet performance and reduce lifecycle costs**. Enhanced Command and Control Systems follow as the second-largest application, supported by ERTMS evolution and GNSS-based train localisation, which **is expected to reduce reliance on trackside equipment**.

Emerging applications include Passenger Information Systems, meeting demand for real-time location and arrival data, and Driver Advisory Systems, which improve **energy efficiency and timetable adherence**. While applications for public transport and trackside personnel protection are still emerging, they demonstrate how GNSS is extending its value into safety-critical and urban mobility functions.

Overall, the chart illustrates GNSS's transition from **a supporting technology to a core enabler of automated, resilient rail operations across Europe**.

Energy optimisation and decarbonisation with satellite data

As rail networks expand electrification and high-speed services, **energy efficiency is becoming a strategic priority**. Future developments focus on **integrating GNSS for precise train telemetry, EO for environmental and energy context, and Connected Driver Advisory Systems (C-DAS) to enable real-time eco-driving**. Together, these technologies aim to optimise energy use across the entire operating cycle.

From the driver's perspective, **C-DAS will play a pivotal role in guiding eco-driving practices**. By continuously adjusting driving profiles to real-time conditions, drivers can maximise coasting, smooth acceleration and regenerative braking while avoiding unnecessary stops or high-power traction. **GNSS ensures accurate positioning and speed control**, allowing the system to adapt to gradients, curves and timetable constraints with minimal energy waste.

EO, particularly through the Copernicus programme, including several services as C3S, CAMS and CLMS, adds broader operational context by providing data on weather, temperature and renewable energy availability. This information supports short-term decisions such as adjusting driving strategies during extreme heat or storms and long-term planning where renewable generation forecasts align with train energy demand. By linking EO data with train telemetry and advisory systems, operators can move toward **dynamic energy management that reduces costs and minimises emissions**.

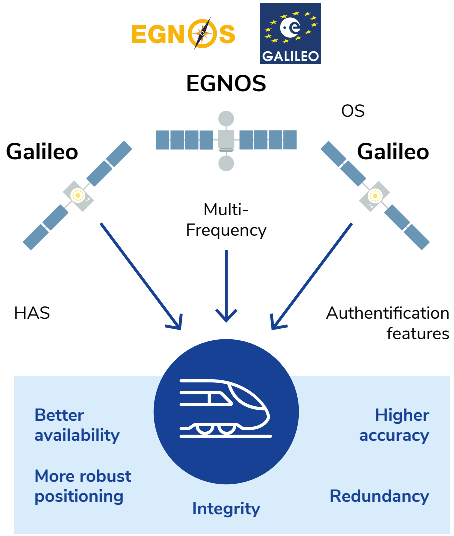
Safer Digital Freight Corridors Powered by GNSS Authentication

In the coming years, **authenticated GNSS will become a cornerstone of secure and efficient freight operations**, addressing growing concerns around cybersecurity and supply chain integrity. **Galileo's OSNMA** service provides cryptographic authentication of positioning signals, ensuring that location data is genuine and resistant to spoofing or tampering. This capability is critical as rail freight becomes increasingly digital, supporting **paperless logistics, automated customs clearance and cross-border interoperability**.

The integration of OSNMA with **secure software platforms, digital signatures and authorised economic operator procedures** can support the uptake of **digital waybills**, which replace traditional paper documentation with secure electronic records detailing shipment contents and routes. This shift will streamline customs processes, reduce manual checks and accelerate international freight flows, making rail a more competitive alternative to road transport.

Early trials, such as the JULIA project in Greece, have demonstrated the feasibility of GNSS authentication in real-world conditions. As these technologies mature, adoption will expand beyond pilots to large-scale deployment, creating a trusted ecosystem for freight logistics. In the long term, authenticated GNSS will underpin **automated freight corridors, support real-time cargo tracking** and enable **integration with blockchain-based supply chain systems**, reinforcing Europe's ambition for secure, sustainable and fully digital rail freight operations.

Driving rail digitalisation: EGNSS integration across key innovation projects



EDITA: Autonomy and high-accuracy GNSS for safer rail operations

On the Kopidlno–Dolní Bousov line in Czechia, EDITA has been operating **autonomous passenger services** under supervision since April 2025, marking Europe's first deployment on an open railway with level crossings. The system combines **Galileo-enabled GNSS** with cameras, lidar and a **detailed digital map to detect obstacles** and handle real-world variability. This achievement demonstrates that **GNSS-enabled ATO can reliably function beyond fenced metro-style** environments, paving the way for wider adoption on conventional rail networks.

Horizon Europe, a programme of the European Union

CLUG 2.0: Advancing train localisation for reliable on-board positioning

CLUG2 advances from **feasibility to full-scale demonstration** by consolidating **requirements, RAMS and a multi-sensor fusion architecture** (EGNSS, odometry/inertial, and track map) into a failsafe localisation unit (LOC-OB) that delivers absolute train positioning for ETCS. The project integrates **integrity monitoring, track selectivity and start-of-mission functions** with live trials, including a Switzerland demo, to prove readiness for ERTMS integration. Its results and interfaces are designed to align with **R2DATO activities, supporting harmonisation of technology, operations and standardisation**.

EGNOS4RAIL: Building safety-critical GNSS positioning for European rail

Europe's rail digitalisation depends on bringing **absolute, integrity-backed positioning** onboard trains to enable ERTMS evolution towards GNSS-based train localisation, Level 3, and ATO, **reducing trackside assets and lifecycle costs**. This is the missing link between research pilots and harmonised deployment.

EGNOS4RAIL, a project assessing the feasibility of using EGNOS in the rail domain, adapts **Safety-of-Life integrity to rail requirements**, preparing an augmentation service for future ERTMS. In parallel, R2DATO under Europe's Rail FP2 is developing the **Absolute Safe Train Positioning (ASTP)** concept, which fuses Galileo/EGNOS with odometry, inertial sensors and digital track maps. The two initiatives are closely connected: six of eight ASTP demonstrators will use the EGNOS for rail service demonstrator provided by ESA and EUSPA to validate if the rail service performances correspond to user needs.

EGNOS augments GNSS with corrections and integrity monitoring, which is used for example in aviation to ensure that users can rely on the localisation information. The EGNOS Service needs to be adapted for rail, where multipath, NLOS and interference are handled within ASTP's multi-sensor architecture. Tests using the respective emulated EGNOS messages are carried out within the rail demonstrators to provide RAMS evidence while preserving interoperability and allowing suppliers to innovate and develop the GNSS-based Absolute Safe Train Positioning solutions.

On the programme side, R2DATO deliverable D22.7 formalised the need for an early EGNOS service to de-risk demonstrations and feed System Pillar standardisation. The Steering Group requested EUSPA and ERA involvement to define interfaces and a roadmap, anchoring EGNOS in the future ERTMS localisation layer.

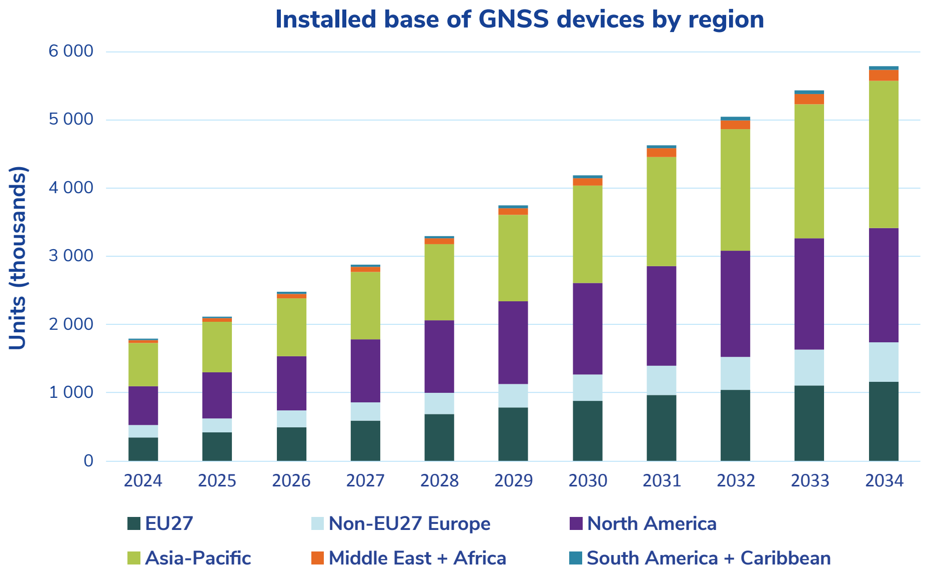
Horizon Europe, a programme of the European Union

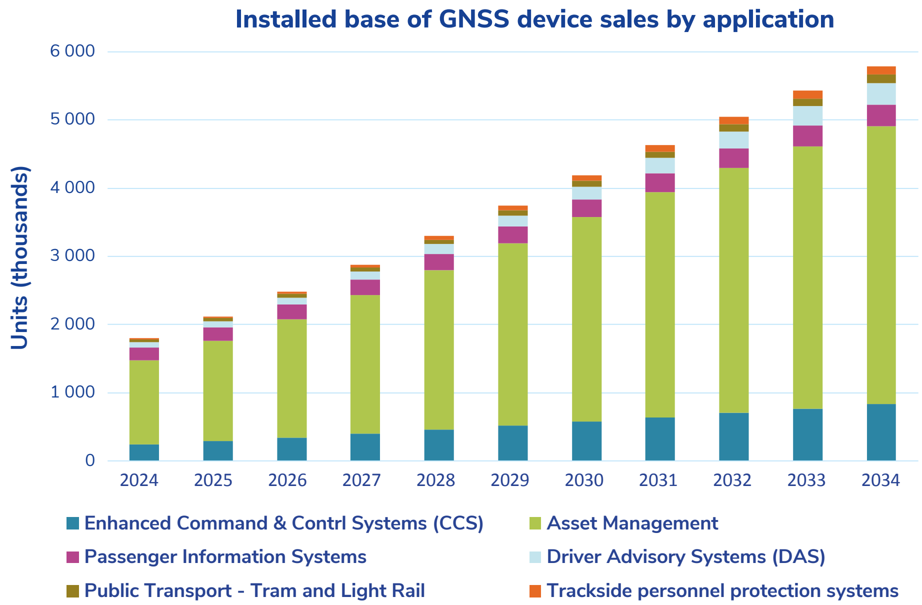
VICE4RAIL: Certifiable GNSS solutions for future digital rail systems

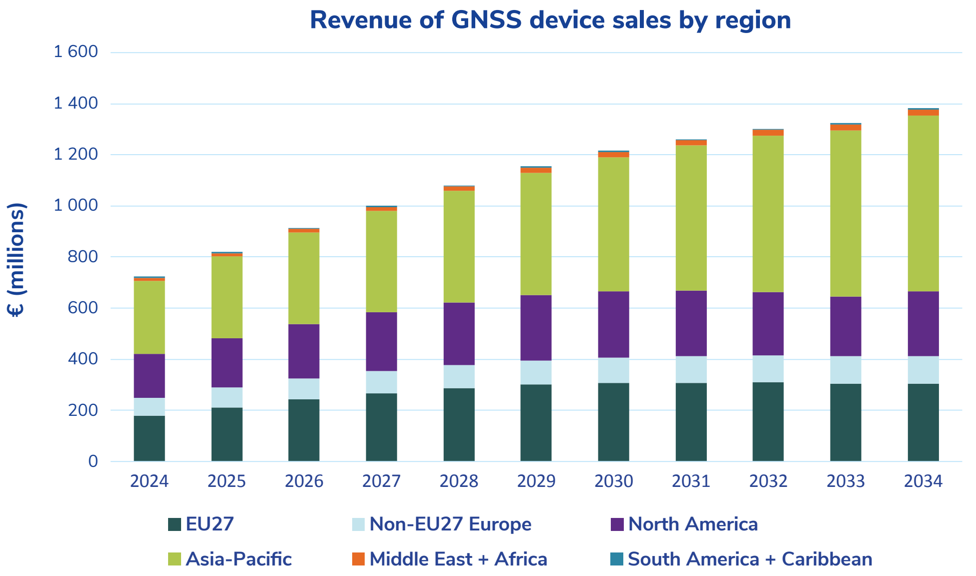
VICE4RAIL tackles one of the most critical challenges for GNSS adoption in rail: **achieving certification**. The project is developing a **Hybrid Virtualized Testing Environment** that links an RFI pilot line with the CEDEX ERTMS laboratory, creating a powerful platform for suppliers to **validate GNSS-based train positioning** without months of costly and logistically complex on-track trials. This environment combines virtual scenarios with real-world data to replicate rare fault conditions, verify integrity and demonstrate compliance with CENELEC safety standards.

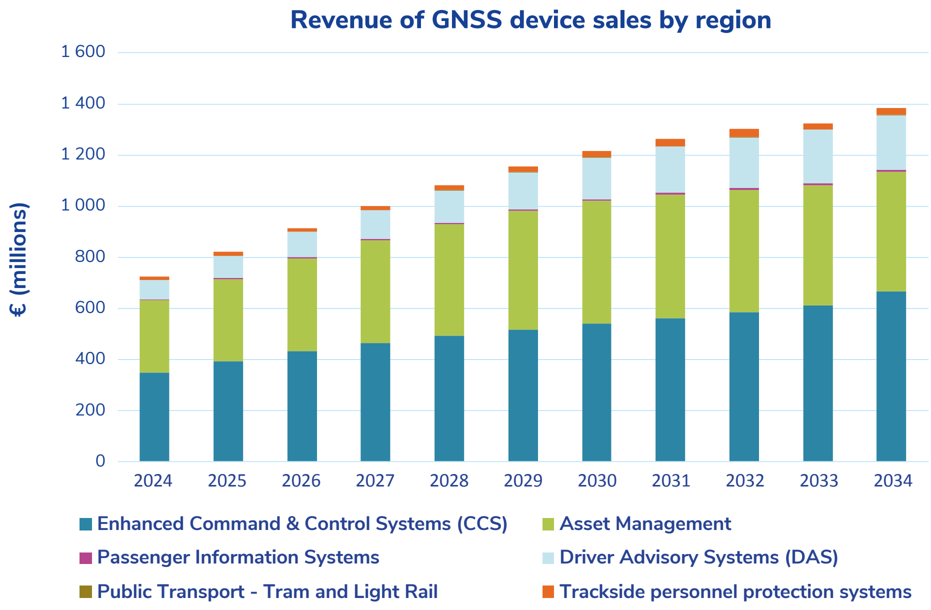
By aligning with **EGNOS** evolution and the **R2DATO** programme, **VICE4RAIL** establishes a repeatable, **Europe-wide certification pathway** that accelerates innovation while maintaining interoperability. The approach offers significant benefits to the market: reducing certification costs, shortening time-to-market and enabling **faster deployment of Galileo/EGNOS-enabled localisation** within the ERTMS framework. Ultimately, VICE4RAIL helps unlock the **full potential** of **GNSS for rail**, supporting safer, more efficient and future-ready signalling systems.

Terminology used on this page is explained in Annex 2 for both GNSS and EO performance parameters.


Installed base of GNSS devices by region
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Installed base of GNSS device sales by application
6 000
5 000
4 000
3 000
2 000
1 000
0
Units (thousands)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Enhanced Command & Contrl Systems (CCS)
Asset Management
Passenger Information Systems
Driver Advisory Systems (DAS)
Public Transport - Tram and Light Rail
Trackside personnel protection systems


Revenue of GNSS device sales by region
1 600
1 400
1 200
1 000
800
600
400
200
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
Middle East + Africa
South America + Caribbean


Revenue of GNSS device sales by region
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1 000
800
600
400
200
0
€ (millions)
2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034
Enhanced Command & Control Systems (CCS)
Asset Management
Passenger Information Systems
Driver Advisory Systems (DAS)
Public Transport - Tram and Light Rail
Trackside personnel protection systems

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ROAD AND AUTOMOTIVE

Asset management

- Bike sharing
- Public transport - buses
- Road asset management[1]

Liability and enforcement

- Insurance telematics
- Road User Charging (RUC)
- Smart tachographs

Safety related

- Connected and Automated Driving (CAD)[2]
- Emergency assistance

Smart mobility

- Navigation (IVS & PND)[3]
- EO for automotive

- EO application
- GNSS application
- Synergetic application (combined use of EO and GNSS)

1: Used by commercial vehicles, for dangerous goods tracking, by taxis, rental cars and car sharing.

2: Supports automated driving for SAE levels 4 and 5.

3: Portable navigation devices (PNDs) and in-vehicle systems (IVS) built in cars support turn-by-turn navigation. Moreover, IVS support any location-based inputs for Advanced Driver Assistance Systems (ADAS) (SAE levels 2 and 3).

Application descriptions can be found in Annex 3.

ROAD AND AUTOMOTIVE

Transport and mobility are crucial elements in the modern world. The road and automotive market segment covers not only the automotive industry itself, but also a variety of services linked to mobility, logistics and road transport infrastructure.

This report groups road and automotive applications into several categories: **safety-related**, where precise positioning data support safety-critical functions such as connected and automated vehicles, as well as emergency services like eCall; **liability and enforcement**, including road user charging and smart tachographs; **asset management**, where GNSS technology enables efficient management of diverse vehicle fleets and related operations; and **smart mobility**, where GNSS and EO are used for navigation and road weather and traffic services.

GNSS use is ubiquitous in the segment, as this technology is a must-have for all applications requiring absolute positioning of vehicles. EO is used to support the basic layers of maps, as well as to support traffic and weather information services provided to infrastructure managers, transport operators and connected vehicles. Road infrastructure managers increasingly rely on EO to address needs like monitoring extreme weather impacts or geohydrological impacts enabling proactive maintenance and risk mitigation.

SATCOM connectivity, as a form of non-terrestrial network (NTN), is set to complement various applications by providing reliable coverage in areas where terrestrial networks are limited or unavailable, thereby ensuring continuous communication for safety, operational coordination and data transfer.

The importance of space in transport infrastructure: Space-based technologies play a crucial role in enabling mobility, transport and logistics by supporting transport infrastructure, industrial applications, and a wide range of traffic management services, while EO supports all phases of the road transport infrastructure lifecycle, including planning, design, construction and monitoring of road infrastructure. This application is detailed and quantified in the **Infrastructure** segment.

The role of HD maps: HD Maps represent an enabler for connected and automated driving, as they provide detailed information on the environment, necessary for determining driving instructions for automated vehicles. HD maps are a relevant space-enabled application since the basic layer of HD maps is derived from satellite imagery. Moreover, GNSS (absolute) positioning is used to locate the vehicle in such maps. In this edition of the Market Report, players active in HD maps are included in the analysis, but the application is not quantified.

What you will find in this chapter

- **Key trends:** How software, autonomy and electrification are reshaping mobility.
- **Industry:** Road and automotive value chains.
- **Recent developments:** Space technologies boosting autonomous and connected mobility.
- **Future market evolution:** Space-enabled technologies accelerates autonomous mobility and vehicle connectivity.
- **European systems and projects:** From GNSS precision to Copernicus insights: space technologies transforming mobility.
- **Reference charts:** Yearly evolution of the installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

How software, autonomy and electrification are reshaping mobility

Key market trends

- Software-defined vehicles represent a major shift in the automotive industry, transforming cars into dynamic, connected platforms supported also by space technologies.
- Automated driving is progressively advancing toward high-level autonomy, with major Original Equipment Manufacturers (OEMs) deploying Level 3 systems and preparing for Level 4.
- Fleet management software increasingly integrates telematics and AI to provide fleet managers with comprehensive visibility of their vehicles.
- The rising adoption of Electric Vehicles is driving a significant transformation in the global automotive market, reflecting a decisive shift toward sustainable and interconnected mobility solutions.

Driving on code: The rise of Software-Defined Vehicles

The concept of **Software-Defined Vehicles (SDVs) has redefined the automotive segment by shifting the focus from hardware to software**, enabling continuous updates and feature enhancements through over-the-air communication. Relying on centralised computing platforms and modular software architectures, SDVs are replacing traditional systems, allowing vehicles to evolve over time and offer personalised user experiences.

SDVs are unlocking new business models, including feature subscriptions, dynamic pricing and predictive maintenance, transforming vehicles into connected, digital platforms and laying the groundwork for autonomous driving and smarter mobility ecosystems across Europe. These business models rely on GNSS for **precise localisation**, SATCOM for **connectivity in remote** or underserved areas and EO for **traffic and weather information**.

The European Union is supporting this development through initiatives such as the European Connected and Autonomous Vehicle Alliance (ECAVA) and emphasising the integration of space-based data from Galileo, Copernicus and IRIS2 into vehicles through the **Industrial Action Plan** for the European automotive sector.

Fleet management evolves into advanced telematics

The management of fleets is being **significantly transformed by the integration of advanced telematics**. Evolving beyond traditional fleet management solutions, advanced telematics systems now offer far more than simple vehicle tracking; they deliver real-time information on the location and performance of fleet vehicles, along with in-depth analysis of driver behaviour and timely predictive maintenance alerts. By leveraging **Artificial Intelligence** (AI) and **big data** analytics, these **systems can process vast datasets to extract practical insights**.

Modern fleet management software gives managers **detailed, real-time insight into the location, condition and usage of their vehicles and equipment**, while automating many aspects of the management process. This enables fleet managers to make more informed decisions, schedule maintenance proactively and optimise routes for maximum efficiency.

The adoption of these technologies directly **reduces operational costs**. By identifying issues early, lowering fuel consumption and improving overall asset utilisation, advanced telematics help organisations streamline their fleet operations.

How space technologies enable connected and automated driving

Connected and **automated driving** is **advancing rapidly**. Level 2 and Level 2+ systems allow the vehicle to steer and control speed while the driver remains fully responsible and attentive. Level 2+ offers smoother and more advanced assistance than standard Level 2 but still requires full driver attention. This type of automation is now a **mainstream feature** in many new vehicle models worldwide, forming the bulk of automated driving currently on the roads.

Driven by innovations from premium OEMs and supported by regulatory progress, the industry is advancing toward more ambitious automation, exemplified by BMW's Personal Pilot L3 enabling automated driving up to 60 km/h and Mercedes-Benz's DRIVE PILOT reaching 95 km/h on the German Autobahn. At the same time, the EU fosters broader development through initiatives like CCAM and ECAVA, while industry groups such as Car2Car and the 5G Automotive Association ensure that connectivity solutions meet automotive needs by integrating digital infrastructure, GNSS capabilities and reliable communication systems.

GNSS provides the **high-accuracy positioning** needed for navigation, localisation and real-time decision-making, while GNSS and EO together enable **high-definition, continuously updated maps**. SATCOM **extends connectivity where terrestrial networks are limited**, supporting real-time data exchange for V2X, remote monitoring and traffic coordination. Combined with AI and sensor/data fusion, these space technologies help automated systems interpret sensor inputs, detect objects, predict hazards and traffic conditions, and adapt their behaviour in real time to ensure safe and reliable operation, even in challenging environments.

Electrification powers the future of mobility

Electrification is accelerating, with global **electric vehicle** (EVs) sales increasing by 20% in 2025 to 20.7 million units, representing around one quarter of all new vehicle sales. This growth is being driven by environmental goals, conducive policy frameworks and ongoing innovations in battery technology. As the transition to electric mobility continues at pace, the need for d vehicle intelligence and connectivity becomes increasingly important.

GNSS enables precise EV routing. It allows vehicles to optimise trips by taking into account battery status, charging station availability and real-time traffic conditions. With such capabilities, drivers become less anxious about range and are able to plan journeys more efficiently, making EV ownership more convenient and reliable. SATCOM is set to ensure continuous connectivity, supporting remote monitoring, OTA updates and fleet management even in areas with limited terrestrial coverage.

These developments support a broader shift toward sustainable, connected and service-based mobility, transforming how vehicles are used and managed.

Road and Automotive GNSS Value Chain[1]

GNSS

System Integrators

COMPONENT AND RECEIVER MANUFACTURERS

- AIROHA
- AISIN
- BEIJING BDSTAR NAVIGATION
- BROADCOM
- CADENCE DESIGN SYSTEMS
- FURUNO
- GARMIN
- HEXAGON*
- HITACHI
- HIRSCHMANN*
- JAPAN RADIO CO.
- KATHREIN-WERKE*
- LAIRD*
- MEDIATEK
- NIHON DEMPA KOGYO
- NUVOTON TECHNOLOGY
- NXP SEMICONDUCTORS*
- ORBCOMM
- QUALCOMM
- SIERRA WIRELESS
- STMICROELECTRONICS (STM)*
- TE CONNECTIVITY*
- TRIMBLE.
- U-BLOX*
- YAGEO
- ZHEIJANG JC

TIER 1 SUPPLIERS

- ACTIA*
- ALPS ALPINE CO
- AUMOVIO (former Continental)*
- BOSCH*
- DENSO
- FICOSA*
- THALES GROUP
- PIONEER
- SIEMENS*
- STONERIDGE
- VALEO*

HD MAP PROVIDERS

- GOOGLE
- HERE*
- TOMTOM*

AUTOMATED DRIVING SOFTWARE PROVIDERS

- AURORA INNOVATION
- AVISENSE**
- MOBILEYE (INTEL)
- NVIDIA
- ...

VEHICLE MANUFACTURERS

- BMW*
- BYD
- CHANGAN GROUP
- CHERY
- DAIMLER*
- DONGFENG
- FAW GROUP
- FORD
- GEELY
- GM
- GREAT WALL
- HONDA
- HYUNDAI
- MAZDA MOTOR
- NISSAN
- RENAULT*
- SAIC MOTOR
- SUBARU
- STELLANTIS*
- SUZUKI
- TATA MOTORS
- TESLA
- TOYOTA
- VOLKSWAGEN*

AFTERMARKET AND DEVICE VENDORS

- GARMIN
- MARELLI*
- MICHELIN (MASTERNAUT)*
- OCTO TELEMATICS*
- TOMTOM*
- TRAKM8*

SERVICE PROVIDERS

- **MOBILE NETWORK OPERATORS:**
- AIRTEL, AT&T, CHINA MOBILE, T-MOBILE*, TELEFONICA*, VODAFONE*

- **TRAFFIC INFORMATION PROVIDERS:**
- GARMIN, GOOGLE, TOMTOM*

- **ROAD TOLLING:**
- KAPSCH*, MHIESA, NTPS*, SATELLIC*, SIEMENS*, SKY TOLL*, TOLL COLLECT*

- **AUGMENTATION SERVICE PROVIDERS:**
- U-BLOX*, HEXAGON*, SWIFT, TOPCON, TRIMBLE

- **CAR SHARING OPERATORS**

- **TELEMATICS SERVICE PROVIDERS**

- **FUEL/FLEET CARD ISSUING COMPANIES**

- **MAINTENANCE & DIAGNOSTICS**

INFRASTRUCTURE MANAGERS

- CAR OWNERS
- COMERCIAL VEHICLES DRIVERS
- ENFORCERS
- FLEET OPERATORS
- INSURANCE COMPANIES
- MEMBER STATES
- ROAD NETWORK OPERATORS

LEGEND

Commercial offering
Public offering
User segments

European[2] GNSS industry in the global arena

In 2024, the GNSS industry in the Road and Automotive segment represents one of the largest and most dynamic global markets, with Europe holding a 30% share of the total global GNSS revenue. This segment is primarily driven by the mandatory integration of Galileo-enabled eCall systems in all new vehicle-types and the rapid adoption of autonomous driving and connected mobility solutions. While North America maintains a leading global share of 40% in the overall GNSS market, Europe remains a specialised powerhouse in road-user charging and high-precision automotive timing, led by major players such as STMicroelectronics, u-blox, and Hexagon AB.

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded a prize by the EU CASSINI initiative.

Road and Automotive EO Value Chain[1]

EO

DATA PROVIDERS

- AIRBUS*
- BLACKSKY
- GEOSAT*
- E-GEOS*
- ICEYE*
- VANTOR
- PLANET
- SATELLOGIC
- UMBRA
- ZHUHAI ORBITA

MAP PROVIDERS:
APPLE, GOOGLE, MAPQUEST, MICROSOFT, OPENSTREETMAP*, OVERTURE MAPS*

HD MAP PROVIDERS:
GARMIN, HERE*, TOMTOM*

- ALOS-2 (JAXA)
- COPERNICUS SENTINELS*
- COSMO-SKYMED (ASI)*
- EUMETSAT METEOSAT, METOP*
- GOES (NOAA)
- JMA (HIMAWARI)
- NISAR (NASA/ISRO)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- USGS/NASA LANDSAT
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- ALIBABA CLOUD
- AWS
- CLOUDFERRO*
- GOOGLE CLOUD PLATFORM
- HUAWEI CLOUD
- IBM CLOUD
- MICROSOFT AZURE
- OVHCLOUD
- T-SYSTEMS*

PLATFORM PROVIDERS

- CREODIAS*
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- OPEN DATA CUBE
- OPENEO*
- SENTINEL-HUB (PLANET)
- UP42*

- COPERNICUS DATA SPACE ECOSYSTEM (CDSE)*
- WEKEO*

EO PRODUCT, SERVICE AND INFORMATION PROVIDERS

- ACCUWEATHER
- AFRY*
- AIRBUS SE*
- AVINEON*
- BEIJING DIGSUR SCIENCE AND TECHNOLOGY CO.
- DETEKTIA*
- E-GEOS*
- GAF*
- GEOFEM*
- METEOBLUE AG*
- PLANETEK*
- SATSENSE*
- SCICROP INFORMACAO E TECNOLOGIA S.A.
- SPOTLITE*
- TRE ALTAMIRA*
- VAISALA*

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS EUROPEAN GROUND MONITORING SYSTEM (EGMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*
- COPERNICUS SERVICES*

END USERS

- CAR OWNERS
- COMMERCIAL VEHICLES DRIVERS
- ENFORCERS
- FLEET OPERATORS
- INSURANCE COMPANIES
- MEMBER STATES
- PRODUCERS OF INFOTAINMENT
- SYSTEMS
- ROAD AUTHORITIES
- ROAD NETWORK OPERATORS

LEGEND

Commercial offering
Public offering
User segments

Companies active in weather monitoring

Companies active in infrastructure monitoring

European[2] EO industry in the global arena

While in 2024 North America continues to lead the global arena with a dominant share up to 45% of the EO market, Europe distinguishes itself through flagship institutional programmes like Copernicus and a rapidly expanding commercial sector. The industry is dominated by established giants like Airbus, alongside specialized firms such as Iceye.

NOTES

1: The value chain considers the key global and European companies involved in EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity the data providers are not repeated in other stages of the value chain in which they are active.

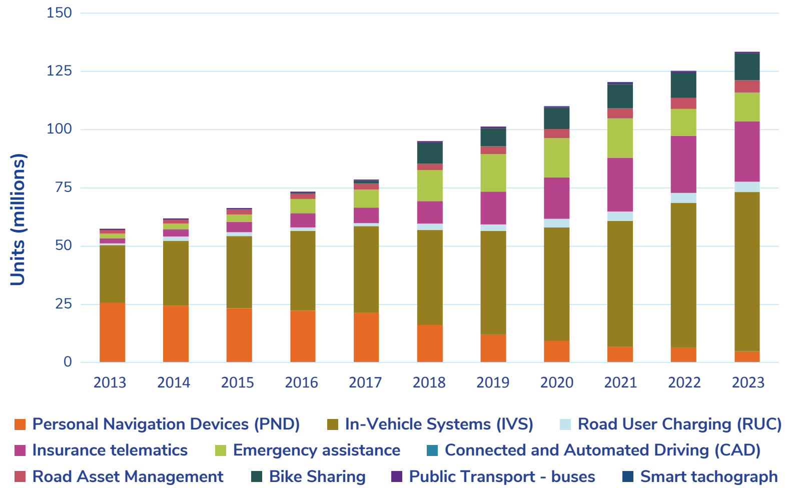
2 In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 for a comprehensive description of the EO value chain and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

Space technologies boosting autonomous and connected mobility

Shipments of GNSS devices by application



GNSS device shipments for the Road and Automotive segment have doubled, rising from around **57 million units in 2013 to over 130 million units in 2023**. This surge has been largely fuelled by the increased adoption of in-vehicle systems (IVS), emergency assistance features and insurance telematics solutions.

Shipments of **IVS** alone **grew from 25 million units in 2013 to more than 65 million in 2023**, reflecting a robust **CAGR** of about **10.6%** throughout this period.

Insurance telematics has consistently expanded in recent years, becoming the second-largest application in 2020 and reaching close to **26 million units in 2023. Bike sharing** applications have also experienced significant growth, with shipments reaching **11.6 million** units, driven by urbanisation, sustainability initiatives and the integration of new technology.

On the contrary, the market for **Personal Navigation Devices (PND)** has sharply declined, dropping from 25 million units in 2013 to fewer than 5 million in 2023, mainly as a result of the widespread use and advanced capabilities of smartphone navigation applications.

Robotaxis go mainstream as space tech powers the autonomous urban mobility revolution

The **robotaxi segment is rapidly transitioning** from isolated pilot programmes **to early commercial deployment** in major cities like San Francisco, Phoenix, Beijing, Shanghai and Shenzhen. Companies such as Cruise, Baidu Apollo Go, Didi and Waymo are introducing **Level 4 autonomous fleets** that operate within geo-fenced urban areas, elevating standards in urban mobility. **By 2035, up to 80 cities worldwide** are expected to **offer robotaxi services, with the market potentially reaching €113 billion**[1]. This growth highlights the shift toward mainstream, driverless ride-hailing as a preferred urban transport option.

Space-based technologies contribute to this evolution. GNSS provides the precise positioning required for reliable navigation and location-based functions such as automated pick-up, geo-fencing and regulatory compliance. Combining GNSS with multi-sensor fusion strengthens accuracy, even in complex city environments. Satellite communications, such as Starlink for Tesla robotaxis, further ensure continuous fleet connectivity for monitoring, teleoperation and software updates.

GNSS road user charging: expanding scale and scope

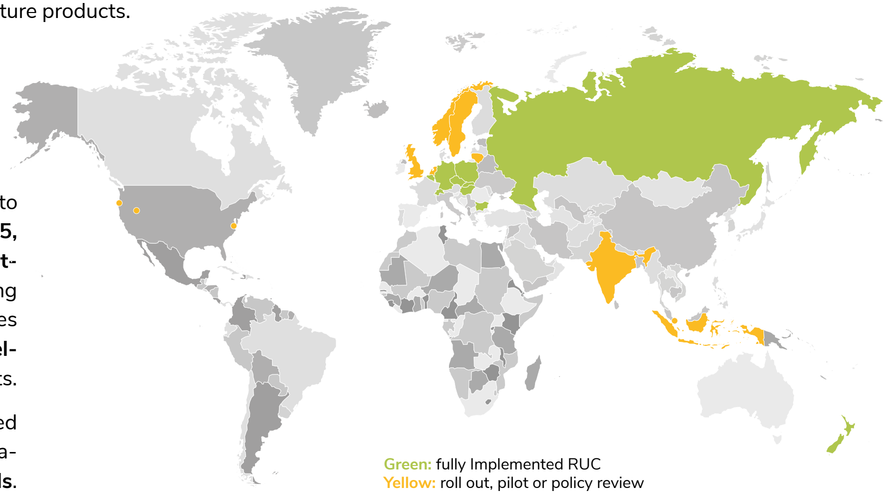
The adoption of Global Navigation Satellite System (GNSS) road user charging is becoming global and is increasingly applied to passenger vehicles, reshaping how highway infrastructure is funded and supporting more sustainable transport networks. **By 2025, numerous EU Member States**, alongside countries such as **India, Russia and New Zealand**, and pilot **cities in Asia, had implemented GNSS-based tolling**. These systems ensure equitable, distance-based charging across broad road networks, with users paying according to usage. Global rollout is now taking place also thanks to Europe leading on the implementation of heavy-goods vehicles schemes. The scope of GNSS-based schemes is now broadening. Countries including India and Singapore are now introducing **satellite-based tolls for all vehicle types**, leveraging locally developed technologies such as NavIC and BeiDou with hybrid onboard units.

These solutions offer real-time, transparent billing and help improve traffic flows. By enabling distance-based and emission-based charging, they also give authorities **tools to encourage cleaner vehicle choices**. Supported by affordable hardware, flexible regulations and widespread GNSS device use, **this shift is transforming legacy tolling into digital, scalable and more sustainable models**.

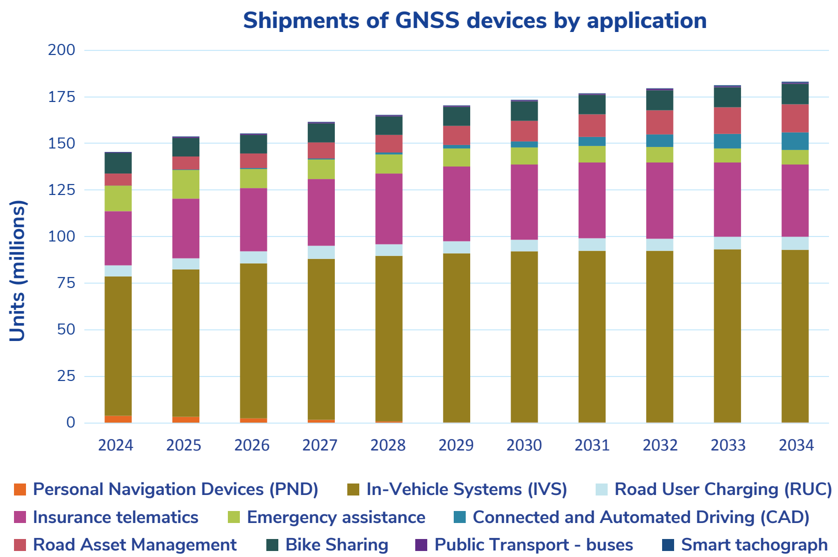
EO use for road infrastructure monitoring – specific use cases

Earth Observation (EO) is gradually shifting from pilot projects to emerging operational services supporting road infrastructure managers and agencies in several countries. Applications include ground motion monitoring with Sentinel-1 and commercial SAR for detecting subsidence, vegetation mapping for roadside management, and hazard risk assessment for landslides and extreme weather. Agencies like National Highways (UK), ANAS (Italy), and some US State Department Of Transportation (DOT) are integrating EO data into infrastructure planning and risk management, though full operational use remains limited.

X-band SAR expands revisit rates, typically from days to weeks, while free and open L-band satellites such as the recently launched NISAR and the upcoming Copernicus ROSE-L will allow expanded ground motion measurement points in vegetated areas and higher resolution soil moisture products.



Technological advancements in automotive GNSS and emergency services drive market growth



The road and automotive segment is anticipated to grow steadily, with GNSS device shipments projected to rise from nearly **150 million units in 2024 to over 180 million units by 2034**. This increase reflects rising automotive sales, rapid technological innovation and evolving consumer preferences, particularly the growing demand for connected and advanced vehicle features.

Growing vehicle demand is expected to further drive the expansion of In-Vehicle Systems (IVS), which have become standard features of new vehicles, to support all the positioning-based services and features offered by OEMs.

An analysis of the 10 applications within the segment shows that **IVS is the dominant application, accounting for over 53% of total shipments**. Insurance telematics and emergency assistance devices follow, representing 19.3% and 9.7% respectively.

On the contrary, shipments of **emergency assistance are expected to decline from nearly 14 million units in 2024 to 7.7 million units by 2034**. Outside the EU, these systems are increasingly being replaced by personal consumer devices, whereas within the EU, the eCall service typically shares the same GNSS receiver as the IVS.

Smaller but growing categories, include smart tachograph and public transport such as buses, meeting demand for fleet management, regulatory compliance and improved passenger safety and service efficiency.

EU eCall legislation stimulated regulatory and commercial advancements worldwide

The introduction of the EU's eCall legislation contributed to broader international momentum on emergency assistance. Similar systems and regulatory approaches have been implemented in Russia (ERA-GLONASS harmonisation), Japan (automatic emergency call rules), South Korea (Vehicle Emergency Rescue System standards) and India (AIS-140 mandate), as well as through early commercial deployment in EU early adopters (Italy, Slovenia, Spain and Sweden) and Australia. Together, these developments have supported faster emergency response and improved vehicle safety worldwide. The **transition to Next Generation eCall** (NG eCall) builds on this foundation by leveraging **LTE/5G and IP-based networks** to enable richer data like images, video and sensor diagnostics, thereby enhancing **interoperability and emergency response capabilities across Europe**.

Emergency assistance systems are now being extended beyond passenger cars to motorcycles and other two-wheelers. BMW was among the first to implement eCall for motorcycles with its Intelligent Emergency Call system. To support this endeavour, CEN TC278 WG15 developed EN 17240:2024, outlining testing for eCall in powered two-wheel vehicles, in cooperation with ACEM to promote safety and interoperability. CEN further adapts eCall for pan-European use in powered two-wheelers, reinforcing high standards for these vehicles.

Globally, countries such as **China have mandated eCall-like systems in New Energy Vehicles**, integrating BeiDou and hybrid satellite/cellular networks for broad coverage. **Japan, India and South Korea are also developing emergency response standards for connected vehicles**. Beyond regulated implementations, premium vehicles now feature advanced eCall solutions, combining satellite systems like Galileo and BeiDou for precise crash localisation and satellite messaging. The integration of AI allows for accident severity prediction, real-time diagnostics and more efficient triage.

AI-enabled eCall systems promise smarter, more resilient post-crash assistance worldwide, **raising standards beyond current regulations and driving continued market growth**.

Mobility as a Service: how space helps cities become smarter and greener

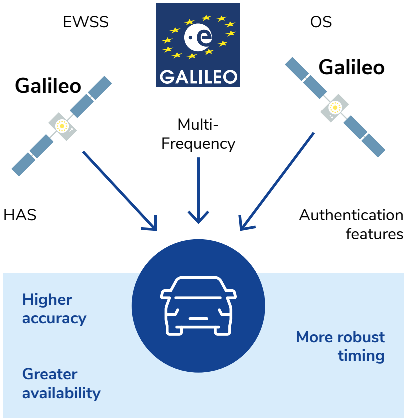
Mobility as a Service (MaaS) is **reshaping urban transport** by uniting public transit, ride-hailing, bike- and car-sharing **into integrated digital platforms**. This streamlines trip planning, booking and payments, giving users efficient, sustainable ways to navigate cities. MaaS offers a streamlined experience: with one app, such as Whim for Helsinki or Citymapper for London, users access multiple travel options, receive personalised routes and benefit from dynamic pricing. This makes journeys more convenient, economical and informed.

Technology is driving MaaS's flexibility and sustainability. AI and 5G are spurring its growth, while space solutions, such as GNSS for real-time positioning and Earth Observation for environmental monitoring, can support more informed routing and congestion management.

European providers such as **Loxo** (Switzerland) and **MyWheels** (Netherlands) are rolling out on-demand, integrated mobility services. Their platforms help **cut congestion** and **promote sustainable city travel**, supporting the **transition to smarter, cleaner urban environments**.

In turn, cities leading on MaaS implementation, such as **Barcelona, Helsinki and London**, are seeing **public transport use rise by 8-10% and private car use fall by 40-50%**, alongside a **rapid growth in bike-sharing**. These results highlight MaaS's role in advancing **greener travel habits**.

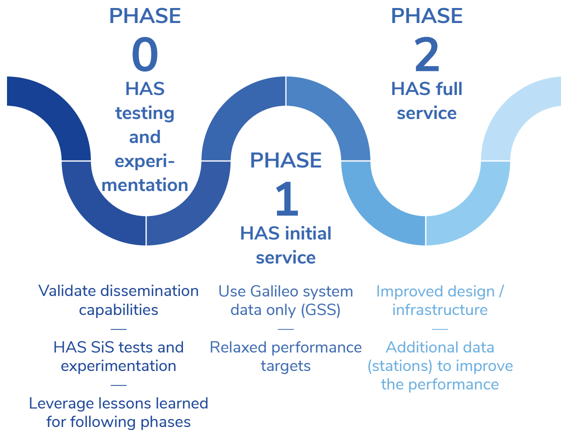
From GNSS precision to Copernicus insights: space technologies transforming mobility



Galileo HAS – Service Level 2 (SL2)

The planned **Galileo High Accuracy Service (HAS) Service Level 2** is set to deliver rapid, highly accurate and stable positioning critical for safety and advanced mobility applications. Through the **reduced time to convergence** (less than 100 seconds) vehicles are expected to gain reliable decimetre-level accuracy quickly, enabling real-time adaptive functionalities essential for autonomous driving, advanced driver-assistance systems (ADAS) and precise navigation in complex urban and rural environments.

The free availability of Galileo HAS can support automated driving deployment, improve cost-efficiency and enhance scalability for automotive manufacturers and technology integrators. Its overall contribution will depend on factors such as the convergence time by service area, and the integration with complementary technologies (e.g. providing accurate localisation in challenging environments for GNSS). If these limitations are progressively addressed, HAS could also help the wider adoption of connected and automated mobility solutions.



Galileo OSNMA fuelling smart tachographs

On 24 July 2025, **the Galileo programme officially launched** its Initial Service for Open Service Navigation Message Authentication (**OSNMA**), a **major advance in satellite-based security**. OSNMA ensures that navigation messages received from Galileo satellites are genuine and have not been altered, providing a critical layer of trust for applications that rely on accurate positioning.

A key application for OSNMA is its integration into **smart tachographs**, as required by the Smart Tachographs v2 Regulation (EU 2021/1228). These devices, used in commercial vehicles to monitor driving times and rest periods, **will now benefit from authenticated satellite data, making them resistant to tampering and spoofing**.

Copernicus European Ground Motion Service (EGMS)

Copernicus EGMS provides **millimetre-precision, ground-motion information across Europe** using Sentinel-1 InSAR, helping infrastructure managers detect surface instability, track long-term trends and identify risk zones such as areas prone to subsidence or landslides. **The service offers regularly updated data that supports monitoring and maintenance of transport networks**.

EGMS can be combined with GNSS, EO and IoT sensors **to monitor infrastructure conditions and detect anomalies throughout the asset lifecycle**. Organisations such as ANAS SpA, and Statens Vegvesen, the Norwegian Public Roads Authority, already use EGMS **to support decision-making and asset management**, helping build safer and more resilient transport networks.

Fundamental Elements

RELIANT4AD: Powering the future of safe and secure CCAM

RELIANT4AD is part of the EU's Fundamental Elements programme, which supports industry in developing advanced Galileo and EGNOS technologies and bringing high-quality GNSS receivers to market. Through this support, the **project strengthens Galileo's accuracy, robustness and authentication to provide automated vehicles with a secure, precise positioning base**.

The project, led by Thales Alenia France, and involving Valeo, Thales SIX, STM and FDC, aims to integrate HAS and OSNMA for Level 4 vehicle automation and combines **multiple sensors** with **integrity-monitoring techniques to keep positioning reliable in varied environments**, enabling early issue detection, continuity and clearer situational awareness for automated vehicles.

Safety remains central: RELIANT4AD adheres to automotive safety standards (such as functional and SOTIF) to deliver a trustworthy platform for future automated mobility, contributing to Europe's efforts to build a safe and resilient foundation for CCAM.

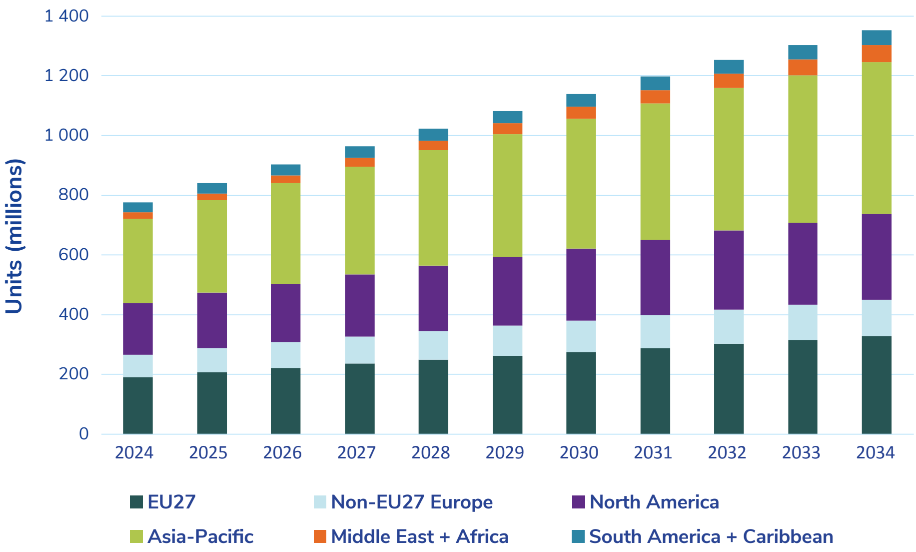
PAVESCAN Horizon Europe, a programme of the European Union

PAVE-SCAN: Smarter roads through everyday sensors

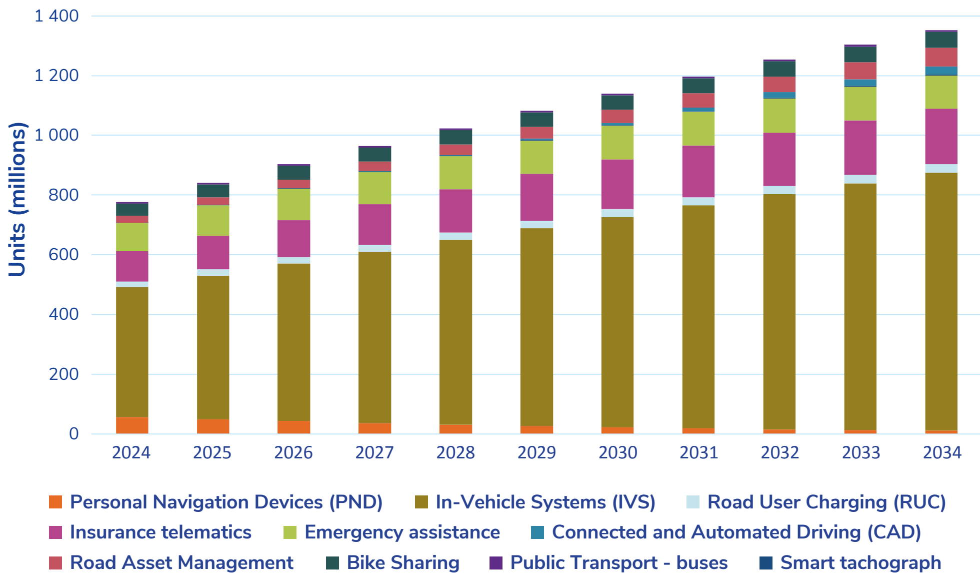
PAVE-SCAN is developing an **AI-powered system for intelligent road-surface monitoring**, combining low-cost EGNSS-based sensors with an open, machine-learning platform to detect and map damage such as cracks and potholes. Designed to be **scalable and market-ready**, the solution will be tested on public buses in five pilot cities: Genova, Madrid, Nicosia, Tallinn and Valletta.

The project also **explores participatory sensing, using smartphone-like devices to crowd-source road-condition data, which feeds into GIS-based pavement management systems**. This provides authorities with real-time, georeferenced insights for faster maintenance and better resource allocation, improving safety for citizens and reducing costs for infrastructure operators.

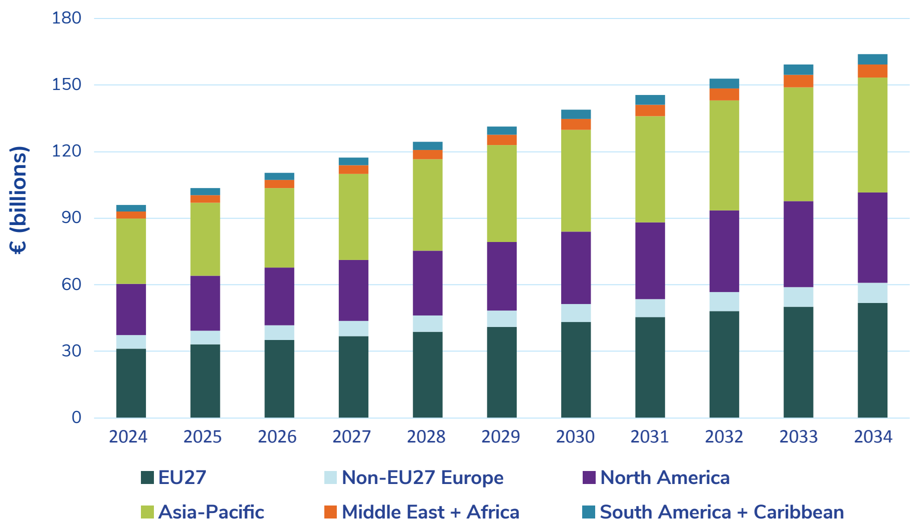
Installed base of GNSS devices by region



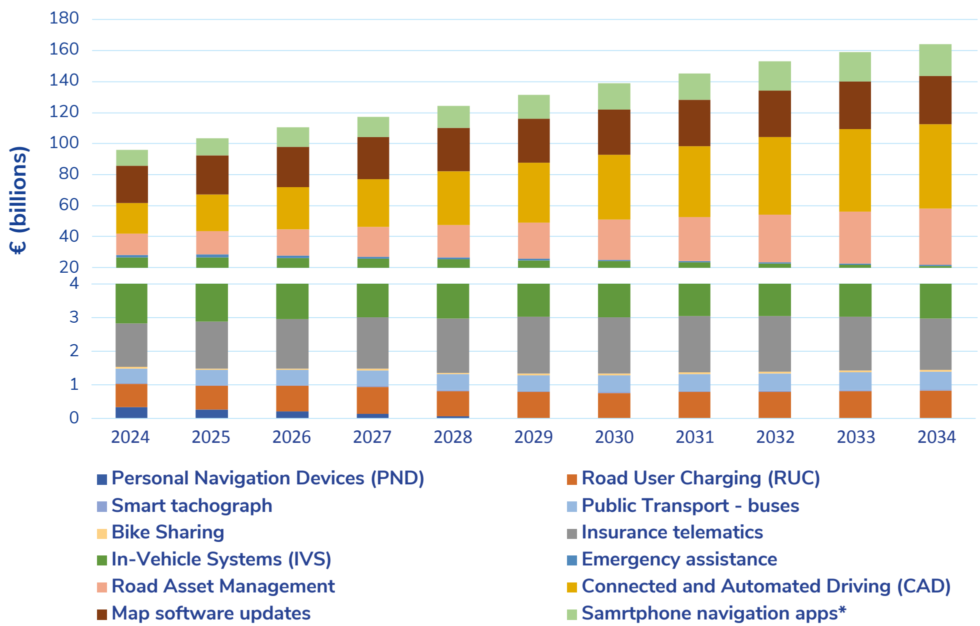
Installed base of GNSS devices by application



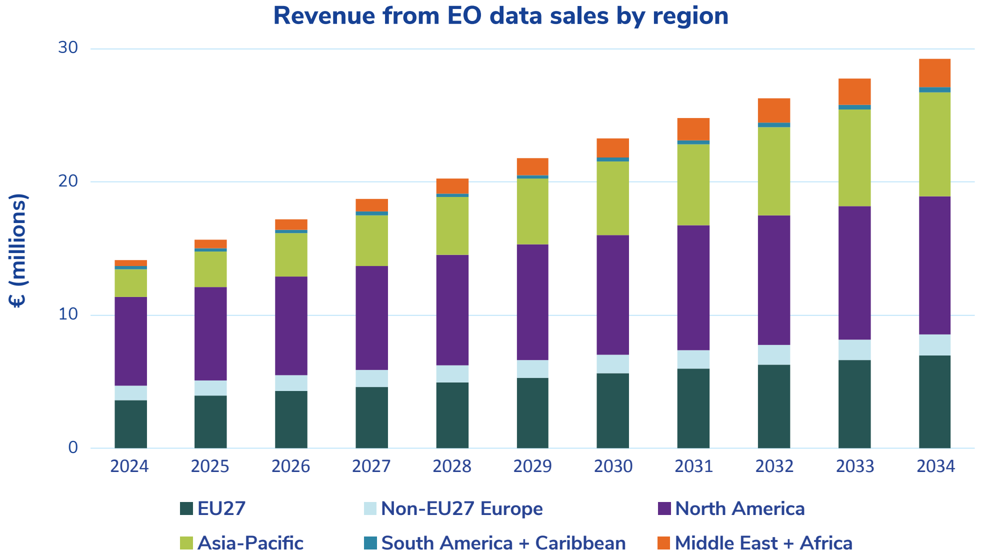
Revenue of GNSS device sales and services by region



Revenue of GNSS device sales and services by application



*Pay-to-download, In-app-purchases and ad revenue from navigation apps


Revenue from EO data sales by region
€ (millions)
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20
30
2024
2025
2026
2027
2028
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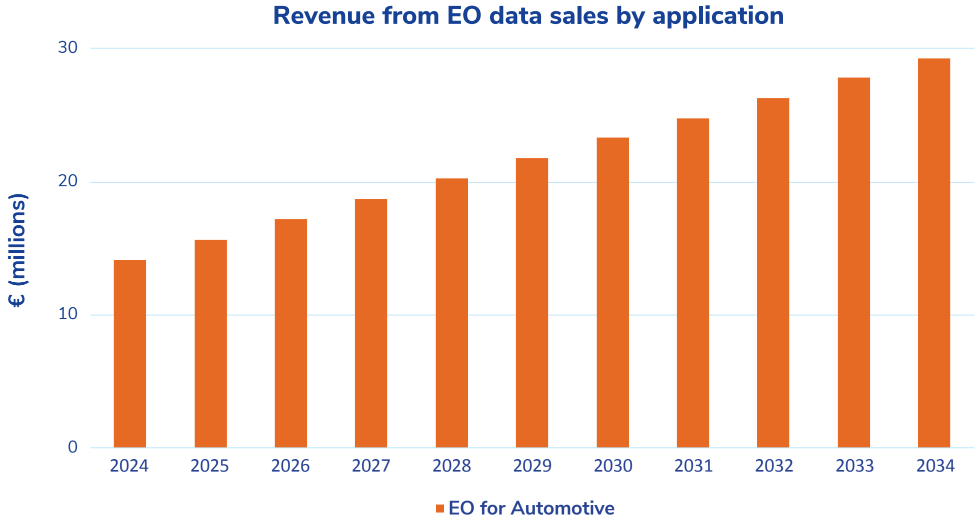
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
0
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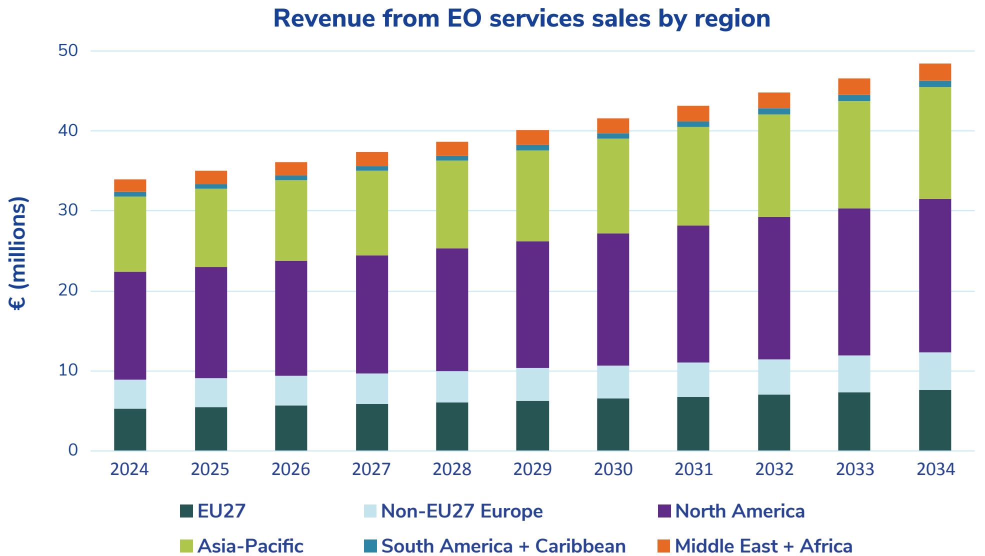
2034
EO for Automotive


Revenue from EO services sales by region
€ (millions)
0
10
20
30
40
50
2024
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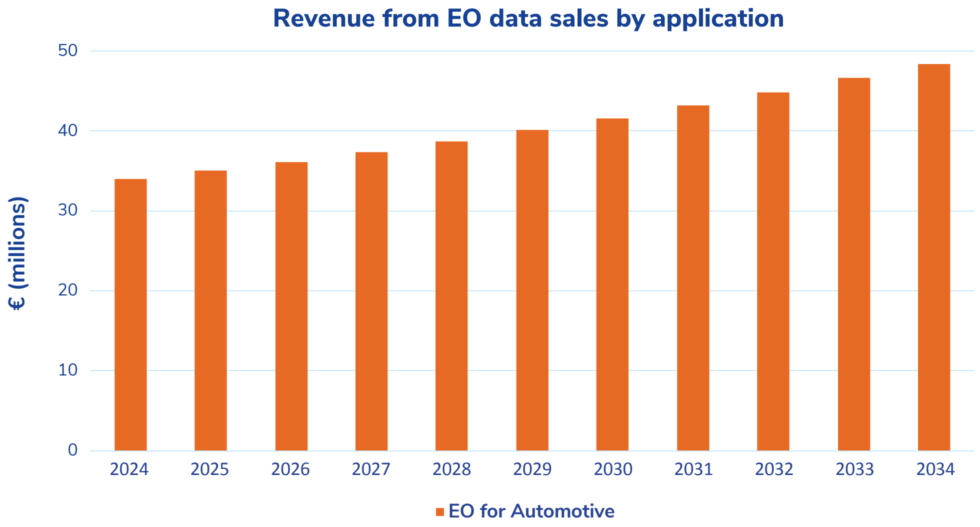
2032
2033
2034
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
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2031
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2034
EO for Automotive

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SPACE

Guidance, Navigation and Control (GNC) subsystem

- Attitude Determination (AD)
- Precise Orbit Determination (POD)
- Real-Time Navigation (RTN)
- Space Timing & Synchronisation (S-T&S)

Lunar Applications

- Lunar Orbit (LO)
- Moon Surface positioning (MS)
- Translunar Orbit (TLO)

Supporting or acting as mission payloads

- Scientific & Operational Missions (SOM)
- Technology Demonstration (TechD)

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

Application descriptions can be found in Annex 3.

SPACE

Originally designed for terrestrial use, GNSS have become a fundamental enabler of PNT services for space users, and nowadays it is embedded across the full satellite mission lifecycle. GNSS receivers are now a standard component from launch to end-of-life, supporting ascent navigation, precise orbit determination and increasingly autonomous manoeuvring and disposal.

Delivering low-cost, high-performance navigation and timing capabilities in comparison to other technologies, it is also an enabler for advanced scientific and Earth Observation applications such as remote sensing techniques and accurate georeferencing. In addition, space-based monitoring of space assets is also gaining relevance as an emerging application, as addressed in the EUSPA User Consultation Platform 2025.

Beyond Earth orbits, demonstrations of GNSS signal reception at lunar distances, together with ongoing international coordination and standardisation initiatives, are enabling GNSS to contribute to an increasing number of missions and systems expected for emerging lunar and cislunar activities. These efforts will be synchronised with the development of interoperable frameworks that aim to integrate Earth-based GNSS as a first step to future lunar navigation and timing services.

In this evolving landscape, Galileo provides distinct added value through its services for improved performance, resilience to interference and support to further innovation. For instance, successful tests conducted in space have demonstrated that the EWSS service can be used to support deep space missions.

What you will find in this chapter

- **Key trends:** Shaping the next orbital era: from LEO dominance to deep-space navigation.
- **Industry:** Space GNSS value chain.
- **Recent developments:** A growing market over the next 10 years, powered by Galileo services.
- **Future market evolution:** International standardisation and interoperability meets together.
- **European systems and projects:** Galileo solutions adopted by space users.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues by application and region.

Shaping the next orbital era: from LEO dominance to deep-space navigation

Key market trends

- LEO mega-constellations continue to dictate the lead, with GNSS as a key backbone for precision, timing and sustainability.
- GNSS consolidation is enabling the evolution of remote sensing techniques (GNSS-RO, GNSS-R) to support EO services.
- Deep space is within reach, with GNSS recently acquired from the Moon, paving the foundation for future cislunar services.

Low Earth Orbit (LEO) mega-constellations continue to dominate

With increasing yearly records of launches, **the growing demand for global coverage and low latency has positioned LEO constellations as a core enabler** – accounting for over 70% of the 12,000 active satellites in different orbits, as of 2025 – of broadband connectivity and EO services, and an emerging contributor to Positioning, Navigation and Timing (PNT) capabilities.

SmallSats continue to lead deployments in orbit, accounting for 97% of launches in 2024, while their average spacecraft mass is steadily improving as operators integrate more capable payloads to support advanced mission needs.

Within this evolving landscape, **GNSS is an essential operational backbone**, supporting Precise Orbit Determination (POD), constellation phasing, and time synchronisation required for efficient and resilient operations, enhancing autonomy, safety and sustainability of LEO missions:

- Autonomous space operations: GNSS-enabled orbit control, manoeuvres and collision avoidance – mega-constellations lead to a striking increase in close approaches – and disposal.
- Sustainability by design: GNSS supports stricter end-of-life and de-orbiting manoeuvres, aligned with space traffic management needs.
- Timing information: secure GNSS-disciplined time delivery to space and ground infrastructures.

In addition to support in-orbit operations, GNSS capabilities are also extending through the entire launch lifecycle, including Ascent trajectory monitoring, support to Flight Termination Systems, accurate stage separation or enhanced re-entry tracking and controlled recovery of first-stage boosters.

GNSS consolidation supporting space-based services

Advances in multi-constellation, multi-frequency receivers are improving data quality and reducing reliance on ground infrastructure, since GNSS capabilities supports the consolidation of demanded EO requirements and emerging space-based sensing and tracking techniques:

- **POD remains a cornerstone for EO missions**, with post-processing activity now often performed directly onboard the satellite in real time, thanks to the growing maturity of spaceborne GNSS receivers,
- GNSS is a key enabler of advanced spaceborne science techniques, including **Radio Occultation (GNSS-RO) and Reflectometry (GNSS-R)**. These methods rely on low-SWaP (Size, Weight, and Power) multi-constellation, dual/triple frequency receivers that provide higher-quality and more abundant measurements. This enables CubeSat constellations to deliver reliable, georeferenced data with minimal ground segment complexity.
- GNSS is also supporting the development of **space-based surveillance activities of space assets**, complementing ground-based tracking techniques with emerging space-based techniques.

In this context, a consistent understanding and monitoring of standardisation aspects for space applications is essential to continue a coherent and sustainable GNSS consolidation.

Deep space within reach

The **space economy is extending well beyond geostationary orbit** as exploration efforts accelerate. Confirmation of accessible lunar water, particularly near the lunar south pole, has intensified international focus on supporting sustainable human presence, while missions to Mars continue to pursue similar long-term objectives. This shift is translating into a rapid increase in projects, mission demonstrations and standardisation initiatives aimed at extending GNSS capabilities into these regions.

The **successful demonstration of the Lunar GNSS Receiver Experiment (LuGRE)** on the Blue Ghost Mission 1 – landed in March 2025 – provided valuable data for future lunar missions. The joint NASA-Italian Space Agency initiative successfully acquired Galileo and GPS signals for the first time in history, both during transit through cislunar space (in lunar orbit) and on the lunar surface, with a 3D POD Position Error < 200 m and <1km respectively.

The mission confirmed that GNSS signals – via side lobes – can be utilised both in lunar orbit (~395,900 km) and on the Moon's surface, opening the door to exploiting GNSS beyond Earth orbit, but also highlighting potential limitations such as signal strength, geometry and receiver sensitivity. PVT solutions were not the only achievements but also the successful acquisition of OSNMA and EWSS messages.

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Performance data from the mission (e.g. acquisition times, signal strength) has been available to all publics to support future design of next-generation receivers, algorithms mission planning.

International standardisation and cooperation efforts remain synchronised to ensure that **future lunar navigation architectures can interoperate seamlessly**. To this end, global community is working toward defining compatibility frameworks between the GNSS Space Service Volume and emerging lunar PNT systems to accommodate the needs of cislunar transit users.

The specifications of LunaNet, the international initiative aiming to provide PNT services at the Moon, continue to mature with interoperability demonstrations planned between ESA's Moonlight system and other prospective lunar communication and navigation nodes. Moonlight itself is progressing rapidly, with plans to deploy navigation and communication satellites in lunar orbit and to initiate early operations by the end of 2028. The system is designed to provide surface positioning with an accuracy in the range of 10m and landing accuracy of around 50m.

These developments confirms that the prospect of a functional **lunar economy is shifting from near-term exploration to concrete operational planning, in which GNSS will be a foundational enabler of this transition**. In addition, Mars remains the definitive horizon, with GNSS-inspired (not GNSS-powered) architectures expected to be developed. The European MARCONI mission, which is expected to be launched in the 2030s, is a key step in this direction, aiming to provide continuous relay and navigation signals around Mars.

Space-borne GNSS Value Chain[1]

GNSS

COMPONENT AND RECEIVER MANUFACTURERS (HW / SW)

- AIRBUS*
- ANALOG DEVICES
- BEYOND-GRAVITY *
- BLILEY TECHNOLOGIES
- CAES
- CHINA GREAT WALL INDUSTRY*
- COBHAM*
- INDRA DEIMOS*
- DLR*
- GEA SPACE*
- GENERAL DYNAMICS
- HEXAGON*
- HONEYWELL
- NEC
- NEWSPACE SYSTEMS*
- OHB*
- RAKON
- RISE*
- MOOG
- PLANETIQ
- QASCOM*
- SAFRAN*
- SKYFOXLABS*
- SPACEMANIC*
- SPACEOPAL*
- SPACEPNT*
- SPACEX
- SSTL
- SYNTONY GNSS*
- SYRLINKS*
- THALES*
- U-BLOX*
- WAY4WARD*

SPACECRAFT MANUFACTURERS & DEVELOPERS

- AIRBUS*
- ARIANEGROUP*
- AVIO*
- BLUE CANYON TECH
- BLUE ORIGIN
- BOEING
- CHINA GREAT WALL INDUSTRY
- FIREFLY AEROSPACE
- HEXAGON*
- ICEYE*
- LOCKHEED MARTIN
- LANTERIS
- MUON SPACE
- NORTHROP GRUMMAN
- SPACEX
- SPIRE GLOBAL
- THALES*
- ROCKET LAB
- SMALL SATELLITES DEVELOPERS (E.G. AAC CLYDE SPACE*, REDWIRE, INDRA DEIMOS*, GOMSPACE*, SATREV*, ISISPACE*)
- SSTL
- UNITED LAUNCH ALLIANCE
- UNIVERSITIES

SPACECRAFT OPERATORS

- ARIANEGROUP*
- BLUE ORIGIN
- ENDUROSAT*
- EUTELSAT GROUP*
- HISDESAT*
- HISPASAT*
- ICEYE*
- INMARSAT
- INTELSAT*
- EUTELSAT ONEWEB
- PLANETIQ
- ROCKET LAB
- SES*
- SPACEX
- STARLINK
- UNITED LAUNCH ALLIANCE
- VIASAT
- AMAZON LEO

- ARMED FORCES
- ESA (ESOC)*
- EU
- NASA
- NATIONAL SPACE AGENCIES
- NON-PROFIT ORGANISATIONS (E.G. AMSAT)
- RESEARCH CENTRES
- UNIVERSITIES

PROVIDERS OF SERVICES GENERATED IN SPACE

- PROVIDERS OF EO SERVICES
- PROVIDERS OF TELECOM. SERVICES

- EU (E.G. COPERNICUS)*
- GOVERNMENTAL INSTITUTIONS
- RESEARCH CENTERS
- UNIVERSITIES

FINAL USER COMMUNITIES

- EARTH SCIENCES RESEARCHERS
- EMERGENCY SERVICES
- ENVIRONMENTAL MONITORING AGENCIES
- GEOSPATIAL INTELLIGENCE AGENCIES
- INFRASTRUCTURE OPERATORS
- LAW ENFORCEMENT BODIES
- PUBLIC SAFETY INSTITUTIONS
- TERRITORY PLANNERS

LEGEND

- Commercial offering
- Public offering
- User segments

The European[2] industry in the global arena

In 2025, Europe continues to play a major role in the global market for space components, supported by a strong industrial base across all the value chain. This diversified ecosystem also allows the European industry to continue supporting the significant variety of demands, from LEO to more stringent requirements in higher orbits. Airbus, Safran, Hexagon and Thales, among other companies, are the largest contributors to strengthen the European position in the market segment.

NOTES

1: The value chain considers the key global and European companies involved in GNSS downstream activities.

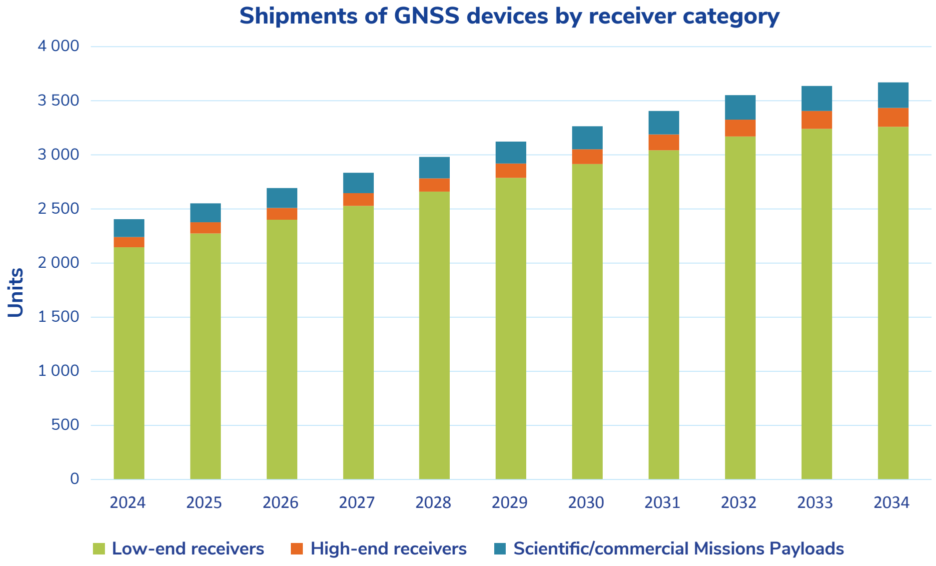
2: In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 30 for a comprehensive description of the GNSS value chain and how to interpret it at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider.

** Company awarded prizes by the EU CASSINI initiative

A growing market over the next 10 years, powered by Galileo services



Receiver category \ Applications	Attitude Determina-tion (AD)	Precise Orbit De-termination (POD)	Real Time Navigation (RTN)	Space Timing & Synchro-nisation (S-T&S)	Lunar Orbit (LL)	Moon Surface positioning (MS)	Translunar Orbit (TLO) Translunar Orbit (TLO)	Scientific & Operational Missions (SOM)	Technology Demon-stration (TechD)
Low-End	Early Stage	Early Stage	Used	Used		-	-	Used	Early Stage
High-End	Used	Used	Used	Used	Early Stage	Early Stage	Used	Used	Used
Payload/ -Scientific	-	-	-	-	Early Stage	Early Stage	-	Used	-

Due to the diverse roles of GNSS receivers in space, and the corresponding differences in needs and requirements, three major receiver categories are defined.

‘Low-End’ receivers encompass COTS New Space technologies and low-cost products. These are widely adopted in mega-constellations and small satellites thanks to lower cost and increased use of multi-constellation. **'High-End’ receivers** are still the baseline for higher orbits and long-duration missions, due to inherent reliability requirements. Finally, **‘Payload/Scientific’** receivers are used as part of the payload instrumentation. A recent example is its use on the lunar surface to help characterise its environment.

Overall, GNSS has become a standard component in almost every space mission because the availability of multi-constellation multi-frequency receivers provides a superior cost-effective positioning accuracy.

The adoption of GNSS receivers onboard space assets continues to expand not only due to the increasing number of LEO constellations but also due to the rise of new applications, such as their use on GEO platforms to support orbit control and station-keeping – reflecting the shift toward autonomous navigation for optimised mission profiles – and the extension of GNSS use beyond near-Earth missions.

Lunar and deep-space missions will create a smaller but higher-value segment, where European companies are already driving the development of advanced, long-duration radiation-tolerant receivers, despite the cost challenges tied to demanding qualification requirements and low-production volumes.

The chart to the left shows the continued evolution of demand alongside an intensification in market concentration, with few operators dominating launch activity. Mass production will push down the cost of GNSS receivers, which will require additional capabilities such as anti-spoofing and support to sustainability activities. In parallel, emerging applications – such as space-based monitoring of space assets – are expected to also contribute to demand, as growing niches for GNSS receivers.

In this fast-changing context, it would be beneficial for developers of European GNSS receivers for space assets to conduct a study on the future target cost range of space GNSS receivers across different mission profiles, including ongoing technology developments (e.g. quantum technologies, miniaturisation, radiation hardening vs commercially derived solutions, AI-enabled processing).

Growth is projected to tail off towards the end of the next 10 years, as the market enters a mature yet diversified phase, balanced between mass volume LEO demands no longer experiencing cost-reduction, and high-end receivers designed to satisfy stringent requirements.

Galileo services in support of space: HAS evolution, OSNMA declaration and EWSS testing

Galileo’s service evolutions are opening new possibilities for space users, particularly through the introduction of the High Accuracy Service in 2023, the declaration of OSNMA and the first successful tests of the EWSS for Space performed in 2025.

HAS has triggered new receiver developments, including the integration of the E6 band into compact receivers, to new algorithms designed to shorten convergence for satellites in highly dynamic regimes or operating at very high altitudes such as GEO orbits. With expectations from near term in-orbit testing of HAS-capable receivers providing enhanced accuracy (~5cm) and 3D convergence time, further improvements are anticipated with the future declaration of Service Level 2 expected by 2027.

In addition, the arrival of OSNMA supports new applications based on authenticated data, such as interference-mapping tools and authenticated geolocation for EO products, while posing additional constraints on power consumption and processing timing requirements. Likewise, EWSS has recently been tested in cislunar environments with dedicated Galileo dummy messages, where preliminary results were quite positive, underlining how the service can become vital for deep space situations.

Finally, the 2024 publication of the Galileo Reference Antenna Pattern provides valuable information for missions operating from beyond MEO, where spacecraft can rely on predictable signal characteristics.

In this current scenario, funding mechanisms will continue to prioritise the development and adoption of of GALILEO differentiators supporting user needs, as exemplified by the recently published EUSPA call for new HAS receivers for Space launched in 2025, where there is the opportunity to look at both short and medium-term evolutions.

International standardisation and interoperability converge together

GNSS in navigation: supporting all space operations

GNSS will continue to serve as a core navigation enabler across all orbital regimes in the future, expanding its role as mission requirements demand higher autonomy from ground, increased resilience and enhanced precision.

In launch systems, GNSS is progressively being used for safety-critical functions, performed jointly with inertial systems. The different phases – including ascent navigation, flight termination systems, and booster recovery – are driving the sector to more stringent requirements. As a result, the demand is growing for improved accuracy, anti-spoofing-capable receivers qualified for high dynamics. This is complemented by the **need to continue evolving the antenna capabilities**, aiming at higher robustness in signal reception.

In **Low Earth Orbit, as analysed in other sections of this report, GNSS remains the primary navigation source for spacecraft, enabling precise orbit determination, flying formation and autonomous manoeuvring**. With mega-constellations raising fast, navigation robustness and accuracy in congested orbital environments is and will be essential for collision avoidance and coordinated space traffic management operations, in compliance with emerging sustainability requirements. In addition, the number of interference events detected are rising, driving the need to further enhance GNSS reliability.

Beyond LEO, **GNSS adoption is steadily expanding into MEO, GEO and Highly Elliptical Orbits, as receivers can track and exploit side-lobe signals at these altitudes**. These techniques, used in conjunction with antenna pattern information – reinforcing the need to further develop advanced GNSS antenna solutions – support station keeping, orbit control, and precise timing.

Looking beyond, the early demonstrations of GNSS signal reception in cislunar space and on the lunar surface have shown that GNSS will play a crucial role in meeting navigation needs at these environments for those missions planned in the short and medium term.

Multi-GNSS SSV expected to address deep space

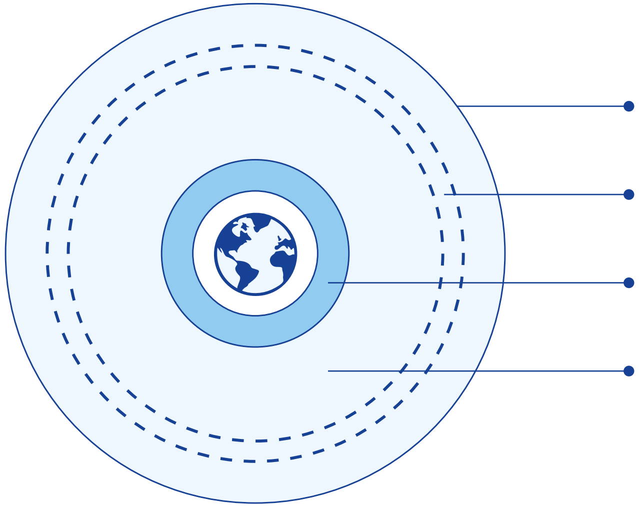
The extension of GNSS use beyond Earth-centred orbits is gradually demanding an evolution of the Multi-GNSS Space Service Volume (SSV) framework.

The **United Nations International Committee on GNSS (UN ICG)** continues to reference the second version of the **Interoperable Multi-GNSS Space Service Volume (SVV)** booklet published in 2021, and building on this foundation, ICG Working Group B is working on extending the SSV concept beyond the current definitions to include cislunar and lunar environments.

Through a series of dedicated workshops held **in 2024 and 2025, the importance of coordinating GNSS and lunar Positioning, Navigation and Timing (PNT) systems has been emphasised**. This reflects a need to ensure future interoperability, spectrum compatibility, lunar reference systems and timing frameworks for lunar PNT. In accordance, this coordination brings together GNSS providers, space agencies and lunar navigation developers to share lessons learned and to align future technical assumptions.

Thus, the future Multi-GNSS SSV evolution shall be developed in close coordination to address the expectations for lunar PNT systems.

The GNSS space service volume and its regions



Standardisation and interoperability in the lunar environment

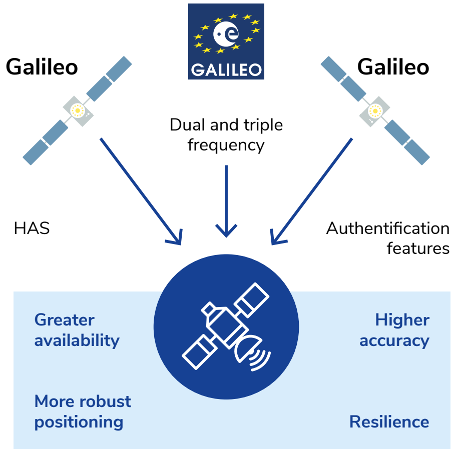
Workshop discussions also highlighted that the development of lunar PNT architectures must build on existing GNSS experience while addressing unique aspects of cislunar operations. Therefore, standardisation and interoperability efforts shall be at the core of the activities to align GNSS services with future lunar systems, supporting both the short and the long term PNT needs.

In this context, **LunaNet is emerging as a reference architecture for the main services** to be covered: lunar communications, navigation and timing. In fact, the foreseen architecture is that LunaNet Interoperability Specification (LNIS) plays a central role, thus ensuring full compatibility between current GNSS and future systems. LNIS defines a common set of standards for LunaNet services, designed to allow multiple LunaNet Service Providers to be integrated seamlessly into a shared lunar infrastructure. In this framework, the future use of Low-SWaP receivers to support the operational realities of surface and orbiting assets is a primary goal.

By defining common interfaces, reference frames and timing concepts, **LNIS will also enable receivers to benefit from Earth-based GNSS signals, lunar PNT services, and communications links within a coherent framework**. This approach is expected to improve resilience through the combined use of GNSS and Lunar Augmented Navigation Services (LANS), while also simplifying qualification and certification processes for operation in the lunar environment.

Looking further ahead, these efforts will also set the basis for future Mars architectures. While Mars navigation systems will not rely directly on GNSS, the principles established through lunar standardisation are expected to form the foundations for the development of Mars navigation and communication infrastructures.

Galileo solutions adopted by space users



Added value brought by EGNSS

Galileo is today consolidated as a solid contributor to the SSV in all of its regions.

In terms of accuracy, Galileo not only outperforms other GNSS thanks to the superior quality of its **determined orbits and clocks**, but its **High-Accuracy Service provides the means to conduct Precise On-board Orbit Determination**.

On the other hand, Galileo, with OSNMA, is currently the only GNSS constellation providing a **dedicated service allowing spacecraft operators to detect in-orbit spoofing attacks**.

It must be highlighted that EUSPA keeps forwarding user requirements from the space community to the EGNSS programmes for their evaluation and possibly inclusion into the evolution of these services, as demonstrated in the dedicated sessions to GNSS receivers onboard space assets that are part of the agency's UCP.

EU Space Programme services and features for space applications

The **EU Space Programme comprises several flagship components** that work in harmony.

For example, Galileo-capable receivers onboard spacecraft can produce precise ephemerides, which will support the evaluation and eventual performance of Collision Avoidance Manoeuvres (CAMs), providing benefits to all users of the EU SST.

Galileo PNT is also expected to support the EU secured satellite connectivity initiative, by enabling orbit determination of the satellites composing the future IRIS² constellation, for example. Complementary, GOVSATCOM is expected to support the connectivity of EU space infrastructures and to even enable satellite connectivity in the future.

Remote-sensing techniques are becoming the paradigm of New Space: GNSS Polarimetric Radio Occultation and GNSS-Reflectometry

GNSS Polarimetric Radio Occultation (PRO) **receivers are now operational in space enabling detection of atmospheric conditions**. The ecosystem brings together users, satellite providers and meteorological agencies around capabilities, future needs and standardisation. For that reason, the Radio Occultation and High Precipitation payload was conceived as a proof-of-concept experiment, making the first operational satellite to collect PRO data. **As of today, commercial GNSS-RO missions are providing operational products**, and in fact, Sentinel-6 satellites carries onboard Radio Occultation (RO) missions for climate users addressing GALILEO occultations.

To further support the performance, Galileo HAS is already relevant and increasingly valuable for RO missions enabling real-time precise orbit determination for LEO platforms carrying dedicated RO-receivers. **HAS corrections available on-board also allow shortened latency for near-real time RO** products which is key in operational meteorology or emergency warning systems applications.

Another remote-sensing technique highly relevant in space is **GNSS-Reflectometry** (GNSS-R), which is now entering the New Space domain with more compact and scalable missions, and especially dedicated receivers, making the technique adequate for regular EO operations. **GNSS-R is reaching a level of maturity that allows global coverage, frequent revisit and routine services.** This situation impacts directly on commercial operations between GNSS-R providers and operational weather forecasting centres, leading to data assimilation for positive impacts on forecast accuracy.

The latest GNSS-R receiver technology onboard HydroGNSS (ESA scout mission recently launched in November 2025) is designed to be multi-constellation and multi-frequency and able to handle dual polarisation, enhancing flexibility and accuracy in reflectometry retrievals.

New marks for Galileo Cyber Space Receiver

After the successful outcomes of the **Galileo Cyber Space Receiver** (GEYSER) project, which was launched in 2021 and funded by EUSPA, the receiver is now available on the market. The project developed an **innovative close-to-market GNSS space receiver for LEO orbits and launchers**. Thanks to its compact, low weight (<1 kg) design, the receiver can be used even in mega-constellations and LEO-PNT concepts.

EYSER prototype
© Qascom

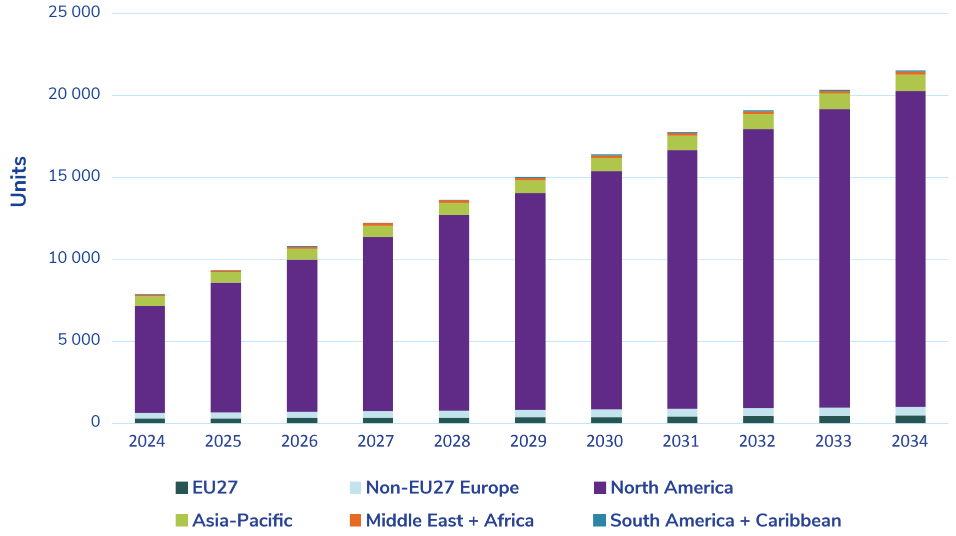
The product also benefits from various Galileo differentiators. The inclusion of E6 frequency enables the **use of HAS** , while the receiver capabilities are complemented by robust protection against interference – thanks to the **authentication provided by OSNMA** – and implementation of INAV improvements (RedCED and RS Codes among others).

The GEYSER product has been also used as the baseline for recent success stories, since its Software Defined Radio additionally supports GTO, GEO and deep space navigation. Indeed, validation activities have been conducted for a range of demonstration scenarios, including:

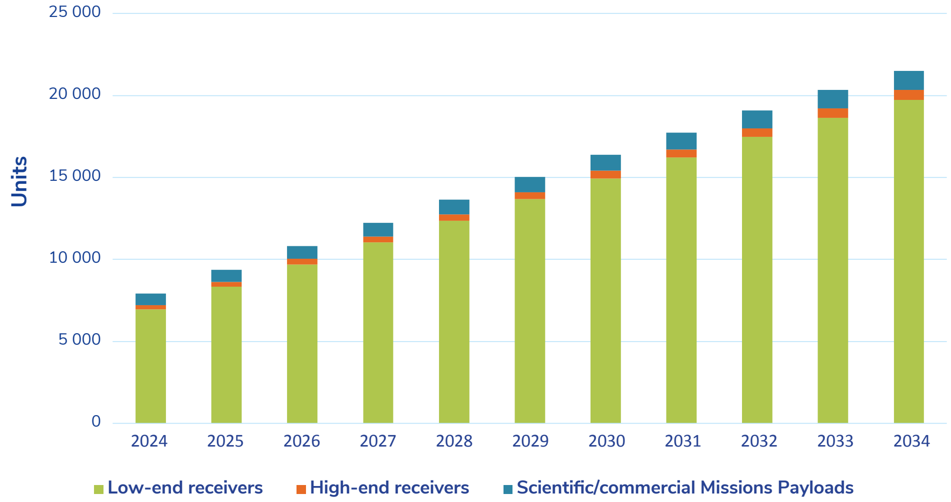
- Launcher phases, with demonstration of real-time navigation solutions during launch and re-entry phases, and its operational use for autonomous flight termination systems.
- Cislunar and lunar surface scenarios, through the Lunar GNSS Receiver Experiment, acquiring the first GNSS Navigation Solution in Lunar Orbit and PVT navigation solution at the Moon surface, while also conducting testing of Galileo EWSS.

The receiver has been selected by ASI as a payload for In-Orbit testing in 2027 and for further experimentation in robustness and security features and high accuracy navigation (dual frequency POD).

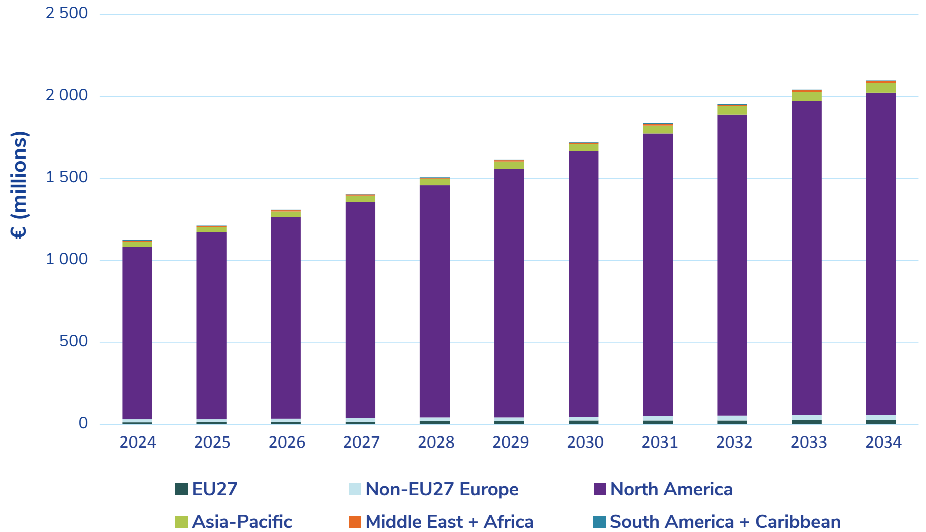
Installed base of GNSS devices by region



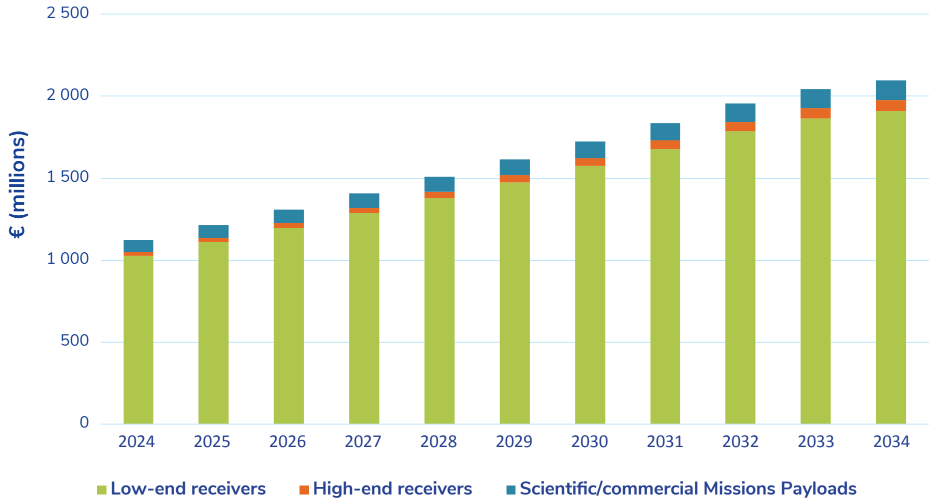
Installed base of GNSS devices by receiver category



Revenue of GNSS device sales by region



Revenue of GNSS devices by receiver category



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URBAN DEVELOPMENT AND CULTURAL HERITAGE

Environmental monitoring
- Urban greening
- Urban climate*

Smart Cities operations
- Smart utilities
- Smart waste management

Urban planning
- Surveying and mapping of urban areas**
- Urban modelling and planning***

Cultural heritage monitoring
- Ground deformation
- Change in built and natural environment
- Risk mapping
- Conflict-related damage and looting
- Air quality impact
- 3D modelling, digital twins
- Visitor management

- **EO application**
- **GNSS application**
- **Synergetic application** (combined use of EO and GNSS)

* incl. thermal monitoring, urban heat islands;
** incl. surveying & mapping, informal dwellings, real estate, light pollution;
*** incl. urban planning, urban modelling, 3D modelling, digital twins

Application descriptions can be found in Annex 3.

URBAN DEVELOPMENT AND CULTURAL HERITAGE

Earth Observation (EO) and Global Navigation Satellite Systems (GNSS) play a vital role in supporting the evolution towards smart, interconnected and climate-neutral urban centres. Solutions driven by EO and GNSS are utilised by city authorities, urban planners, estate agents, cultural heritage professionals and surveyors for a broad spectrum of tasks.

EO delivers crucial data for urban planning, keeps track of informal housing, and assists in monitoring the status and advancement of urban greening initiatives. Furthermore, EO-based services are instrumental in providing key information about air quality in cities, detecting particles that could impact public health and keeping tabs on greenhouse gas emissions. This data is especially important when overseeing cultural heritage locations, as air quality and possible ground subsidence can pose risks to these sites.

GNSS solutions, often employed alongside EO, are used for precise surveying and mapping of urban landscapes, as well as constructing sophisticated 3D representations of the built environment.

What you will find in this chapter

- **Key trends:** Earth Observation and GNSS enable smarter urban planning, monitoring, and preservation.
- **Industry:** Urban development and cultural heritage value chains.
- **Recent developments:** Satellite data support monitoring and planning of urban areas, contributing to improved resilience, sustainability and preservation of cultural heritage.
- **Future market evolution:** EO data form the basis for applications supporting the sustainability of urban spaces and preservation of cultural heritage sites.
- **European systems and projects:** European space data and project enable smarter, safer and climate-resilient cities and heritage sites.
- **Reference charts:** Yearly evolution of installed base of GNSS devices and revenues as well as EO revenues by application and region.

NEW! This edition now relies on an improved methodology for the estimation of EO service revenues.

EO and GNSS enable smarter urban planning, monitoring, and preservation

Key market trends

- Satellite EO is gaining traction for urban greening and heat-mitigation policies, helping cities monitor vegetation, canopy cover, sealed surfaces and cooling effects in line with EU and local regulations.
- Surveying and mapping are moving to GNSS-enabled UAV and mobile platforms, delivering fast, high-accuracy 3D data for cadastral updates, construction monitoring and digital twin workflows.
- EO time series increasingly support urban growth, heritage monitoring and housing-resilience assessments, using long-term archives and analytics to forecast change and identify at-risk areas.

Earth Observation as a key enabler for urban green regulation & heat mitigation

The EU's Nature Restoration Law mandates that Member States halt net loss of urban green space (including tree canopy) by 2030 and achieve increases in the coming years. This is mirrored by national and regional regulations, such as Germany's Bebauungsplan, requiring designated unsealed green areas and tree planting on large parking lots, or Zurich's rule mandating greening of flat roofs.
Earth observation, using vegetation indices (e.g. NDVI) built-up and imperviousness indices (e.g. NDBI, IBI), together with land surface temperature, can **pinpoint areas with high impervious coverage** (e.g. parking lots) that drive urban heat islands. These hotspots become **priority zones for greening interventions**.
Studies show that dense and well-distributed greenery lowers surface temperatures. Authorities can use periodic EO data to track land cover changes, confirming whether sealed areas are converted to permeable or vegetated surfaces per regulations (e.g. tracking tree count, canopy growth over time).
EO-derived data before and after **interventions reveal cooling effects**. Research shows urban green spaces (parks, trees, roofs) can reduce surface and air temperatures by 2-5 °C depending on the intervention type. Emerging EO-based methods, which combine thermal and multispectral imagery with machine learning, enable granular, low-cost and scalable monitoring of tree health, greenness and microclimate impacts across cities.

Urban growth forecasting from EO time series

Urban growth forecasting is largely benefitting from Earth Observation (EO) time series. With more than 30 years of open archives from missions like Landsat or Sentinel-2, planners now have consistent, long-term datasets to **track urban expansion and land-use conversion**. Machine learning models trained on these EO records can project how and where cities are likely to grow in the coming decade, offering **predictive insights** beyond backward-looking statistics. By integrating data from cadastral surveys, these forecasts can be calibrated against authoritative local records, ensuring alignment with planning needs on the ground. Real-world adoption of EO-based urban forecasting is already visible in municipal planning practice. Helsinki's 3D Digital Twin integrates aerial and LiDAR data to simulate urban expansion and assess green infrastructure under different growth scenarios. Barcelona's Urban Monitoring Lab employs Copernicus and Landsat time series to track land-use change and urban densification, supporting climate adaptation and sustainable mobility planning. The EO4SD-Urban initiative (ESA, World Bank) has worked with cities such as Kigali, Accra, and Addis Ababa to develop predictive urban growth tools that guide infrastructure investment and housing allocation. These operational cases demonstrate how EO-based forecasting is evolving from a research concept into a practical decision-support tool for urban planners and municipal authorities worldwide.

High-accuracy UAV surveying and mapping with GNSS

Surveying and mapping are increasingly performed using Unmanned Aerial Vehicle (UAV) platforms equipped with high-precision GNSS positioning systems, enabling rapid data acquisition and accurate georeferencing. With correction techniques, such as Real-Time Kinematic (RTK) and Precise Point Positioning (PPP), UAV-derived products can achieve centimetre-level positional accuracy for 3D models of construction sites, transport corridors and large built environments, while reducing the need for time-consuming field campaigns.
UAVs act as data-collection platforms, while positioning accuracy is determined mainly by the GNSS correction method, sensor calibration and data processing workflows. Combined with advanced Earth observation sensors (i.e. RGB, multispectral and LiDAR) these systems generate rich datasets for cadastral mapping, change detection and infrastructure monitoring at scale.
Galileo's High Accuracy Service (HAS) provides free, global decimetre-level positioning accuracy without reliance on local correction networks. It does not replace RTK for centimetre-level applications but enables consistent positioning performance in regions where ground infrastructure is limited or unavailable.
Automated workflows integrate UAV and GNSS data to update land registries, monitor urban growth and detect illegal construction, compressing project timelines from months or years to days. As surveying shifts from traditional fieldwork to digital workflows supported by GNSS and EO, new opportunities emerge across the geospatial value chain, making high-accuracy geospatial intelligence more accessible.

EO-based monitoring of housing stock resilience and vulnerability

A growing EO trend in the housing sector focuses on **assessing housing resilience and vulnerability**. Many cities face challenges linked to ageing, informal or hazard-exposed housing. Using high-resolution optical and radar imagery, EO enables large-scale assessments of the condition and density of buildings, terrain instability and post-disaster change. These data help identify structurally weak dwellings, informal settlements and areas at risk from floods, landslides or subsidence.
EO is particularly valuable where cadastral or housing data are limited. Satellite indicators reveal **patterns of inequality and inadequate housing**, supporting planners in targeting rehabilitation, upgrading or relocation. Research also shows how building morphology and roof condition derived from EO can act as proxies for housing deprivation.
EO provides objective, repeatable information that supports resilience planning and the SDG 11 goal of adequate, safe and affordable housing. While high-resolution data and local validation remain essential, EO is becoming an operational tool for **visualising and quantifying** housing vulnerability. It complements traditional surveys and strengthens evidence-based approaches to improving the safety and resilience of urban housing stock.

EO and GNSS enable smarter cultural heritage monitoring

Key market trends

- Cultural heritage is increasingly exposed to manmade and natural threats, exacerbated by climate change. EO and GNSS can provide accurate, abundant, reliable and continuous data useful to monitor and safeguard cultural sites and monuments.
- Digital twins and AI models have great potential to boost the integration of satellite-based data in digital monitoring systems.
- EO data can be essential for monitoring damage and looting in areas that are difficult to access, such as conflict zones and after major disasters.
- Successful examples exist using GNSS to enhance management of sites and tourist fluxes, and to enable innovative fruition tools.


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Earth Observation to feed maps of natural risks threatening cultural heritage

Natural phenomena such as soil subsidence, coastal erosion and extreme weather events increasingly threaten cultural heritage. Managers of monuments and sites therefore require continuous and reliable information to monitor risks that are further exacerbated by **climate change**. Earth Observation provides large volumes of optical, atmospheric, radar, SAR, InSAR, multispectral and altimetry data that support the mapping, categorisation and monitoring of natural hazards across wide areas. These data can be transformed into actionable information through digital risk maps. EO-based risk maps help cultural heritage managers and public authorities assess vulnerability to natural hazards, identify critical points and implement **preventive measures** before disasters occur. For example, within the EU Horizon 2020 HYPERION project, Copernicus imagery was used to map environment- and microclimate-related damage at the Rodini sites in Rhodes and support conservation planning, while the Italian Ministry of Culture collaborates with ASI to monitor deformation in the Archaeological Park of the Colosseum using InSAR data. Such information can also support **disaster response**, strengthen early warning systems and enable damage assessment even under extreme conditions, providing essential input for restoration planning. **Artificial Intelligence** and **machine learning** further enhance these capabilities by facilitating EO data processing and enabling automated detection of changes affecting cultural heritage sites and monuments.


© unsplash

Earth Observation data to monitor damage and looting in conflict zones

The 1954 Hague Convention mandates protecting cultural heritage during armed conflicts. In conflict zones, EO can be the only reliable way to monitor damage and illicit activities affecting heritage. Satellite imagery from optical, radar, hyperspectral, and multispectral sensors allows authorities to detect changes over time in inaccessible areas and **assess damage** to cultural heritage. For example, the Copernicus Service in Support to EU External and Security Actions and the European Union Satellite Centre analysed time-series of EO images to classify damage from military actions or looting in conflict zones including Iraq and Syria. More recently, UNESCO and UNOSAT used satellite imagery to monitor and document damage to over 200 cultural sites in Ukraine since 2022. Through change detection and image analysis, EO also enables the **early detection of illegal excavations** and looting pits. Finally, recent developments in AI and ML facilitate automated identification of **looting** patterns using multi-source satellite data. Such technologies support timely damage assessment, legal evidence collection and planning for restoration efforts.

GNSS to build digital twins of cultural heritage sites

GNSS provides valuable data for building **digital twins** of cultural heritage sites and monuments, complementing other sources such as Earth Observation. Digital twins support research, excavation planning and conservation activities, and allow authorities to model risk scenarios and forecast the impact of natural or human-induced phenomena such as floods, ground subsidence, humidity, vegetation encroachment, agriculture, urban expansion and construction. They also enable innovative educational and recreational experiences through **augmented and virtual reality** (AR/VR).

GNSS, often augmented with **RTK**, ensures accurate positioning of built and natural assets, enabling precise 3D reconstruction of buildings, monuments and entire sites. Mapping is typically carried out using UAV or terrestrial surveys, with georeferencing performed via onboard RTK GNSS or GNSS-measured ground control points, often combined with photogrammetry and LiDAR depending on site complexity. GNSS-based ground-penetrating radar can also help detect and digitise **buried structures** and artefacts.

GNSS stations can further provide real-time data to update digital models. For example, within the TRIQUETRA project the ERATOSTHENES Centre of Excellence is developing a digital twin of the Choirokoitia Neolithic settlement using GNSS data from a permanent station and corner reflector, combined with multitemporal SAR satellite data and UAV photogrammetry for rockfall modelling.

GNSS to improve management of cultural heritage sites and visitor flows


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GNSS-based data can provide cultural heritage managers with insights into visitor movements and usage patterns when collected through GNSS-enabled mobile applications, on-site digital services, ticketing platforms or anonymised and aggregated location datasets.

Such data, gathered with user consent and in compliance with data protection regulations, can generate statistics on visitor flows and support evidence-based site management decisions (e.g. identifying suitable locations for drinking fountains or rest areas). GNSS can also help identify **optimal access points** and reduce risks to visitors from unstable terrain, structural weaknesses or falling rocks along access routes.

Visitor pressure on specific areas can be analysed using anonymised, aggregated data from opt-in GNSS-enabled apps or on-site digital services. These data support near-real-time monitoring and allow managers to guide visitors (via apps or digital signage) towards less crowded routes or attractions.

When integrated into mobile apps, GNSS also enables interactive tours and **serious games** that guide visitors through sites and trigger geolocated content such as text, audio, video and augmented or virtual reality (AR/VR) experiences. For example, the Firenze Game Next app, launched by the Municipality of Florence, uses gaming to steer tourist flows towards lesser-known attractions while educating younger audiences.

Urban Development and Cultural Heritage EO Value Chain[1]

EO

DATA PROVIDERS

- AXELSPACE
- AIRBUS*
- BLACKSKY
- CAPELLA SPACE
- CONSTELLR*
- GEOSAT*
- ICEYE*
- E-GEOS*
- PLANET
- SATELLOGIC*
- UMBRA
- VANTOR

- COPERNICUS SENTINELS*
- LANDSAT (USGS)
- METEOSAT (EUMETSAT)*
- NISAR (NASA/ISRO)
- RADARSAT (CSA)
- RELEVANT IN-SITU NETWORKS
- OTHER RELEVANT EUROPEAN NATIONAL MISSIONS

INFRASTRUCTURE PROVIDERS

- ALIBABA CLOUD (ALIYUN)
- AWS
- CLOUDFERRO*
- GEOVIS OPEN CLOUD PLATFORM
- GOOGLE CLOUD PLATFORM
- HETZNER*
- IBM CLOUD
- MICROSOFT AZURE
- OVHCLOUD*
- SCALEWAY*
- T-SYSTEMS*

- FEDERATED INFRASTRUCTURE (E.G. GAIA-X)*
- ATIVE GROUND SEGMENT*

PLATFORM PROVIDERS

- BENTLEY
- CREODIAS*
- ESRI
- EURODATACUBE*
- GOOGLE EARTH ENGINE
- MICROSOFT PLANETARY COMPUTER
- OPEN DATA CUBE
- SENTINEL-HUB* (PLANET)
- TERRADUE*
- UP42*

- CODE-DE*
- COPERNICUS DATASPACE ECOSYSTEM*
- DESTINATION EARTH*
- ESA TEP (URBAN)*
- OPENEO*
- WEKEO*

EO PRODUCT AND SERVICE PROVIDERS

- AIRBUS*
- ASITIS*
- E-GEOS*
- ESRI
- GAF*
- GAMMA REMOTE SENSING*
- GEOSYSTEMS HELLAS*
- GEOVILLE*
- KSAT*
- OHB*
- PLANETEK*
- VITO*
- WORLD FROM SPACE*

- COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)*
- COPERNICUS CLIMATE CHANGE SERVICE (C3S)*
- COPERNICUS EMERGENCY MANAGEMENT SERVICE (CEMS)*
- COPERNICUS LAND MONITORING SERVICE (CLMS)*, INCL. COPERNICUS EUROPEAN GROUND MONITORING SERVICE (EGMS)*
- COPERNICUS SECURITY SERVICE (CSS)*

INFORMATION PROVIDERS

- ARCHAI
- CGI
- CLS*
- DETEKTIA*
- EONSIGHT*
- HEXAGON GEOSPATIAL
- KERMAP*
- LUXCARTA*
- SATSENSE*
- SENSAR*
- SPACEKNOW
- TETRA TECH
- TRACASA*
- TRE ALTAMIRA*

- CENTER FOR CULTURAL HERITAGE TECHNOLOGY*
- CNR*
- ERATOSTHENES CENTRE OF EXCELLENCE*
- ISPRA*
- LINKS FOUNDATION*

END USERS

- ARCHITECTS
- CONSTRUCTION COMPANIES
- CITIZENS
- ENGINEERING COMPANIES
- INSURANCE COMPANIES
- INTERNATIONAL ORGANISATIONS (E.G. UNITED NATIONS, UNESCO)
- PUBLIC AUTHORITIES (HEALTH, ENVIRONMENT, CULTURE, HERITAGE, MONUMENTS)
- REAL ESTATE AGENCIES
- TAX AUTHORITIES
- URBAN PLANNERS
- URBAN PUBLIC TRANSPORT PROVIDERS
- UTILITY COMPANIES

LEGEND

- Commercial offering
- Public offering
- User segments

GNSS

AUGMENTATION SERVICE PROVIDERS

- HEXAGON (LEICA GEOSYSTEMS, NOVATEL)*
- SPACEOPAL GMBH*
- SWIFT NAVIGATION
- TERIA*
- TOPCON CORPORATION
- TRIMBLE NAVIGATION LTD.
- U-BLOX*

- NATIONAL AND REGIONAL RTK NETWORK PROVIDERS
- SBAS PROVIDERS

COMPONENT AND RECEIVER MANUFACTURERS

- BEIJING UNISTRONG SCIENCE & TECHNOLOGY
- HEXAGON*
- HI-TARGET SURVEYING INSTRUMENT
- QUALCOMM
- SATEL OY*
- SBG SYSTEMS*
- SHANGHAI HUACE NAVIGATION TECHNOLOGY CO LTD.
- TOPCON CORPORATION
- TRIMBLE NAVIGATION LTD.
- U-BLOX*

SYSTEM INTEGRATORS

- ALLSAT GMBH*
- EATON LTD.*
- HEXAGON AB*
- RACELOGIC LTD*
- RIEGL*
- SHANGHAI HUACE NAVIGATION TECHNOLOGY CO LTD.
- STONEX SRL
- TRIMBLE INC.

SOFTWARE, APPLICATIONS AND ADDED VALUE SERVICES

- BENTLEY SYSTEMS
- CARLSON
- ESRI
- HEXAGON*
- JAVAD GNSS
- TOPCON CORPORATION
- TRIMBLE NAVIGATION LTD.

PROFESSIONAL USERS

- CONSTRUCTORS
- EDUCATORS
- ENGINEERS
- ENVIRONMENTALISTS
- PRESERVATIONISTS
- SCIENTISTS
- SURVEYORS

CUSTOMERS OF SURVEYING SERVICES

- ARCHITECTS
- CONSTRUCTION COMPANIES
- CITIZENS
- INSURERS
- PUBLIC AUTHORITIES
- URBAN UTILITIES

The European[2] EO and GNSS industry in the global arena

Although North American and Asian companies are expanding rapidly in Earth Observation, Europe still accounts for over a quarter of the global downstream market. Key European actors include Airbus, Thales Alenia Space and Leonardo's e-GEOS, alongside strong service providers such as GAF, VITO, and GMV. In urban development and cultural heritage, GNSS underpins cadastral mapping, 3D modelling and structural monitoring. Europe remains highly competitive in GNSS hardware and systems integration, with companies such as Hexagon (Leica Geosystems, NovAtel), SBG Systems and u-blox providing high-accuracy receivers and GNSS+INS solutions for urban and heritage applications.

NOTES

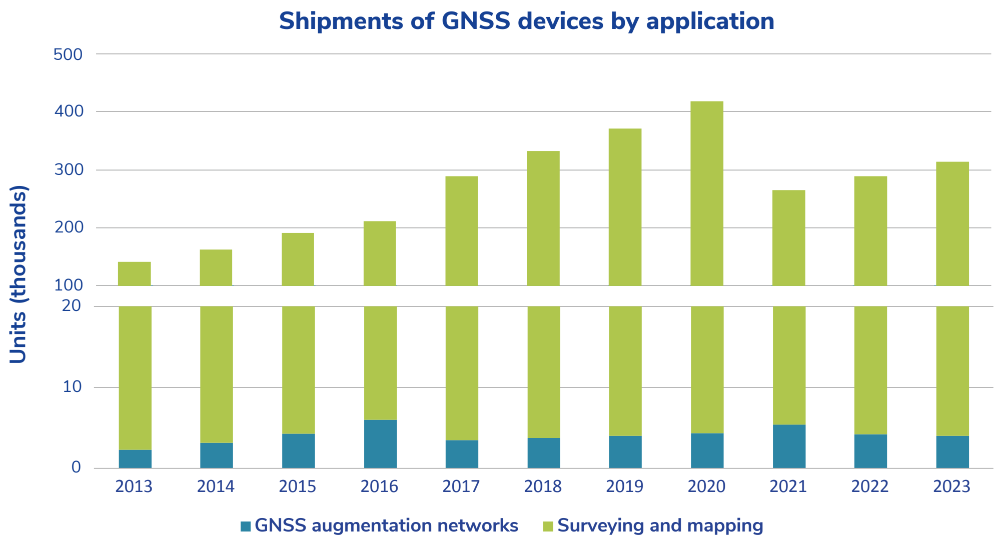
1: The value chain considers the key global and European companies involved in GNSS and EO downstream activities. Please note that enterprises listed in the data providers step of the value chain often provide platforms as a service. For the sake of simplicity, the data providers are not repeated in other stages of the value chain in which they are active.

2 In the market share analysis, Europe is defined as EU27 plus Norway, Switzerland and the UK.

Please refer to page 20 and 30 for a comprehensive description of value chains and how to interpret them at segment level.

* European-based company. The region is defined with respect to the headquarters of the company, though the actual area of activity might be wider

Cutting edge technologies are enhanced with GNSS information to improve the precision and versatile applicability of GNSS



Shipments of GNSS receivers for **urban surveying and mapping** have risen steadily across the 2013–2023 period, increasing from around 140,000 units in 2013 to more than 310,000 units by 2023. This sustained growth reflects the **progressive digitalisation of urban planning**, where accurate geospatial data underpins redevelopment, cadastral maintenance, zoning enforcement and continuous monitoring of land-use change. Strong gains through the mid-2010s coincide with the rapid expansion of UAV-based mapping and the growing need for timely geodata to manage urban densification, regeneration projects and early Smart City initiatives. After a decline in 2021, which was likely linked to the significant impact of the COVID-19 pandemic on the building sector, constant growth has been observed corelated to recovery.

Growth becomes more uneven toward the later years of the period, shaped by project cycles, shifting capital budgets and external disruptions. However, GNSS remains **fundamental for updating 3D city models**, validating EO-derived land-cover changes and feeding trusted data streams into emerging urban digital twins. Advances in multi-GNSS capability and wider use of enhanced high-accuracy services strengthen performance in dense environments, helping surveyors and municipal teams maintain efficiency despite increasingly complex urban settings.

The GNSS augmentation-network segment, though much smaller in volume, has also expanded from around 2,200 units in 2013 to over 6,300 in 2023, supporting high-precision positioning for **cadastral tasks**, **utility mapping** and **inspection** workflows. Despite its limited shipment scale, the specialised nature of these systems keeps replacement intervals long and service value high.

Together, these developments illustrate an urban GNSS market driven by the need for **frequent**, **reliable geospatial updates** as cities modernise their planning frameworks, **digitise** operational processes and adopt more data-centric management tools.

GNSS-enabled monitoring of cultural heritage assets

Cultural heritage buildings face risks such as subsidence, slope instability and subtle structural deformation that may threaten their long-term stability. Recent applied research has shown that installing **high-precision GNSS stations** on or near historic structures enables continuous detection of millimetric movements that cannot be observed visually, offering early warning of emerging instability and supporting timely conservation action.

These GNSS measurements can be combined with satellite radar (SAR) data from missions like Sentinel-1 or higher-resolution sensors. **Fusing** point-based GNSS time series with wide-area SAR deformation maps improves spatial coverage and accuracy, providing a more complete understanding of both structural and terrain dynamics around heritage sites. Automated processing and visualisation allow this monitoring to operate continuously with minimal on-site intervention.

Similar techniques have been used for tracking slope movements near sanctuaries, monitoring long-term settlement or tilting of historic towers, and assessing deformation in dense heritage districts. Together, GNSS and EO data form a scalable, non-intrusive toolset for protecting cultural heritage.

Multi-band RTK integration in consumer-grade drones and rovers

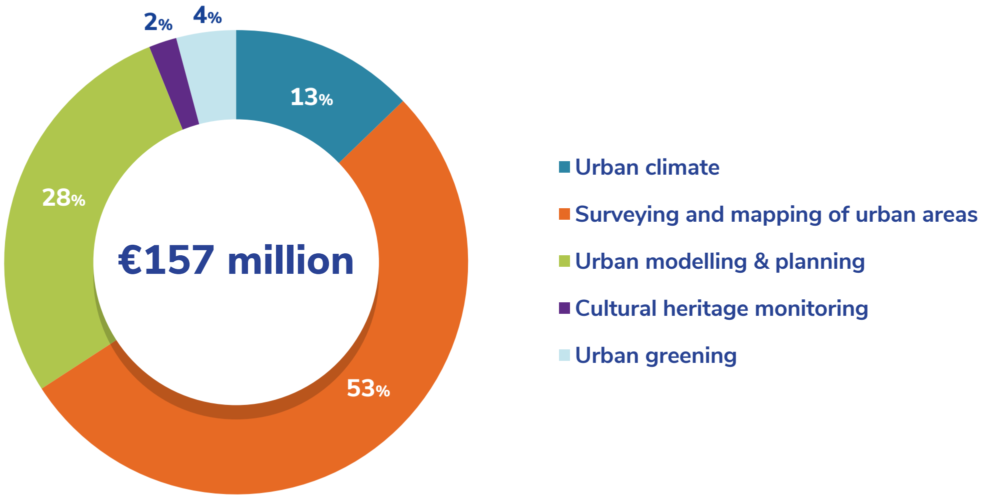
Recent advances have brought multi-band RTK GNSS technology, previously reserved for professional surveying, into affordable consumer platforms. These recent systems deliver **centimetre-level positioning accuracy** in compact, easy-to-use devices.

In the Cultural Heritage domain, this development directly tackles the challenge of **accurate, repeatable spatial documentation of monuments, archaeological sites and historic urban areas**, where conventional survey equipment is often too costly or cumbersome. RTK-enabled drones allow rapid, ground-control-point–light 3D mapping of buildings, streetscapes, and vegetation, which is essential for digital twins, structural risk assessment and change detection in heritage environments.

By enabling **precise, low-cost and high-frequency UAV surveys**, these tools empower heritage authorities, small municipalities and NGOs to monitor deformation, encroachment and illicit modifications. The result is a major step towards the mainstream use of GNSS for digital documentation and conservation of cultural heritage assets.

Satellite data support monitoring and planning of urban areas, contributing to improved resilience, sustainability and preservation of cultural heritage

Revenues from EO services and data sales by application 2024



Expanding the role of satellite EO in urban governance and resilience

Satellite EO is not a traditional service at urban scales. Urban stakeholders are well accustomed to high resolution optical, LiDAR, thermal data captured from aerial, drone, street cars and portable instruments. These allow the development of high-fidelity BIM as-built and digital twin models. Update cost and cadence is the biggest challenge opening complementary roles to satellite EO.

In 2024, global revenues from satellite EO data and services related to the analysed urban applications amounted to around €157 million. The **largest share** of these revenues continues to come from **surveying and mapping** of urban areas, which generated about €84m, accounting for just over half of total revenues. **Urban modelling and planning** represents the second-largest application area, with revenues of around €43m, followed by **urban climate** applications at around €20m.

While smaller in absolute terms, urban greening (€7m) and cultural heritage monitoring (€3m) are **gaining visibility**, reflecting a broader diversification of EO use cases in cities. The growing **importance of urban climate-related applications** aligns with wider policy attention on heat mitigation and resilience, including the increasing appointment of municipal heat officers. Similarly, applications such as cultural heritage monitoring and urban greening, illustrate how EO is being adopted by **new user groups** beyond traditional mapping communities.

Overall, the shifting revenue distribution across applications indicates a continued expansion of EO adoption into thematic urban domains beyond surveying and mapping. As in previous years, revenues are predominantly driven by services rather than raw data, a trend that is reinforced by open data availability and is expected to further raise the relative value of EO-based services in the coming years.

Encroachment & land use pressure on heritage sites

Cultural and natural heritage sites face increasing pressure from urban expansion, infrastructure growth and agricultural conversion. These activities often cause encroachment into protected zones, illegal construction in buffer areas and land conversion for incompatible uses. Gradual yet persistent changes threaten the integrity, setting and stability of heritage assets, undermining their Outstanding Universal Value and compliance with UNESCO protection standards, for example.

EO offers an effective way to monitor and manage these pressures. Through multi-temporal satellite imagery, EO tracks urban growth, road development and land cover change in and around heritage zones. Time-series analyses reveal encroachment trends, enabling early detection of threats to buffer zones and the visual or ecological context of cultural sites.

The geospatial evidence from EO strengthens accountability and enforcement. Data can be shared with bodies like UNESCO and national authorities to verify whether land use activities respect protection rules. This evidence-based approach supports targeted action, such as halting illegal construction, adjusting zoning or planning measures to prevent damaging land use near sensitive landmarks.

Providing consistent, transparent and timely information, EO offers a compliance and monitoring tool for cultural landscape preservation, helping authorities protect heritage sites from unsustainable development and ensure their long-term conservation.

Fusion of spectral EO imagery and LiDAR for 3D urban vegetation mapping

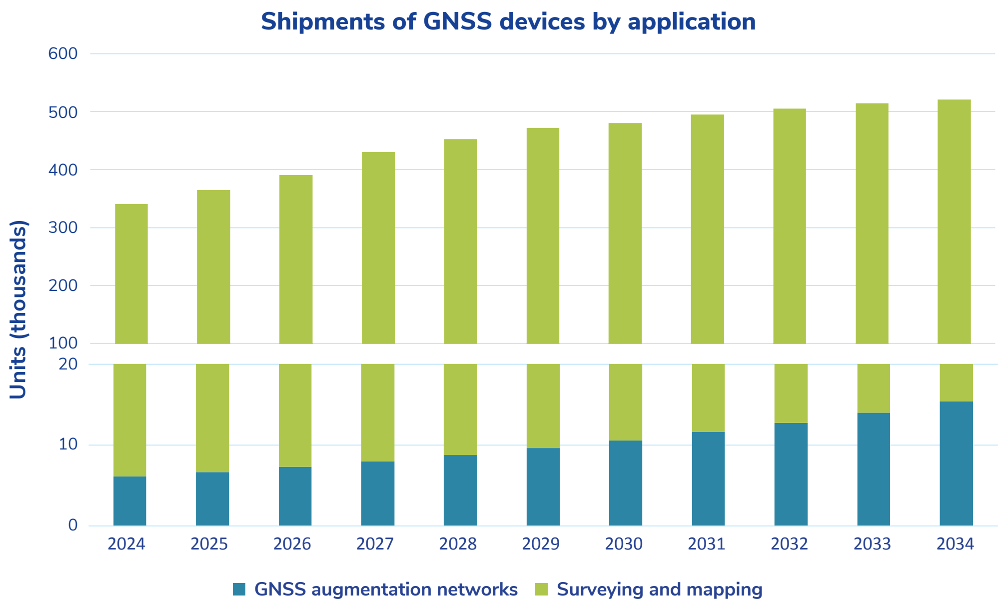
Cities increasingly combine spectral EO data (satellite and aerial multispectral and hyperspectral imagery) with LiDAR point clouds to produce detailed **3D maps of urban vegetation**. This fusion joins EO's spectral richness with LiDAR's structural precision, offering a comprehensive view of urban green infrastructure.

The combined datasets enable accurate estimation of canopy cover, tree height, crown volume, biomass, and species composition, while revealing vegetation health indicators. Merging spectral and structural data enhances monitoring accuracy and supports advanced ecological analyses beyond what either source can provide alone.

Municipalities use these 3D vegetation models to **assess cooling effects**, carbon storage, storm-water retention, and biodiversity corridors, quantifying vegetation's role in climate adaptation and sustainability. Linking vegetation metrics with ecosystem services provides a strong evidence base for greening and resilience policies.

Examples from Melbourne, Houston, and European smart-city projects show how fused datasets feed Digital Twins for continuous monitoring and planning. In historic districts, the same methods guide vegetation management around monuments, preventing damage from encroaching trees while preserving cooling and landscape value.

GNSS sensor and signal fusion will increase precision and availability of location-based services and information



Total GNSS shipments are expected to rise steadily across the two main application categories, increasing from around 330,000 units in 2024 to more than 523,000 units by 2034. This increase reflects the growing need for accurate, frequently updated geospatial information across **expanding and modernising urban environments**. The surveying and mapping segment dominates throughout the period, increasing from about 358,000 units in 2025 to nearly 506,000 units by 2034. This is driven by the **intensifying digitalisation of urban planning**, including regular updates to cadastral layers, redevelopment monitoring, UAV-based mapping and the growing use of **3D models and Digital Twins**. The acceleration corresponds to rising demand for detailed geospatial datasets to manage e.g. densification, infrastructure renewal and data-driven land-management policies.

The much smaller GNSS augmentation-network segment will also expand strongly from about 6,500 units in 2024 to more than 17,300 units by 2034. This reflects widening adoption of high-precision positioning across multiple sectors, led primarily by mass-market and automotive autonomy applications, with urban surveying, utility mapping and infrastructure monitoring representing a smaller but high-value professional segment. Growth accelerates as more cities require high accuracy for **underground-asset management**, automated surveying workflows and integration with sensor networks. Despite its limited size, the specialised nature of augmentation systems keeps service value high and encourages continued investment in dense urban regions where reliable correction data are becoming increasingly essential.

Together, these application-driven trends illustrate a GNSS market shaped by the operational needs of modern cities: frequent geospatial updates, precision positioning for critical infrastructure and the steady migration of planning and maintenance workflows toward fully **digital, data-centric systems**.

GNSS for underground utility mapping

GNSS has long been a core enabler for **underground and utility mapping** in urban environments, where complex networks of water, gas, electricity and telecommunications require precise localisation to avoid costly errors during construction, maintenance and emergency interventions. When integrated with ground-penetrating radar, electromagnetic locators and inertial sensors, GNSS allows buried infrastructure to be accurately georeferenced, supporting **safe excavation** and reliable asset documentation.

Recent advances (including multi-constellation, multi-frequency GNSS, real-time corrections, and seamless integration with mobile mapping platforms) have improved reliability and positioning accuracy in dense urban canyons where signal obstruction is common.

These positioning improvements, together with emerging tools such as augmented reality visualisation, cloud-based asset platforms and digital twins, are transforming traditional utility surveys into continuously updated **digital utility cadastres**. Such systems provide municipalities and operators with a unified, spatially accurate view of underground assets, enabling coordinated roadworks, reducing service conflicts, improving worker safety and helping cities anticipate vulnerabilities in ageing networks. As urban infrastructure becomes denser and more interconnected, GNSS-referenced digital utility registries are no longer optional, but essential for resilient city management.

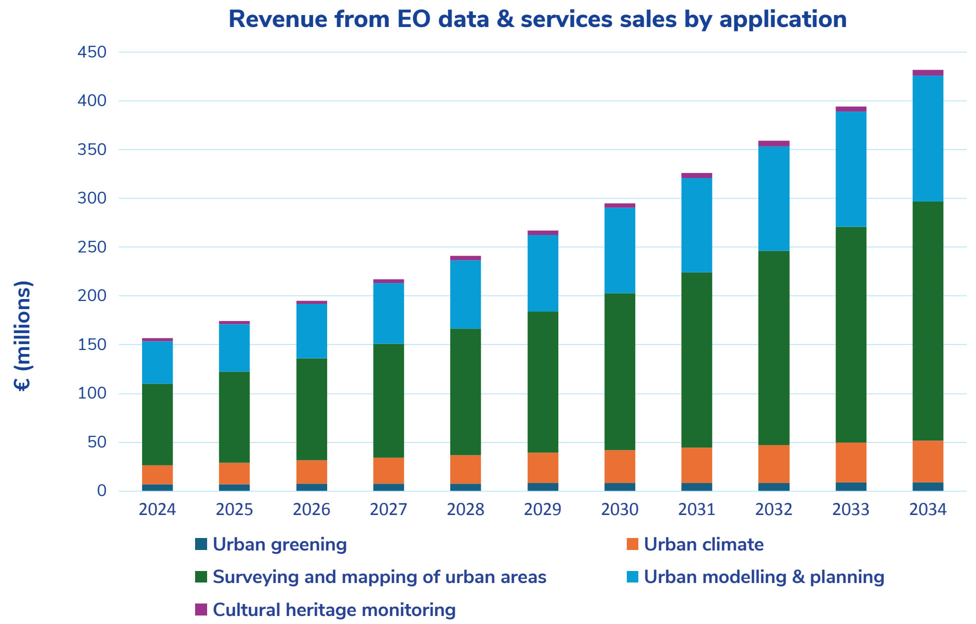
Hybrid LEO+GNSS PNT services

Hybrid LEO+GNSS positioning services are emerging as a future capability for urban and heritage environments, with the potential to offer **greater resilience and accuracy** where classical GNSS alone is often challenged. By combining GNSS signals with those from Low Earth Orbit (LEO) constellations, which can provide stronger signals, faster dynamics and much denser sky coverage, these systems are expected to help **overcome multipath and blockage** in narrow streets, dense urban canyons and historic districts with complex architectural layouts.

Early research, pilot deployments and commercial trials suggest that fusing GNSS timing with LEO-based Doppler, ranging and signal-of-opportunity measurements could enable **sub-metre to decimetre positioning** in environments that are currently difficult for GNSS-only solutions. However, most solutions remain at prototype or pre-commercial stage, and large-scale operational services are still under development.

In the coming years, such hybrid approaches may unlock more reliable pedestrian positioning, autonomous delivery robots, UAV-based inspection flights and continuous updates to **urban digital twins**. Around monuments and archaeological sites, hybrid services could enhance the safety and precision of UAV surveys, improve visitor-guidance applications and support accurate monitoring of structural risks –without requiring extensive local ground infrastructure.

EO data form the basis for applications supporting the sustainability of urban spaces and preservation of cultural heritage sites



Estimated global revenues from satellite EO data and services in urban applications are expected to grow from around €150 million in 2024 to more than €420m by 2034, reflecting the expanding role of EO in urban development, climate resilience and heritage protection. **Surveying and mapping** of urban areas remains the **largest revenue-generating application** throughout the period, increasing from around €80m in 2024 to over €240 million, driven by continued demand for high cadence and resolution monitoring in **construction**, infrastructure **renewal** and **digital city management**.

Urban **modelling and planning** and urban **climate** applications show particularly **strong growth**, together accounting for a rapidly increasing share of total revenues. Urban modelling and planning revenues are forecast to rise from €45m in 2024 to nearly €130m in 2034, reflecting the growing use of EO to support **evidence-based planning, digital twins** and scenario modelling. Urban climate applications are expected to grow from less than €20m to over €40m, driven by policy focussed on **heat mitigation** and **climate adaptation** requiring reliable, spatially consistent information.

Smaller but steadily expanding segments further illustrate the diversification of EO use in cities. **Urban greening** revenues are expected to more than double over the period, supported by the monitoring of nature-based solutions, green infrastructure and biodiversity targets. **Cultural heritage monitoring**, while remaining a niche application, grows to almost €6m, driven by rising awareness of **climate-related risks to historic assets** and the need for non-invasive, repeatable monitoring of sensitive sites in dense urban environments.

Across applications, there is a growing demand for **value-added analytics**, integration and decision-support tools.

Climate-responsive urban design metrics

Climate-responsive urban design is increasingly driven by EO data and modelling. Using EO-derived 3D morphology, planners can **model urban canyons, sky-view factors and ventilation corridors** at scale, providing the foundation for **resilient city layouts**. The emerging integration of EO with computational fluid dynamics (CFD – simulations to model how liquids and gases move and interact with surfaces) enables city-wide **airflow simulations**, identifying priority zones for breezeways, optimal street orientations and ventilation gaps.

These capabilities are central to the planning of so-called 'sponge cities' (an urban design and planning concept aimed at making cities more resilient to extreme rainfall, flooding and water scarcity) and other climate-resilient urban forms, where **design mitigates** heat stress, flooding and extreme weather impacts.

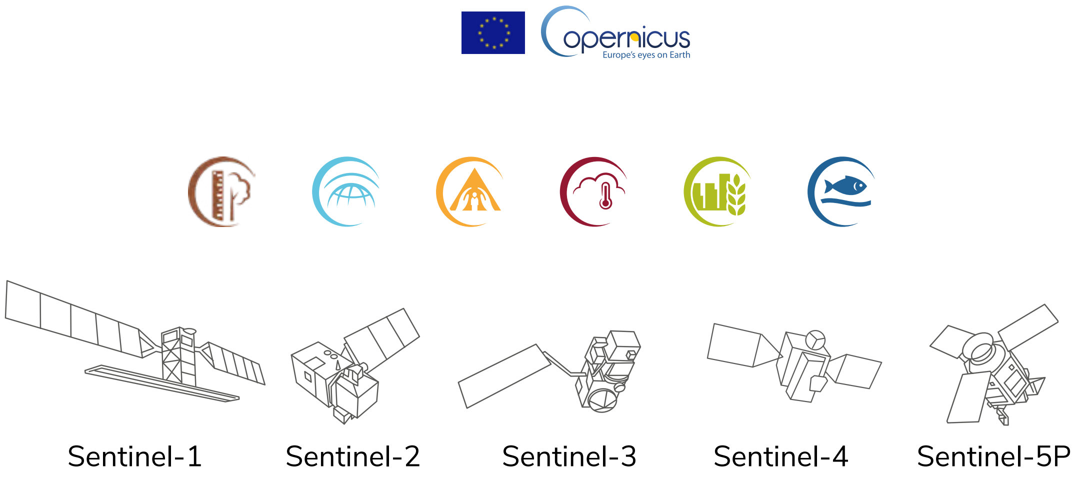
By shifting from local surveys to EO-enabled, city-wide modelling, authorities gain design metrics that can be embedded directly into zoning codes, masterplans and building guidelines. For urban planners, real-estate developers, and climate adaptation specialists, EO-based design metrics provide a scalable and evidence-based approach to **future-proofing urban areas**. Instead of reacting to climate impacts, cities can **anticipate vulnerabilities** and shape their built environment accordingly.

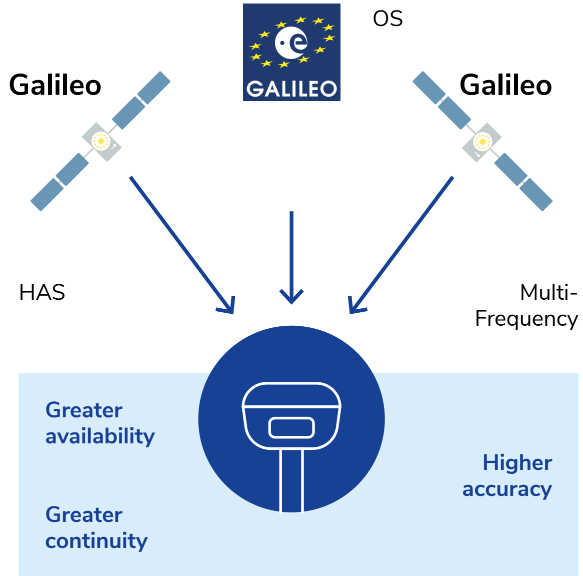
EO-enabled heritage watch platforms

EO-enabled Heritage Watch platforms are emerging as a new class of **operational services** for cultural heritage protection, shifting from isolated research pilots to continuous, **subscription-based monitoring tools**. By integrating multi-source satellite data, including optical, radar and thermal imagery, and with AI-enabled change-detection algorithms, these platforms will be able to identify early signs of risk such as subsidence, erosion, vegetation encroachment and conflict- and disaster-related damage. Early operational examples include UNESCO–UNITAR's UNOSAT heritage damage monitoring and a few commercial monitoring services. Coordination frameworks and enabling initiatives, such as the Copernicus Cultural Heritage Task Force and ESA's Space4Heritage programme, are supporting the transition from pilots to operational services.

They will deliver regular, standardised **condition reports** and near-real-time **alerts**, enabling heritage authorities to intervene before deterioration accelerates. These outputs will feed directly into urban digital twins and municipal planning systems, embedding heritage conservation within wider strategies for urban resilience, risk management and sustainable development. Further, open or semi-open dashboards have the potential to improve **transparency and public engagement**, giving governments, UNESCO networks, NGOs, insurers or citizens shared **access** to up-to-date information. These capabilities will make EO-enabled platforms a key operational component of modern heritage risk assessment and conservation management.

European space data enable smarter, safer and climate-resilient cities and heritage sites





Current and future use of Copernicus

The Copernicus programme supports urban planning and monitoring through its satellite and in situ data as well as through services such as the Copernicus Land Monitoring Service (CLMS) (e.g. via its Urban Atlas). CLMS is also critical for cultural heritage monitoring, identifying and mapping risks such as coastal erosion or ground subsidence. Its European Ground Motion Service (EGMS) enables investigation of ground motion affecting buildings and linear infrastructures.

The Copernicus Emergency Management Service provides products related to natural and manmade disasters impacting urban environments (e.g. floods, landslides). Additional value comes from the Copernicus Atmosphere Monitoring Service (air-quality forecasts including particulate-matter data) and the Copernicus Climate Change Service (C3S) (data on regional climate). Both support preservation of cultural-heritage sites by assessing vulnerability to climate-change effects (e.g. heat waves, sea-level rise). The Copernicus Support to EU External & Security Actions (SESA) Service provides geospatial support for monitoring cultural-heritage damage in conflict or inaccessible zones. It can only be activated by authorised users. The Security Service supports damage assessment in conflict-affected heritage sites and the protection of critical urban infrastructure, while the Marine Service contributes to risk assessment for coastal cities and heritage sites exposed to sea-level rise, storm surges and coastal erosion.

Sentinel-2 maps green areas, urban sprawl and land use. Sentinel-1 supports InSAR monitoring of infrastructure (e.g. tunnels, bridges, roads) to detect displacement or ground movement. Sentinel-3 provides land-surface-temperature (LST) data to detect heat islands; Sentinel-2 surface-reflectance data further enhance LST resolution. Sentinel-4 and Sentinel-5P measurements support urban air quality monitoring.

Copernicus expansion missions such as CO2M (Anthropogenic Carbon Dioxide Monitoring) and Land Surface Temperature Monitoring (LSTM) will improve greenhouse gas tracking and high-resolution land temperature mapping.

Current and future use of EGNSS

Galileo services and features have proven to be crucial tools for urban planners and cultural heritage management professionals in ensuring accurate positioning, safety, and efficient coordination of activities within urban areas and historic sites.

The High Accuracy Service (HAS) of Galileo can be beneficial for urban planning and documenting cultural heritage sites by providing improved accuracy for creating detailed topographic maps, identifying property boundaries, and conducting land surveys.

Urban planners can benefit from this technology by quickly and accurately assessing the impact of proposed construction projects or existing infrastructure. In addition, Galileo contributes to improved positioning accuracy in urban canyon environments when used in multi-constellation GNSS receivers. The additional satellites increase satellite visibility and measurement redundancy, while Galileo's modern signal design provides improved signal robustness and higher signal-to-noise ratios. These characteristics help mitigate positioning errors caused by multipath effects and signal blockage from tall buildings.

The system's navigation features can assist in navigating through urban areas and cultural heritage sites by providing accurate positioning, route planning, and real-time guidance.

Several European funded projects combine EO and GNSS to propose solutions in support of the Urban Development and Cultural Heritage sector

Horizon Europe, a programme of the European Union

Integrating Galileo and Copernicus for Urban Operations – Space4Cities

The Space4Cities project enhances how European cities plan and manage urban services by **integrating GNSS and Earth Observation data** into everyday municipal workflows. It supports applications such as infrastructure monitoring, mobility management, environmental assessment and climate-resilience planning, ensuring that space-based technologies directly address the operational needs of local authorities.

The project develops advanced digital services, including high-accuracy positioning tools, EO-derived urban analytics and integrated decision-support dashboards, that **can be readily adopted by city administrations**. By promoting common standards and interoperable data models, Space4Cities makes it easier for municipalities to embed satellite-based insights into existing Smart City platforms and digital twins, while reducing cost and technical barriers.

Through **real-world validation** and the development of sustainable service models, Space4Cities aims to accelerate the uptake of space-enabled solutions across European cities.

Horizon Europe, a programme of the European Union

Optimising urban planning through satellite data – UDENE

The UDENE project strengthens evidence-based urban planning by creating a virtual laboratory that integrates EO data from Copernicus with local and socio-economic datasets. By combining spatial, environmental and historical information, UDENE enables planners to analyse 'natural experiments' – i.e. comparable interventions carried out in other cities or periods to anticipate the likely effects of new policies or infrastructure changes. This approach offers a practical way for municipalities to **use EO insights without needing specialised expertise**.

Central to UDENE are two digital tools: an Exploration Tool for scenario analysis using EO time series and urban indicators, and a Matchmaking Tool that links planners with relevant EO services and solution providers. These tools support tasks such as evaluating **heat-island** mitigation measures, **climate-resilience** options, **mobility** planning and land-use strategies.

By validating these tools across different urban contexts and promoting low-barrier access to satellite-based information, UDENE aims to make EO an operational asset for cities seeking more resilient, transparent and data-driven development pathways.

Horizon2020 European Union Funding for Research & Innovation

GNSS-based autonomous mobile mapping system

The GAMMS project enhances **urban mobile mapping** by integrating high-accuracy GNSS, multi-sensor perception and autonomous navigation into a compact terrestrial platform. Designed to complement UAV and LiDAR workflows, it enables rapid **3D capture** of streetscapes, construction areas and public spaces at walking or driving speed, reducing the cost and effort of traditional surveying.

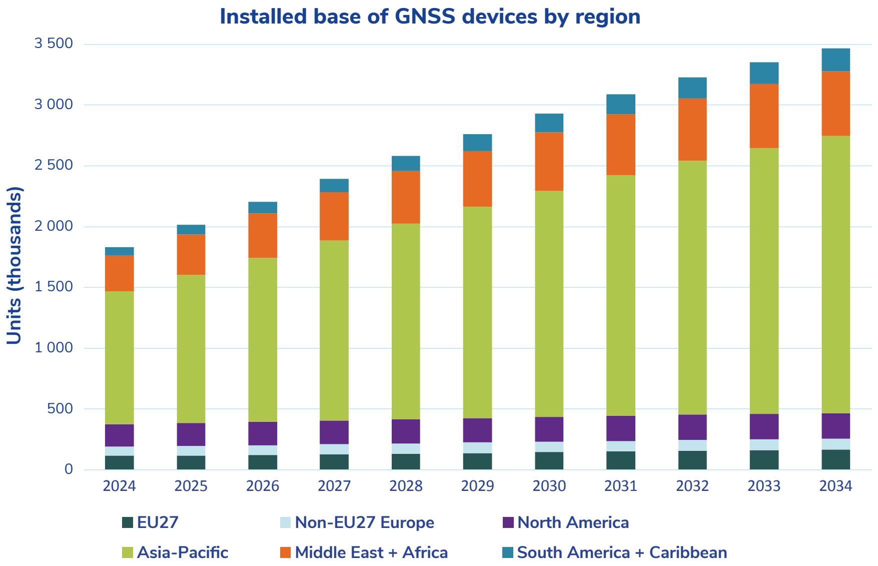
By **fusing GNSS, LiDAR, cameras and inertial sensors**, GAMMS maintains centimetre-level accuracy even in dense urban canyons. Its **autonomous** operation minimises setup time and supports frequent updates of infrastructure conditions, mobility assets, pavements and temporary changes. The resulting datasets feed directly into **municipal GIS systems**, digital twins and planning tools.

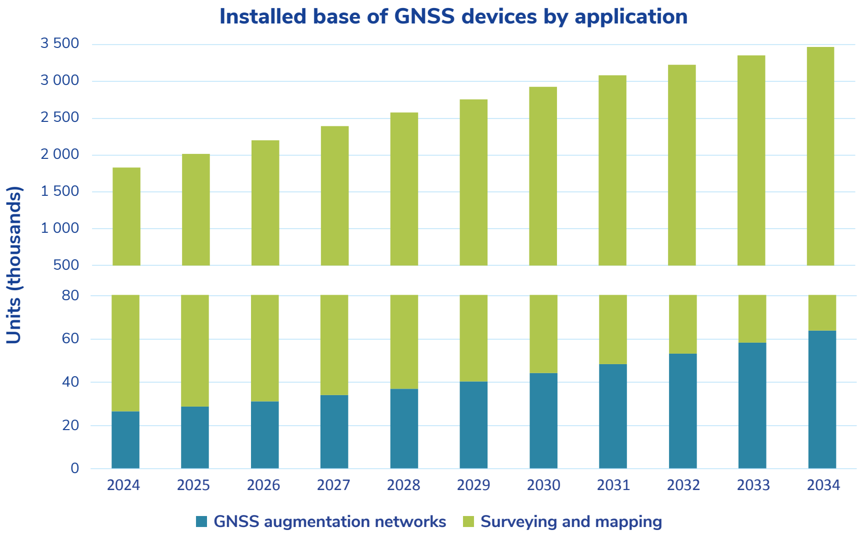
Through real-world demonstrations, GAMMS showcases a scalable approach to maintaining up-to-date urban geospatial information, supporting applications such as smart mobility, accessibility assessment and urban environmental modelling.

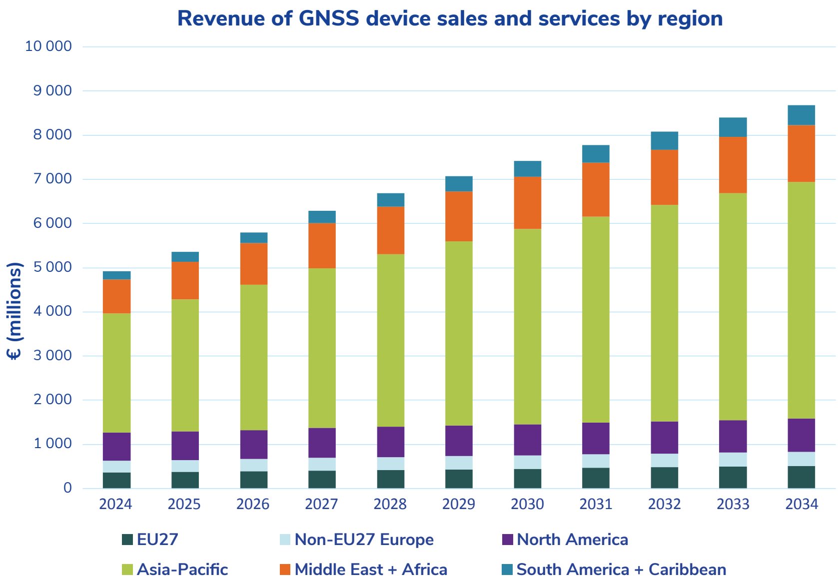
PROGRAMME OF THE EUROPEAN UNION

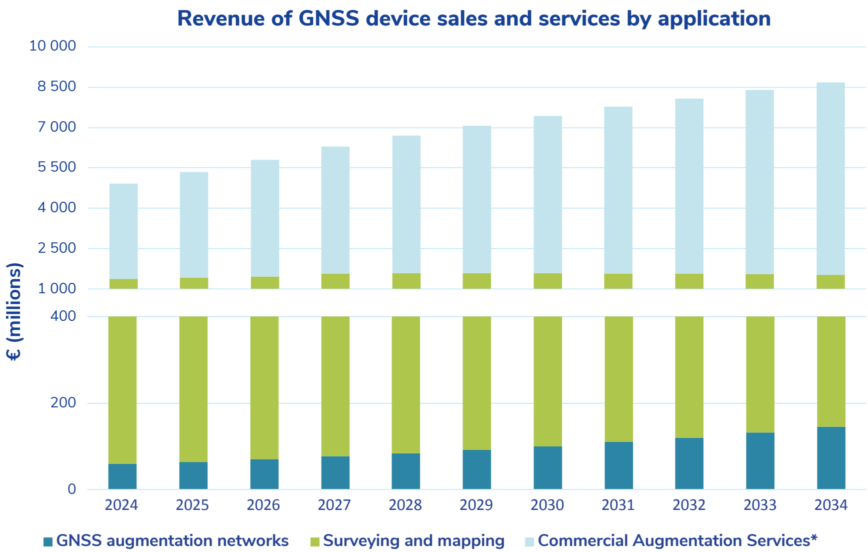
Copernicus World Heritage Hub – from reactive to proactive risk management

World heritage sites are cultural and natural heritage sites offering outstanding universal value for humanity. The World Heritage Hub bundles free access to data, which can support monitoring, conservation and management of heritage sites. The Copernicus World Heritage Hub serves as a **centralised, one-stop-shop** dedicated to supporting using Copernicus and other data including UNESCO World Heritage List and World Protected areas, for the monitoring, preservation and informed management of cultural and natural heritage sites. Through the World Heritage Hub users can explore how satellite data supports the **preservation** of cultural and natural heritage. By bringing together Copernicus datasets and **user-driven insights**, the Hub enables informed decision-making for conservation, risk management, and sustainable site planning. From monitoring **structural risks** at archaeological sites to tracking **environmental changes** in protected ecosystems, these real-world applications highlight the value of EO in safeguarding heritage. The Hub includes a dynamic data viewer to access, download and visualise a selection of open and free Copernicus data from the Copernicus Services, including marine, land, atmosphere and climate data covering cultural and natural heritage sites across the globe and supporting various use cases.

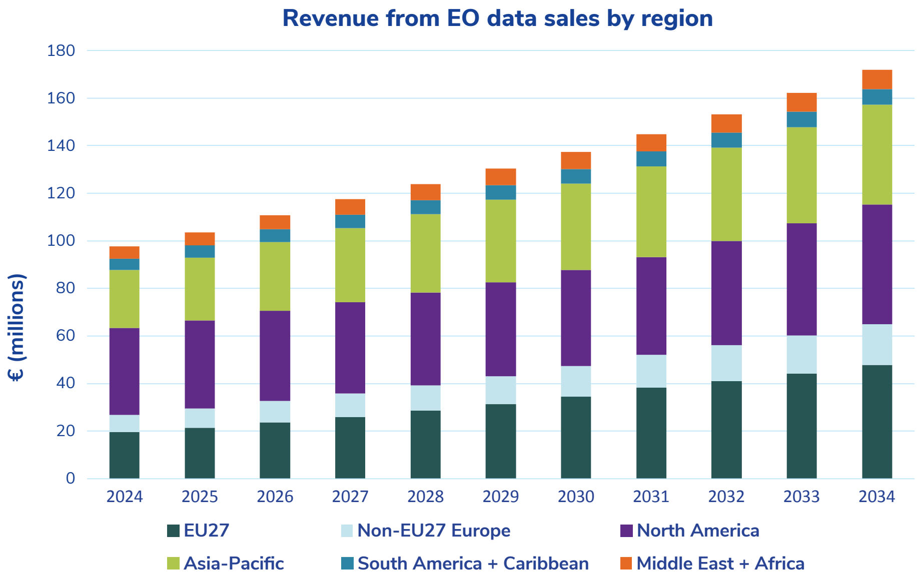


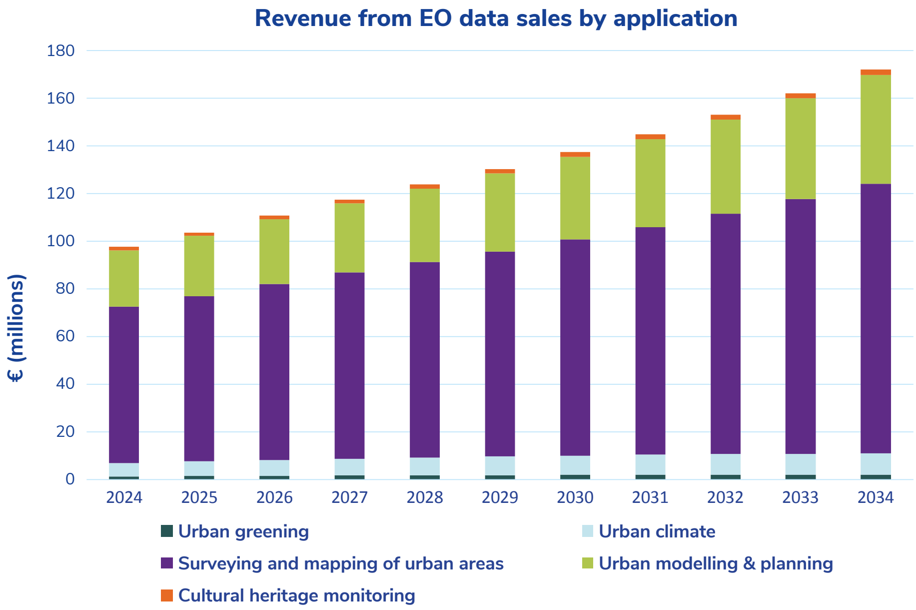


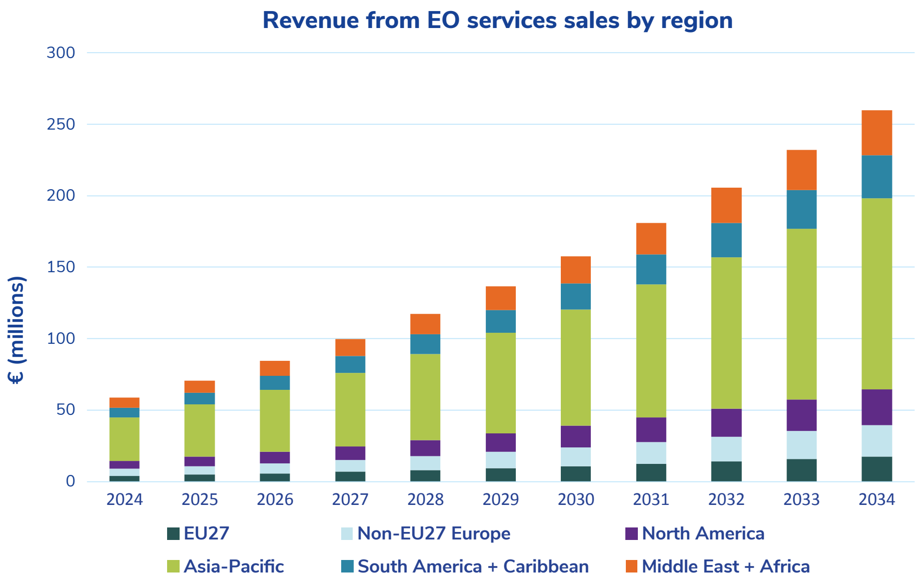


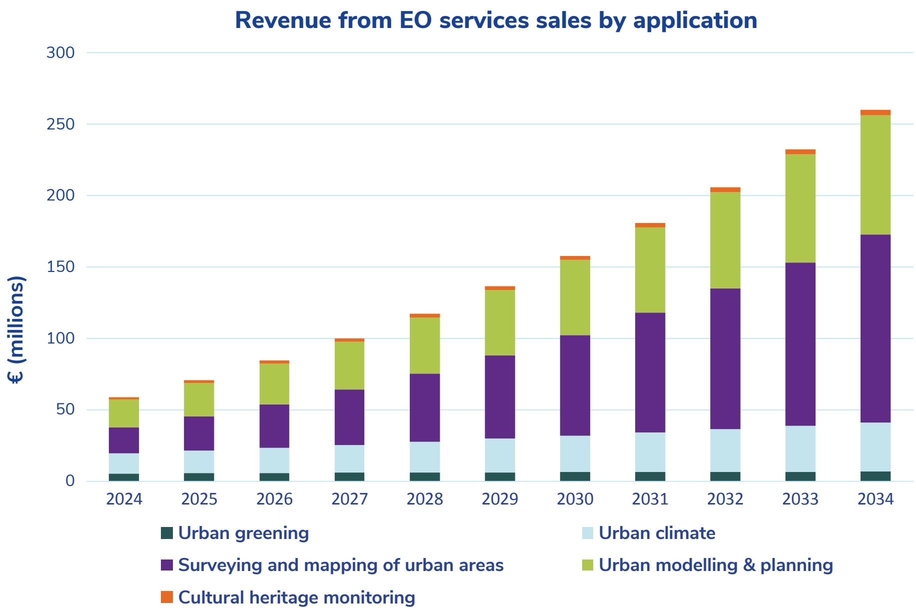


*Commercial Augmentation Services also include revenue from applications in Maritime and Inland Waterways and Infrastructures segments. Commercial Augmentation Services from applications in Agriculture segment are captured in the chart for Agriculture.


Revenue from EO data sales by region
€ (millions)
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO data sales by application
€ (millions)
Urban greening
Urban climate
Surveying and mapping of urban areas
Urban modelling & planning
Cultural heritage monitoring


Revenue from EO services sales by region
€ (millions)
EU27
Non-EU27 Europe
North America
Asia-Pacific
South America + Caribbean
Middle East + Africa


Revenue from EO services sales by application
€ (millions)
Urban greening
Urban climate
Surveying and mapping of urban areas
Urban modelling & planning
Cultural heritage monitoring

Annex 1: Methodology

Methodology

The Market Report applies the EUSPA's Market Monitoring and Forecasting Tool (MMFT). The **model** utilises **advanced forecasting techniques** applied to a wide range of input data, assumptions, and scenarios to forecast the size of the GNSS and EO markets. The GNSS market is quantified according to shipments, revenues and installed base of GNSS devices, while the EO market is defined by purchase of data and services. All revenues are measured from the demand point of view, i.e., in which part of the world the data, services, and devices are purchased. This methodology attributes the size of the EO and GNSS market to the region where, devices, data or services are sold and used. The **forecast methodology** is applied to each application and depends on the availability of input data. For some applications, detailed data on the number of devices shipped or value of the market are available, others rely on the number of devices in the installed base, while others still use the number of potential users as a starting point, or the revenues generated in the market. **Key input assumptions** are collected from market reports and studies to help inform the penetration of GNSS, the average lifetime of a devices, device prices, EO data and services sales, and more. Input assumptions and outputs are subject to internal and external validation with industry experts to ensure emerging trends are captured as soon as they are identified. Where possible, historical values are anchored to actual data in order to ensure a high level of accuracy. **Application-level model results** are cross-checked against the most recent market research reports from independent sources before being validated through an iterative consultation process with European and international sector experts and stakeholders. In particular, quantitative data and forecasts of GNSS devices shipments, installed base and the deriving revenues presented throughout the Market Report are given for all applications listed in the charts of each market segment, carefully cross-checked in order to avoid double-counting of devices. That is why it is possible that the front page of each market segment provides a longer list of applications. In many cases, a single GNSS device contributes to a variety of applications. In the same way, quantitative data and forecasts of EO revenues presented throughout the Market Report are given for all applications listed in the charts of each market segment, carefully cross-checked in order to avoid overlaps and double-counting. The data revenues attributed to the EO applications in the different segments are to be interpreted as the best estimation of relative proportion between them. The authors adopted a best-effort approach to ensure achieving the best possible accuracy. The report features a novel methodology to estimate EO service revenues, based on the combination of top-down and bottom-up analysis, covering both revenues from service providers and surveys on the adoption of EO services by users. A **different methodology** was used **to calculate EO and GNSS revenues** presented **on pages 20-21** and **30-31 respectively**, compared to the rest of the report. This methodology measures the size of the EO and GNSS industry from a supply perspective based on a bottom-up approach which quantifies revenues attributable to EO and GNSS of around 4,000 individual companies. The analysis presented on those pages only relates to companies for which financial data are available (those with turnover greater than the threshold exempting small firms from financial reporting – this threshold is not universal, so smaller companies may be included for some regions and not others). Companies are allocated to a single region based on the registered headquarters of the company (or its ultimate parent), which indicates the regions in which the demand for EO data and services are generated. Changes in market share are driven by general market trends, mergers and acquisitions, and exchange rate fluctuations. **Not all companies are obliged to report their financial information**, so inaccuracies in revenues for individual organisations may exist. In the case of missing financial figures for 2024, especially for relevant players, revenues were extrapolated from available information. The authors are aware that the accessibility of information on the companies' revenues might differ in different world regions, potentially leading to inaccuracies and biases. In particular, there may be vertical integration in the Chinese and Russian governments, this means that activities, which in Europe are procured by the government from industry on market terms, are delivered internally by those governments. This implies that companies from those countries might appear underrepresented in the analysis. **The authors adopted a best-effort approach** to ensure achieving the best possible accuracy and completeness. The revenues of the companies included in the analysis are allocated to the different segments of application and the different steps of the value chain according to the best knowledge available to the authors, which is based on official sources (e.g. companies' annual reports) and other secondary sources, including databases and reports and interviews with the companies of interest and industry experts. Concerning EO, data and data processing services can be used in any market segment, making it difficult to delineate the companies to the different segments of application. Therefore, data acquisition and distribution is not quantified per segment in this study.

Disclaimer

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Any comments to improve the next issue are welcome and should be addressed to: **market@euspa.europa.eu**".

Sources

The model makes use of publicly available information and additional data and reports purchased from private publishers. Primary sources include:
Euroconsult (EO Data & Services Market, 2022), ABI Research; Airbus; American Farm Bureau Federation; App Annie; appFigures; BCG; Berg Insight; BI Intelligence; Boeing; Bombardier; Broadcom; Cisco; Cubris; Deloitte; Digi-Capital; EU C-ITS Strategy; EGNOS Service Provider (ESSP); Embraer; Equasis; Eurocontrol; European GNSS Service Centre (GSC); Eurostat; European Commission; European Securities and Markets Authority; Farstad Shipping; Finnish VTT Research Centre; Food and Agriculture Organisation; FP7 and H2020 project websites; Federal Aviation Administration; Gartner; General Aviation Manufacturers Association (GAMA); General Aviation News; GE Transportation Signaling; Goodyear; Google; GPS World; Grand View Research; GSM Association; Gunter's Space Page; Harbor Research; Hitachi; IBM; IDC; Infomines; Infonetics; Informa Economics and Measure; Inside GNSS; International COSPAS-SARSAT Programme; International Council of Marine Industry Associations (ICOMIA); International Road Assessment Programme (IRAP); International Telecommunications Union (ITU); International Maritime Organisation (IMO); International Convention for the Safety of Life at Sea (SOLAS); International Civil Aviation Organisation (ICAO); Irish Health & Safety Authority; Juniper Research; Kapsch GPS World Receiver Survey; KPMG; London School of Economics; Lux Research; MarketsandMarkets; McKinsey; Ministère de l'Environnement, de l'Energie et de la Mer; Nanosats Database; NATS Jon King blog; Orbis, Organisation Internationale des Constructeurs d'Automobiles (OICA); Pew Research Centre; Proxbook; Research and Markets; Rivers of the World Atlas; Rolls Royce; Royal Institute of Navigation; Sensors Magazine; SESAR Joint Undertaking; Siemens; Statista; Statistic Brain; Technavio; Thales Alenia Space; TTG Transportation Technology; Teal Group; The Verge; TrendForce; TNS/Google; UAVGlobal; UCS Satellite Database; UIC International Railway Statistics; United Nations Conference on Trade and Development (UNCTAD); United Nations public information; UseGalileo; US Bureau of Labor Statistics; US National Transportation Statistics; Vision Mobile; VTPI; World Bank; World Economic Forum; World Shipping Council; World Stock Exchange; Xinhua.

Annex 2: Definition of GNSS performance parameters

The definitions given below are to explain the GNSS performance parameters as referenced throughout the report, in order to support the reader in gaining full understanding of the report content. Although universally accepted definitions for the performance parameters do not always exist, the terminology adopted in this report is based on converging definitions by influential sources and publications.

Key GNSS performance parameters

Availability is the percentage of time the position, navigation or timing solution can be computed by the user. Values vary greatly according to the specific application and services used but typically range from 95 to 99.9%. There are two classes of availability:

- System availability: the percentage of time the system allows the user to compute a position - this is what GNSS Interface Control Documents (ICDs) refer to.
- Overall availability: considers the receiver performance and the user's environment. Values vary greatly according to the specific use cases and services used.

Accuracy is the difference between true and computed solution (position or time). This is expressed as the value within which a specified proportion – usually 95% – of samples would fall if measured. This report refers to positioning accuracy using the following convention: centimetre-level: 0-10cm; decimetre level: 10-100cm; metre-level: 1-10 metres.

Calibration only relates to GNSS Timing Receivers and is the process of measuring the different biases of the GNSS signal's propagation through the antenna cable and equipment hardware in order to characterise and consider them when computing the timing solution.

Continuity is the ability of a system to perform its function (deliver PNT services with the required performance levels) without interruption once the operation has started. It is usually expressed as the risk of discontinuity and depends entirely on the timeframe of the application. A typical value is around 1*10-4 over the course of the procedure where the system is in use.

Integrity is a term used to express the ability of the system to provide warnings to users when it should not be used. It is the probability of a user being exposed to an error larger than the alert limits without timely warning. The way integrity is ensured and assessed, and the means of delivering integrity-related information to users are highly application dependent. Throughout this report, the "integrity concept" is to be understood at large, i.e., not restricted to safety-critical or civil aviation definitions but also encompassing concepts of quality assurance/quality control as used in other applications and sectors.

Robustness relates to spoofing and jamming and how the system can cope with these issues. It is a more qualitative than quantitative parameter and depends on the type of attack or interference the receiver is capable of mitigating. Robustness can be improved by authentication information and services.

Authentication gives a level of assurance that the data provided by a positioning system has been derived from real signals. Radio frequency spoofing may affect the positioning system, resulting in false data as output of the system itself.

Time To First Fix (TTFF) is a measure of time between activation of a receiver and the availability of a solution, including any power on self-test, acquisition of satellite signals and navigation data and computation of the solution. It mainly depends on data that the receiver has access to before activation: cold start (the receiver has no knowledge of the current situation and must thus systematically search for and identify signals before processing them – a process that can take up to several minutes.); warm start (the receiver has estimates of the current situation – typically taking tens of seconds) or hot start (the receiver understands the current situation – typically taking a few seconds).

Other performance parameters

Power consumption is the amount of power a device uses to provide a position. The power consumption of the positioning technology will vary depending on the available signals and data. For example, GNSS chips will use more power when scanning to identify signals (cold start) than when computing a position. Typical values are in the order of tens of mW (for smartphone chipsets).

Resiliency is the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions; including the ability to recover from deliberate attacks, accidents, or naturally occurring threats or incidents. A resilient system will change its way of operations while continuing to function under stress, while a robust (but non-resilient) system will reach a failure state at the end, without being able to recover.

Connectivity refers to the need for a communication and/or connectivity link of an application to be able to receive and communicate data to third parties. Connectivity relies on the integration with both satellite and terrestrial networks, such as 5G, LEO satellites, or LPWANs.

Interoperability refers to the characteristic of a product or system, whose interfaces are completely understood, to work with other products or systems, in either implementation or access, without any restrictions (e.g. ability of GNSS devices to be combined with other technologies and the possibility to merge the GNSS output with the output coming from different sources).

Traceability is the ability to relate a measurement to national or international standards using an unbroken chain of measurements, each of which has a stated uncertainty. For Finance applications, knowledge of the traceability of the time signal to UTC is essential to ensure regulatory compliance of the time-stamp.

Annex 2: Definition of EO performance parameters

The definitions given below are to explain the EO performance parameters as referenced throughout the report in order to support the reader in gaining full understanding of the report content. Although universally accepted definitions for the performance parameters do not always exist, the terminology adopted in this report is based on converging definitions by influential sources and publications.

Key EO performance parameters

Spatial resolution relates to the level of detail that can be retrieved from a scene. In the case of a satellite image, which consists of an array of pixels, it corresponds to the smallest feature that can be detected on the image. A common way of characterising the spatial resolution is to use the Ground Sample Distance (GSD) which corresponds to the distance measured on the ground between the centres of two adjacent pixels. Thus, a spatial resolution of 1 meter means that each pixel corresponds to a 1 by 1 meter area on the ground.

Spectral resolution refers to the ability of a sensor to differentiate electromagnetic radiation of different wavelengths. In other words, it refers to the number and "size" of wavelength intervals that the sensor is able to measure. The finer the spectral resolution, the narrower the wavelength range for a particular channel or band. In remote sensing, features (e.g. water, vegetation) can be characterised by comparing their "response" in different spectral bands.

Radiometric resolution expresses the sensitivity of the sensor, that is to say its ability to differentiate between different magnitudes of the electromagnetic energy. The finer the radiometric resolution, the more sensitive it is to small differences in the energy emitted or reflected by an object. The radiometric resolution is generally expressed in bit, a resolution of 8 bit meaning that the "brightness" of the image is measured with a scale of 28=256 nuances.

Temporal resolution relates to the time elapsed between two consecutive observations of the same area on the ground. The higher the temporal resolution, the shorter the time between the acquisitions of two consecutive observations of the same area. In absolute terms, the temporal resolution of a remote sensing system corresponds to the time elapsed between two consecutive passes of the satellite over the exact same point on the ground (generally referred to as "revisit time" or "orbit cycle"). However, several parameters like the overlap between the swaths of adjacent passes, the agility of the satellites and in case of a constellation, the number of satellites mean that some areas of the Earth can be re-imaged more frequently. For a given system, the temporal resolution can therefore be better than the revisit time of the satellite(s).

Geolocation accuracy refers to the ability of an EO remote sensing platform to assign an accurate geographic position on the ground to the features captured in a scene. An accurate geolocation makes easier the combination of several images (e.g. combination of a Synthetic Aperture Radar image with a cadastral map and a vegetation map).

Spectral range refers to the wavelength range of a particular channel or band over which remote sensing data must be collected. t

Latency is the difference between the reference time of the satellite measurement and the time the final product (e.g. optical or radar image) is made available to users (e.g. value-added service providers).

Other performance parameters

Agility corresponds to the ability of a satellite to modify its attitude and to point rapidly in any direction in order to observe areas of interest outside its ground trace. High agility can improve the temporal resolution compared with the revisit time of the satellite.

Swath corresponds to width of the portion of the ground that the satellite "sees" at each pass. The larger the swath, the bigger the observed area at each pass.

Off-nadir angle corresponds to the angle at which images are acquired compared with the "nadir", i.e., looking straight down at the target. In practice, objects located directly below the sensor only have their tops visible, thus making it impossible to represent the three-dimensional surface of the Earth. High resolution images are therefore generally not collected at nadir but at an angle. A large off-nadir angle enables a wider ground coverage at each pass and the identification of features not visible at nadir, but it reduces the spatial resolution. For optical imagery, typical off-nadir angles are in the range of 25-30 degrees.

Sun-elevation angle corresponds to the angle of the sun above the horizon at the time an image is collected. High elevation angles can lead to bright spots on the imagery while low elevation angles lead to darker images and longer shadows. The most appropriate angle depends on the type of application: a high sun elevation is appropriate for spectral analysis since the objects to be observed are well illuminated while a lower elevation angle is better suited to interpretation of surface morphology (e.g. the projected shadows can enable a better image interpretation).

Annex 3: List of applications

The applications for each market segment are listed below and accompanied with a definition, explaining the use of EO, GNSS or both. The list of segments follows the order of the report.
LEGEND: EO application / GNSS application / Synergetic application (combined use of EO and GNSS)

Agriculture

Environmental Monitoring

Carbon capture & content assessment: The monitoring of agricultural vegetation and grassland cover through EO can help inform carbon sink capacity of different terrains. EO can also be used to monitor the maintenance of agricultural practices which pertain to CO2 sequestration.

Environmental impact monitoring: EO can be used to monitor greenhouse gas emissions associated with agricultural activities; evaluate the impact of fertilisation on the environment; explore the potential of carbon sequestration in agricultural land cover; and assess the level of biodiversity present in agricultural lands.

Natural Resources Monitoring

Vegetation biomass and health monitoring: The use of various radar, optical and in-situ sensor measurements, enables EO and GNSS to monitor the biomass present in a region. This can help in understanding the capacity for CO2 absorption of a given ecosystem or potentials for biomass energy production. EO also enables the monitoring of vegetation coverage and health (through the generation of various indices such as NDVI). This information can be used to understand land cover statistics and provide inputs for efficient farm management practices.

Crop yield forecasting: EO facilitates remote-monitoring and forecasting of harvest potentials, whilst GNSS allows in-situ positioning information of field sensors to feed forecast information.

Soil condition monitoring: EO enables monitoring of soil condition and moisture levels. GNSS positioning helps to identify the exact position of the soil samples sent to laboratories. Soil condition monitoring is important for understanding the growth potential and health status of plants.

Operations Management

Asset monitoring: GNSS provides insightful telematics data from tractors and other farm vehicles/assets to help increase efficiency when conducting operations, monitor workforce activity and reduce costs.

Automatic steering: Automatic steering completely takes over steering of the farm equipment from the driver allowing the operator to engage in core agricultural tasks.

Subsidy & policy control: The enforcement of certain agricultural practices mandated by the likes of the Common Agricultural Policy, such as the maintenance of permanent grassland or the diversification of crop species, can be monitored and enforced using EO data or geotagged photos using GNSS.

Farm machinery guidance: GNSS positioning is used to assist drivers of farm machinery in following the optimal path when conducting activities such as variable rate application, thus minimising risks of overlaps.

Livestock wearables: Animals can be fitted with devices which use GNSS to track and monitor their activity and health status.

Farm operations management: Farm operations management is grouped application which consists of the following sub applications; Field delineation, Farm management systems (FMS), Pastureland management, Variable rate application and Precision irrigation. Field delineation involves the use of both EO and GNSS to allow for the precise measurement and definition of field boundaries. Farm management systems use both EO and GNSS to inform part of an overall management system through various types of practical, operational, and financial data aimed to improve the holistic management of a farm. Pastureland management uses EO to monitor the growth and maintenance of grasslands. Mowing and grazing activities on grassland can also be detected and verified using EO. Variable rate application combines GNSS positioning with EO information to distribute varying amounts of agrichemicals and seeds across a given area. Discrepancies in performance and areas of lower crop yields can be identified and specifically targeted with extra input treatments (fertilisers, pesticides etc.) or seeds by farmers. This can help improve overall performance and reduce agricultural input usage. Similar to variable rate application, precision irrigation combines GNSS positioning with EO information to distribute appropriate amounts of water for irrigating crops.

Weather Services For Agriculture

Weather and climate services for agriculture: Short term weather forecasting, air quality, land temperature and cloud cover can all be understood using EO, which in turn can help form weather forecasts relevant to precise locations. This allows farmers to plan operations such as irrigation or fertiliser scheduling. Climate services involve long term forecasting and monitoring of climate variables relevant to agriculture using remotely sensed data. Air quality and land temperature can be understood through the use of EO, which in turn can help in understanding how our climate could affect future harvests and yields.

Annex 3: List of applications

Aviation and Drones

Communication

ATM system timing: The ground systems used by air traffic control are increasingly connected. The systems rely on precise and high integrity timing for synchronisation of logs, communication and traffic handover at system level - all of which are dependent on GNSS derived timing.

Climate Change Mitigation, Environmental Impact and Hazards

Aircraft emission measurement and monitoring: Enables monitoring of trace gas composition of the Earth's atmosphere at different altitudes to understand more accurately the impact Aviation has on the environment at those different altitudes.

Particulate matter monitoring: Enables air traffic services to monitor particulates in airspace, enabling them to provide avoidance instructions (e.g. to avoid volcanic ash clouds) and allowing improved planning of routes and flight efficiency.

Hazardous weather identification: EO is used to identify and monitor hazardous weather conditions such as- storms, enabling aircraft and air traffic management to detect and avoid these weather phenomena earlier. This leads to a reduction in the number of safety incidents and increased flight efficiency.

Navigation

Drone navigation (uncertified): An uncertified navigation tools capable of PVT and other capabilities related to drone navigation providing horizontal/vertical accuracy, integrity (integrity risk, time to alert and alert limits), continuity and availability for different phases of flight and environments.

Performance Based Navigation (PBN): An umbrella term for navigation based on a specific standard. For-simplicity, this is categorised as:

- Area Navigation: A fundamental requirement for IFR aircraft and certified category drones to be able to navigate along routes with a required accuracy. GNSS is a core capability that enables them to meet the requirements of PBN within the en-route and terminal phases of flight.
- Approach Navigation: The approach phase of flight is a critical phase where high performance is needed from GNSS. SBAS and GBAS are two solutions that are deployed, providing IFR aircraft and certified category drones with the capability to land in low visibility conditions down to 200ft. These performances are expected to be extended by incorporating Galileo and dual frequencies.
- Low Level Routing: An area navigation capability specified initially for helicopter operations but supporting light General Aviation and potentially drones in the future. The ceiling of the routes is low level (<4,000') and enables helicopters to transition busy TMA or areas of high terrain safety.

Performance Based Navigation (PBN) for drones: An umbrella term for navigation based on a specific andcertified standard. An equivalent of PBN for manned aviation.

VFR complement: Use of uncertified GNSS receivers as a navigation complement to VFR piloted operations. This includes moving map displays on portable devices.

Operations Management

Aircraft maintenance and operations optimisation: Identifies areas where aircraft have flown through large areas of particulate matter and in turn require early or more maintenance actions helping airlines and manufacturers save costs. When combined with innovative digital and satellite-based solutions, it also supports new tools and traffic optimisation mechanisms for multimodal access, passenger and freight flows into and out of the airport, as well as between airports, facilitating improved airport access and reducing traffic from/to the city or other key transport nodes.

Airport capacity and safety: EO is a valuable asset to support Advanced-Surface Movement Guidance and Control System (A-SMGCS) surveillance and safety support services as well as helping airport managers to maintain high quality and complete knowledge of their airport assets.

Drone operations planning: Includes the use of EO data to understand the environment close to planned flight trajectory and consequently to support ground risk assessment. EO data supports inclusion of terrain/surface model into route planning in order to apply ground clearance. EO data can also support operators in identifying alternative landing site. GNSS (SBAS) enables precise route planning and increased integrity of positioning signal thus ensuring that positioning and navigation performance is known and acceptable.

Monitoring terrain obstacles: EO assists airport operators in monitoring and managing potential threats to aviation safety from changes to airport surroundings and helping to secure safe flight take-off and landing. Outside of airport's protected areas, EO is also capable to provide high accuracy terrain models supporting airspace users operating close to the ground.

U-space services: The precise positioning and integrity enabled by EGNOS can support U-space services serving both manned and unmanned airspace users. Such services include network identification, geo-awareness or conformance monitoring. It is important to note that network identification only applies to drones. EO can support geo-awareness (post-processing).

Surveillance

Electronic Conspicuity (certified): Provides self-reporting of position from an aircraft or drone to other aviation actors providing a means to learn about position and speed vectors. The information from this is derived from GNSS and covers numerous non-certified solutions used for situational awareness of the operator.

Electronic Conspicuity (uncertified): Provides self-reporting of position from an aircraft or drone to other aviation actors providing means to learn about position and speed vectors. The information is derived from GNSS and covers numerous certified solution used mostly for Air Traffic Management.

GADSS: The Global Aeronautical Distress and Safety System is a concept developed by ICAO which enhances the effectiveness and alerting of search and rescue services in the event of an aviation tragedy. It ensures that the aircraft is tracked and that the lasted known GNSS derived position is always recorded, maintaining an up-to-date record of aircraft progress. GADSS has three components: Aircraft Tracking; Autonomous Distress Tracking; and Post Flight Localisation and Recovery. Aircraft Tracking is enabled through the on-board GNSS equipment (either the PBN or Electronic Conspicuity device), whilst the other components are provided by Emergency Locator Transmitters which are covered in the Emergency Management and Humanitarian Aid segment.

Infrastructure timing: Different solutions, such as radars, are used by air traffic services to track aircrafts and provide services to facilitate conflict free traffic flows. All systems in use today rely on GNSS for timing, and often synchronisation as well, for example in Wide Area Multilateration systems that use multiple synchronised receivers to calculate where an aircraft is.

Annex 3: List of applications

Climate, Environment, and Biodiversity

Biodiversity, Ecosystems and Natural Capital

Animal tracking for biodiversity purposes: GNSS-beacons are used to geo locate animals for the purposes of monitoring migrations, habitats, and behaviours.

Ecosystems monitoring: Includes coastal, snow and ice, terrestrial and water ecosystems. For coastal ecosystems monitoring, EO provides information on multiple parameters, such as coastal wetland loss, land-use cover and change, wetland mapping, coastal geomorphology, water optical properties, waterbody nutrients (chlorophyll-a), littoral and subtidal habitat, erosion and sedimentation mapping, long time series of ocean colour products including uncertainties estimates or health issues such as algal bloom detection. For snow and ice ecosystems monitoring, EO provides data on snow and ice cover (multispectral and thermal, and to a lesser extent microwave), mapping the structural glaciology of big and small glaciers, mapping of glacier change, conducting glacier inventories, mapping glacier thinning, measuring thinning ice shelves, glacier velocity, mapping glacier landforms and measuring the ice-sheet bed. For terrestrial ecosystems monitoring, EO data provides information on plant species which respond differently to light emitted by the sun or by various artificial energy sources, with specific reflection characteristics in the electromagnetic spectrum. This makes EO data of adequate spectral and spatial resolution and a useful tool to distinguish different species. Other relevant data derived from EO relate to air/water quality completing the information for the status/forecasting of the ecosystem. With regards to water ecosystems monitoring, EO provides information on multiple parameters needed to assess the conditions and the equilibrium in water ecosystems, such as: bio-geochemical analyses and forecasts for global and regional seas, topography, bathymetry, ocean colour, sea-surface temperature, ocean currents, fish quantification, and others.

Climate Services

Climate change mitigation and adaptation: Various types of EO data can be used to aid formation of short and long-term climate change mitigation and adaptation strategies.

Climate monitoring and forecasting: Many types of EO data can be used in climate monitoring and forecasting. Air quality, land temperature, cloud cover and several other parameters relevant for the climate can all be understood with EO data, which in turn can be built into relevant models and contribute to climate forecasting.

EO-based climate modelling: Many types of EO data, despite being unavailable for a long period, is used as an input into climate modelling. This results in computer simulated dynamic projections of the Earth's systems behaviour used for various purposes.

GNSS-based climate modelling: GNSS supports a range of geodetic applications that measure properties of the Earth (magnetic field, atmosphere) with direct impact on the Earth's climate.

Environmental Monitoring

Environmental auditing: EO data aids in the assessment of the impact of human activity across four different environments: atmosphere, coasts, land, water and oceans. For atmosphere, multiple EO satellites and sensors are dedicated to monitoring atmospheric conditions, including air quality and the presence of greenhouse gases (GHG) emissions, enabling the provision of short- and long-term forecasting. For coastal environment, relevant EO data can be acquired relating to wetland loss, land-use cover and change, wetland mapping, coastal geomorphology, water optical properties, waterbody nutrients (chlorophyll-a), littoral and subtidal habitat. With regards to land, relevant parameters range from land-use cover and change, vegetation, biomass, and soil monitoring, to the monitoring of human impact, such as waste, constructions, and other infrastructure. The relevant parameters for water and ocean environment which can be acquired through EO include temperature, transparency/turbidity, water depth, tides, currents, and to an extent, flora and fauna. The data also supports the monitoring of infrastructure and other traces of human activities, including waste.

Environmental impact assessment and ESG: EO plays a vital role in conducting impact studies and implementing ESG policies across four distinct environments. For the atmosphere, EO satellites and sensors are deployed to monitor atmospheric conditions, encompassing air quality and greenhouse gas emissions, facilitating both short- and long-term forecasting. Along coastlines, EO data provides insights into wetland loss, land-use changes, wetland mapping, coastal geomorphology, and water properties, including chlorophyll-a levels and littoral and subtidal habitats. On land, EO applications extend to land-use changes, vegetation, biomass, soil monitoring, and the assessment of human impacts like waste disposal, construction, and infrastructure development. In water and ocean environments, EO data captures parameters such as temperature, transparency, water depth, tides, and currents, while also offering insights into flora, fauna, and human activities, including the monitoring of infrastructure and waste.

Environmental resources management: The use of EO satellites and data enables effective environmental resource management in four environments. Firstly, for the atmosphere, multiple EO satellites and sensors monitor air quality and greenhouse gas emissions, providing both short and long-term forecasting capabilities. Secondly, along the coasts, EO satellites track coastal wetland loss, land-use changes, wetland mapping, coastal geomorphology, water properties, and nutrient levels, aiding in erosion and sedimentation mapping, and compliance monitoring for water quality. On land, EO applications encompass land-use changes, vegetation, biomass, soil monitoring, and the assessment of human impacts like construction and waste. Lastly, in water and oceans, EO data measures various parameters to assess the impacts of human and natural activities on aquatic environments, including temperature, transparency, water depth, tides, currents, flora, fauna, and human activities such as waste disposal.

Annex 3: List of applications

Consumer Solutions, Tourism and Health

Corporate

Location-based billing: Payment processing based on location or activity duration for public transport, gyms, theme parks, parking.

Geo-advertising: Consumer preferences are combined with positioning data to provide personalised offers to potential customers. EO represents an additional layer of geospatial information contributing to better audience targeting.

Mapping & GIS: Smartphones enable users to become map creators as a result of the democratisation of digital mapping. Mapping services comprise all consumer applications that draw on EO information for map features, which includes location or navigational services, including navigation, tracking and local search & discovery applications.

Workforce management: Aims to manage employees working outside the company premises and to improve operational efficiency.

Health & Lifestyle

Air quality monitoring: EO enables air quality applications which measure the presence of harmful substances and particulate matter in the air (e.g. sulphur dioxide and PM 2.5). Measurements of air quality are used to inform analytics, such as air quality indexes, and to provide recommendations to users (e.g. to stay indoors and keep windows closed if air quality is very poor).

Games: GNSS enables a wide range of location-based games on smartphones and tablets. Various uses are associated with EO including backdrop images for a game or gamification of EO crowdsourced in-situ information.

Geo-tagging: adding geographical metadata to online content with the purpose of identifying the physical location of where the content was posted from.

mHealth: In combination with other technologies, GNSS enables a vast array of applications from patient monitoring to guidance systems for vulnerable groups (people with reduced mobility, visual impairment and seniors).

Safety and emergency: GNSS, in combination with network-based methods, provides accurate emergency caller location.

Social networks: Friend locators embedded in social networks use GNSS to facilitate keeping in touch and sharing travel information.

Sport, fitness and wellness incl. specialist support tracking: GNSS enables monitoring of users' performance through a variety of fitness applications. It records data such as real-time distance, speed/pace, location, elevation, travelled distance, and step counters to monitor users' performance. Speed and elevation charts are provided (including running, biking, hiking, swimming, etc.). A growing use of EO information is embedded in outdoor apps to provide information on snow coverage and depth, forest elevations, etc.

UV monitoring: EO data is used in consumer UV monitoring applications to provide UV exposure measurements for particular geolocations and to inform analytics about safe levels of UV exposure. This allows them to make recommendations for user behaviour (e.g. recommendations to remain indoors when the UV index is very high).

Tourism fruition: GNSS data can be used to enhance navigational capacities for tourists, including in reaching destinations and exploring the destination areas, as well as providing information on the destinations, such as restaurants, hospitals, ATMs, banks, petrol stations, etc.

Navigation & Tracking

Navigation for smartphone users: Route planning and turn-by-turn instructions enabled by GNSS for both-pedestrian and road users through a smartphone.

Personal & asset tracking: GNSS facilitates innovative tracking solutions, including the deployment of local-geofences that trigger an alarm when users leave a specific perimeter.

Visually impaired support: solutions providing turn-by-turn instructions based on GNSS positioning that help visually-impaired people get around more easily.

Robotics

Consumer robotics: GNSS signals are used along with other sensors integrated into consumer electronics for localisation and navigation purposes. e.g. gardening robots, delivery robots, security and surveillance robots, personal assistant robots, painting robots, automated guided vehicle/logistics.

Enhanced human: Human enhancement refers to methods for altering the human body to enhance mental or physical performance. The most developed examples are untethered mixed reality devices: in the future, GNSS position could be combined with optical feedback and 3D mapping to give users full situational awareness and the most accurate navigation.

Annex 3: List of applications

Emergency Management and Humanitarian Aid

Humanitarian Aid

NGO's asset management: Through smartphones or other devices, GNSS functionalities can be helpful for NGOs in managing and tracking resources, including real-time personnel and asset tracking, route optimisation particularly for disaster relief or healthcare delivery missions, data collection and effective resource allocation for areas of need.

Humanitarian aid applications: GNSS provides accurate location information that can be accessed through smartphones or other mobile devices for recipients and aid distribution points and improves the efficiency and effectiveness of humanitarian efforts. The location information can improve coordination, speed up the delivery of relief supplies to those in need, and ensure the safety of the personnel involved.

Health and medicine response and coordination: EO data can be used to monitor the spread of diseases and the environmental risk factors associated with certain diseases, thus, helping with public health mitigation measures. GNSS, meanwhile, can be used to locate and navigate relief efforts and help patients transport, as well as track the movement of healthcare supplies, especially as the data is easily accessible from smartphones or other mobile devices.

Anticipatory humanitarian action: Anticipatory action is commonly defined as acting ahead of predicted hazards to prevent or reduce acute humanitarian impacts before they fully unfold.

Management of refugee camps: Comprises applications where EO data is used for planning of camp layouts, and for the distribution of resources, e.g. wells and medicine, by displaying settlement concentrations and estimating population in different areas of a camp.

Population displacement monitoring: Monitoring of displacement patterns due to conflict or disaster aimed at, for example, planning humanitarian responses. EO data can be used to monitor migration routes, as well as for the identification of temporary dwelling structures.

Prevention and Mitigation

Impact exposure analysis and proactive mitigation measure: EO data can assist in preparing for potential disasters by helping identify and monitor natural hazards, such as floods, wildfires, earthquakes and hurricanes, and map high-risk areas that may require special attention in disaster planning.

Preparedness

Early warning emergency applications: GNSS and EO technologies perform the systematic monitoring and alerting of various environmental hazards. This includes drought monitoring, early-warning surveillance of forest fires, landslides and terrain deformation monitoring, earthquake and tsunami monitoring, floods monitoring, storm surge monitoring, and volcanic activity monitoring. Leveraging GNSS and EO technologies enables real-time data collection, analysis, and timely dissemination of alerts, enhancing the capacity for early detection, preparedness, and effective response to mitigate the impact of natural disasters and emergencies.

Early-warning surveillance of forest fires: EO thermal imaging can detect the heat signatures associated with active fires, as well as smoke and aerosols that may appear. As an early warning system, EO can provide a risk assessment and vulnerability mapping of forest fires by assessing land cover, vegetation types, and proximity to urban areas.

Hazards monitoring: Hazards monitoring, facilitated by GNSS and EO technologies, encompasses the systematic observation and analysis of various environmental phenomena. This includes the monitoring of landslides and terrain deformation, locust swarms, drought monitoring, earthquake and tsunami occurrences, floods, storm surges, vector-borne diseases, volcanic activity monitoring, and early-warning surveillance of forest fires. Utilizing GNSS and EO technologies enables the real-time tracking, assessment, and early detection of these hazards, contributing to enhanced disaster preparedness, risk mitigation, and timely response efforts.

Landslides and terrain deformation monitoring: EO data can be used to detect changes in the Earth's surface that may indicate potential landslides and monitor ground displacement over time (in conjunction with similar applications in Infrastructure or Rail that are more specifically focused on the infrastructures themselves). GNSS can provide real-time data on ground movement, allowing for an early warning system and a rapid response to landslide threats.

Earthquake and tsunami monitoring: EO satellites can detect and monitor surface deformations caused by tectonic activities, including land and coastal changes. GNSS can provide early warning signals from ground motion or sea-level changes.

Drought monitoring: In parallel to soil condition and vegetation monitoring applications used in Agriculture (that are more specifically focused on plant health), EO can also provide data to assess and manage drought conditions, including monitoring vegetation health, soil moisture, rainfall and water bodies and weather forecasts.

Volcanic activity monitoring: EO can provide thermal imaging to monitor the movement and temperature of lava flows and volcanic gasses and ash clouds. GNSS technology can be used for ground deformation monitoring and eruption early warning systems.

Floods monitoring: EO and GNSS can provide critical data for flood prediction, early warning, and response efforts. EO can provide flood extent mapping and damage assessment, as well as weather forecasts and water bodies and coastal monitoring, while GNSS can provide real-time water-level tracking.

Storm surge monitoring: EO satellites can track the formation, movement, and intensity of storms, as well as changes in ocean temperature and levels, to mitigate storm surge events.

Monitoring of vector-borne diseases: EO can provide environmental data monitoring temperature, humidity, precipitation, vegetation cover and other factors that may influence the spread of vector-borne diseases.

Monitoring of locust swarms: EO satellites can detect the presence of locust swarms and track changes in vegetation cover, as well as monitor environmental conditions that influence movement and breeding patterns. GNSS can provide real-time swarm tracking.

Response

Crisis area assessment: EO data can provide damage assessment and monitor changes in land and vegetation cover. Simultaneously, GNSS can provide real-time tracking of affected populations and relief supplies and personnel.

Operational wildfires modelling: EO data equipped with thermal imaging can be used to model fire spread, as well as provide assessment of the flammability of vegetation and potential hotspots.

Annex 3: List of applications

Search and Rescue

SAR operations - at sea: Ship and person-registered beacons, i.e., Emergency Position Indicating Radio Beacons (EPIRBs) and Personal Locator Beacons (PLBs) transmit, once activated, the necessary information for rescue to authorities via COSPAS / SARSAT payloads carried by GNSS satellites. The AIS-SART (Search and Rescue Transmitter) and AIS-MOB (Man Overboard) beacons not only transmit the position of the person in distress but also share this location through the Automatic Identification System (AIS) with nearby vessels, by pinpointing an AIS distress signal onto the nearby vessel's ECDIS (Electronic Chart Display Information System).

SAR operations - aviation: Aircraft should be equipped with Emergency Locator Transmitters (ELTs) or a PLB that helps Search and Rescue operations in the event of an incident. In line with requirements in ICAO Annex 10 (and standards set in ICAO Annex 6) as well as the implementation of the Global Aeronautical Distress and Safety System (GADSS), many ELTs utilise GNSS to report their position when triggered.

SAR operations - land: Climbers and hikers are advised to equip themselves with a PLB in case they find themselves in distress.

Situational awareness supporting SAR: EO services can assist Maritime and Joint Rescue Coordination Centres (RCC) in a wide range of activities at sea, including support to SAR operations and exercises. EO information, combined with maritime data and external sources, can provide a better understanding and improved monitoring of activities at sea (including detection of ships in distress, SAR response support, etc.).

Post-Event Recovery

Post-crisis damage assessment and building inspection: EO data can be used to map the extent of the damage, including to infrastructures, while GNSS can provide accurate locations of damaged buildings and enable field teams to navigate the impacted areas for inspection.

Restoration of supply chain and infrastructure services: EO data can provide damage assessment to critical infrastructures and transportation networks, including vegetation and land cover, while GNSS enables precise location tracking and mapping of infrastructure damage and repair efforts, in addition to assisting in finding optimal routes for the transportation of goods and resources.

Energy and Raw Materials

Energy Network Fidelity

Energy network planning and monitoring: EO supports energy network planning by providing wide-area, repeatable data to assess terrain, land use, and environmental constraints, enabling natural hazard risk assessments (e.g., landslides, floods, subsidence) for both existing and planned infrastructure. EO also enables continuous detection of ground movement and vegetation encroachment using satellite imagery and InSAR, improving situational awareness across large and remote networks. An important application is also unauthorized construction detection and third-party interference monitoring by identifying activities such as earthworks, or changes near pipelines, power lines, and substations before they escalate into safety or reliability issues.

Phasor Measurement Units (PMU): GNSS provides accurate timing and synchronisation for PMUs, which are deployed across remote locations of the power network (nodes), improving the reliability of power systems.

Environmental Impact Monitoring

Environmental impact assessment for energy: Satellite data supports environmental impact assessments (EIA) for energy projects by establishing baseline conditions, including vegetation cover and land use, before development begins. EO also enables biodiversity and ecosystem assessments by mapping sensitive habitats and tracking changes in vegetation health, wetlands, and water bodies over time.

Environmental impact assessment for raw materials: EO supports EIAs for raw materials projects by establishing baseline conditions for land cover, vegetation, hydrology, and terrain prior to exploration or extraction. This is considered a key applications as many mines are required to compensate the impact their activities have on the area of operations. Furthermore, many mines are required to monitor environmental parameters like water quality, vegetation health, and other environmental impacts (such as acid mine drainage), where EO can support.

Market Intelligence

Supply chain insights: EO data support market analysts, traders, investors, energy operators and regulators, governments, international banking institutions and ultimately, citizens, to better understand the new energy dynamics shifting under the pressure of climate change. AI and advanced analytics are applied to EO for applications such as reservoir monitoring, heavy oil production mapping, underground gas storage, sophisticated methane-detection technologies, etc.

Raw Materials

Mineral exploration, site planning and monitoring: EO and GNSS can provide a large variety of products and information supporting the identification of the most suitable areas for the exploitation of mineral resources. Products and information include geological evaluation, topography mapping, etc. Additionally, EO supports safety applications such as open pit or tailings dam stability monitoring, as a complementary source of data to in-situ sensors such as ground-based radar or piezometers imbedded in the dams.

Mining vehicle management and control: Augmented GNSS solutions enable the accurate guidance of heavy mining machinery.

Annex 3: List of applications

Renewable Energy

Renewable energy site planning and monitoring: EO supports renewable energy potential assessment and forecasting by providing long-term data on key energy resource drivers such as solar irradiance, wind fields, precipitation, snow cover, and surface water dynamics. For solar energy, EO-derived irradiance, cloud cover, aerosol load, and urban 3D context enable site selection, yield estimation, short-term production forecasting, and design optimisation, including assessment of shading and shadow effects from buildings or terrain in dense urban environments. For wind energy, EO supports resource mapping and forecasting using atmospheric and ocean surface data, while high-resolution observations inform layout and design decisions such as wind-park placement, turbine spacing, and wake interaction analysis with existing or planned wind farms. For hydropower, EO enables catchment-scale assessment and forecasting by monitoring precipitation, snowpack, soil moisture, river extent, and reservoir levels, improving long-term resource planning and seasonal inflow prediction, specifically assessing the impact of climate change.

Risk assessment for renewable energy assets: Satellite-powered solutions support risk assessment for energy assets by providing continuous, large-scale visibility of environmental and climate-related hazards that can affect assets. EO enables identification and monitoring of risks such as flooding, wildfires, or ground instability for both existing and planned assets. Such risk insights support the mitigation and design optimisation across various energy assets.

EU Border and Internal Security

EU BORDER SECURITY

Border management

Land border surveillance : EO imagery is used in combination with intrusion monitoring and detection systems, different types of sensors and camera. The data collected from the several technology components of the surveillance system and from the sensors are processed and used in conjuncture with the satellite imagery (overlayed on the top of satellite imagery), to produce multilayered maps of a surveyed area that can be visually assessed by the LEAs. GNSS allows for geo-locating the targets, for the visualisation on digital maps of suspicious activities and for facilitating law enforcement operations in the field. Geo-located information from the sensors and cameras can be aggregated into georeferenced maps.

Sea border and Maritime surveillance: Authorities and LEAs, performing surveillance of sea borders and maritime wide areas, use a wide range of technologies, and receive a huge amount and variety of data, to monitor wide areas, detect threats or crises, and respond to them.

EO and GNSS services are essential for sea borders and maritime surveillance functions (e.g., measurements, mapping, monitoring, risk assessments functions and statistical evaluations), for strengthening the resilience in situational awareness and enabling a prompt detection of suspicious activities, for effective responsiveness and reduced intervention times in field operations.

EO imagery on the EU's external sea borders, combined with in-situ geospatial data, allow authorities and LEAs to achieve an enhanced situational awareness.

GNSS contributes with precise and reliable in-situ, reference and auxiliary information gathered from several sources, depending on the considered type of sea border (off-shore, coastal) and the area to be covered.

Monitoring of irregular migration and smuggling of people: Satellite technologies and services provide crucial instruments in monitoring the movement of migrants and refugees.

EO data enable competent authorities and LEAs to acquire a comprehensive picture of migration trends the external borders of the EU , for preventing and detecting irregular migration, as well as tackling associated cross-border crimes.

Aerial surveillance, including drones empowered by GNSS precise positioning, navigation, and timing services, are combined with satellite images to monitor the movement of people on land and sea, supplying very high-resolution real-time surveillance at specific nodes.

In the case of irregular migration by sea, satellite images are primarily used to spot relevant maritime routes, locate vessels suspected to be engaged in migrants smuggling that often puts the lives of migrants in danger. The aerial surveillance helps to identify and track smuggling networks that exploit vulnerable people, contributing to the goal of preventing loss of life at sea. The flights support early detection of vessels in need of assistance, providing information to rescue coordination centres.

Customs operations

Enhanced risk assessment for EU customs administrations: GNSS position and time information from the vessels AIS are coupled with satellite images by customs administrations, to check the actual shipment with respect to the expected journey, to implement enhanced risk assessment procedures, to prevent and identify illicit activities related to drug trafficking, looting of cultural heritage, smuggling of sensitive and counterfeited goods, illegal mining and fishing.

Suppression and investigation of all illegal activities: Satellite technologies, integrated with a variety of other technological tools and techniques, aid customs officials in the observation, analysis, investigation, inspection, and supervision of the entry, exit, and circulation of ships and freights moving across the seas and in ports. Across the seas, satellite technologies allow to detect the movements of suspicious vessels and monitor their activity in-real time. Satellite imagery enables to oversee the maritime traffic. GNSS instruments such as AIS on-board of the vessels provide their precise continuous positions. Drones equipped with GNSS, advanced sensors and high-resolution cameras give a comprehensive real-time aerial view, and act as a proactive measure for discouraging illicit activities. GNSS-based tracking systems (often using satellite communication to overcome the lack of terrestrial network coverage in open seas) are installed on board of vehicles, trucks and containers to trace their movements, and to identify any deviations from authorized routes. The combination with electronic seals allows to check the integrity of the shipments and to localise the occurrences of possible irregularities. In ports, the data gathered from the GNSS-based tracking systems, coupled with information from others sources, to implement IoT and techniques based on digital twins, ensuring customs authorities the ability to oversee the traffic of freights, as well as detect the presence of suspicious objects and goods.

Annex 3: List of applications

Democracy and Human Rights

Overseeing democracy and human rights: Satellite services offer a powerful contributing to preserving the fundamental and human rights within the European Union and, mainly beyond. Satellite images enable to collect invaluable information for humanitarian response when data is difficult to access due to political or geographical reasons, among others. EO images allow involved non-governmental organisations and bodies, to perform damage and conflict zone mapping. The integration with GNSS technologies and services supports the development of geospatial technologies for crisis mapping, including in large-scale refugee situations and human rights violations. Moreover, GNSS is largely used to geolocate objects and targets, to remotely locate, assist and coordinate humanitarian aid personnel and aid assets.

EU civilian crisis management operations – Common Security and Defence Policy (CSDP): Satellite services play a key role in the technologies employed in the EU's international activities contributing to crisis management, peace-keeping operations, conflict prevention and strengthening of international security. EO data provide a non-intrusive tool in the deployment of non-military civilian crisis missions, enabling an accurate assessment in the preparatory phase to effectively prevent or respond to the outbreak of crisis or conflict situations. Satellite imagery is often combined with drones' operations, supported by GNSS positioning navigation and timing. GNSS provides real-time and precise location data, significantly enhancing the management of the deployed assets, and the safety of the involved personnel.

INTERNAL SECURITY

Law enforcement

Maintaining public order and ensuring public safety: EO images and GNSS are instrumental for a variety of purposes in law enforcement actions aimed to oversee and maintain the public order and safety, and the internal security. EO images are generally utilised in the preparatory phase for planning purposes. Drones empowered by GNSS are invaluable tools for border patrol agents and LEAs officials. Equipped with high-resolution cameras drones have the remarkable ability to ensure a rapid coverage and cost-effective operations, complementing the images from satellite, seamlessly in challenging terrains and adverse environments. Integrated with advanced sensors provide precise real-time geolocated data in a high range of contexts and complexities.

Law enforcement assets and personnel monitoring: GNSS technologies are adopted in law enforcement operations, to provide real-time localisation and tracking of deployed assets and personnel, for a better coordination and management, and for ensuring protection and higher safety especially in critical and risky situations. The integration with EO images gives capabilities for suitable route planning in advance and replanning during operations.

UXO risk assessment and clearance: GNSS technology is an integral part in the explosive ordnance disposal (EOD). GNSS is utilised in the effective detection of unexploded ordnance (UXO) using drones, as well as their precise removal through GNSS controlled automated platforms and robotic systems. Unmanned systems are being increasingly utilised in the critical areas of explosive devices disposal and handling. By deploying unmanned systems assisted through GNSS and equipped with specialised sensors, tool and cameras, bomb technicians can safely and effectively inspect and dispose these devices, minimising the risk of injury or damage to people and property. Additionally, unmanned systems can be used in a variety of environments, including urban and rural areas.

Justice Actions

Prevention, investigation, evidence collection and prosecution of law violations, and forensics: Satellite technologies and services offer a significant contribution to justice actions, devoted to prevention, reaction, investigation and prosecution of misconduct and transgressive behaviours. EO brings instrumental environmental crime-fighting capabilities to LEAs, involved scientists, agencies and organisations, enabling them to automate the surveillance, the detection and the investigation of illegal activities, and the production of the relevant evidence. Satellite imagery is widely adopted in several contexts and situations, such as deforestation, waste dumps and disposal, irregular hazardous material landfills, water pollution, pesticide misuse, mining operations, wildlife crimes, and resource misuse in protected areas. Satellite imagery is also utilised by national revenue agencies and police forces to detect illegal buildings or verify cadastral information. The added functionality of satellite images coupled with GIS maps is in covering vast or inaccessible regions. Over smaller areas, aircraft and drones complement satellite imagery providing remote sensing data in real-time, and with greater detail and precision. Equipped with specific sensors, drones analyse vegetation health, biodiversity, and habitat disruptions. They also monitor water bodies, identifying pollution sources and changes in water quality, contributing to the overall health assessment of aquatic ecosystems, and ensuring a prompt response to possible threats. In maritime and coastal contexts, the integration with the GNSS information from the AIS helps to track vessels with switched-off AIS transmitters or with deceptive AIS. The satellite radar or optical data make it possible to acquire images in near real time, allowing the detection of all ships present in a certain area, including non-cooperative and dark vessels. The continuous stream of imagery and large volumes of data are retrieved and processed through AI , and machine learning techniques, offering a significant value for the investigation, analysis and production of evidence. EO technologies and services have a great potential in court proceedings, as the contemporary forensic evidence systems have considered admissible in legal settings the produced proof of environmental crimes. GNSS services are also adopted in criminal trials and investigations by police forces, authorities and private professionals, to attribute evidence to specific suspects and to prove an intent. GNSS devices embedded in mobile phones/devices or vehicles enable to locate almost in real-time suspected individuals or reconstruct their movements. Based on a series of measurements, coordinates of position are stored in databases that can be recovered and analysed as direct information. Combination with 3D scanning technology allows investigators to reconstruct the dynamics of a crime, by generating a scanned 3D model and a digital twin of the crime/accident scene.GNSS devices could also allow for improved remote monitoring of criminals under legal restrictions (e.g., under house arrest or prison labour schemes).

Annex 3: List of applications

Fisheries and Aquaculture

Aquaculture

Aquaculture operations optimisation and site selection: Throughout the operational phase of the aquaculture plants, EO can provide water quality monitoring notably on harmful algae blooms (HABs), as well as assessment of fish farming environmental impacts, and data for modelling species invasion. GNSS plays a role when the operation of offshore farms is carried out by fully automated vessels which rely on accurate positioning and navigation, or in the upcoming use of GNSS for the localisation of networks of buoys.

Aquaculture site selection is also supported by EO data and forecasting, using relevant parameters to choose aquaculture locations and types in both nearshore and offshore environments.

Fisheries

Catch Optimisation and fish stock detection and modelling: EO data contributes to habitat mapping for fish species. Combined with weather data and data on other relevant parameters (e.g., biogeochemical analyses and forecasts for global and regional seas, topography, bathymetry, ocean colour, sea-surface temperature and ocean currents), the catch optimisation application provides relevant information which allows for the selection of the optimal timing and location for fishing activities.

Fishing aggregating devices: GNSS-enabled buoys that assist fishermen both in locating their fishing nets and equipment as well as the identification and location of fish stock.

Fishing vessels navigation: Using GNSS-enabled navigation devices, fishing vessels can accurately and safely navigate their fishing waters as well as navigate towards their equipment such as fishing cages, buoys or fish lines.

Vessel Monitoring: Satellite data has surveillance capabilities for monitoring IUU (illegal, unreported and unregulated) fishing activities and can contribute to the identification of perpetrators. The data concerned is both EO (optical and radar) and GNSS, providing identification of the vessels, including through positioning systems such as AIS and VMS. With AIS and VMS being mandatory depending on vessel size (i.e. 15 m for AIS, 12 m for VMS), the GNSS receiver in these applications is different to the receiver used for general navigation. GNSS-enabled data from vessels can also be used to monitor the location and intensity of fishing effort, providing an independent and reliable source of information on catch origin.

Forestry

Environmental Monitoring

Biomass monitoring: EO and GNSS enable the monitoring of the biomass present in a forest using various optical measurements, radar measurements and in-situ sensors. This can help in understanding the capacity for CO2 absorption of a given forest or potentials for biomass energy production.

Deforestation and illegal logging monitoring: EO helps in remotely detecting deforestation. Optical and radar data can be used to measure forest vegetation intensity (through the generation of various indices such as NDVI), forest canopy cover and land use changes associated with deforestation. EO can also help in the identification of illegal logging. By using optical and radar data to monitor land use changes and measure forest vegetation cover, illegal destruction of forests can be detected and monitored. GNSS also contributes to this application by helping define plot boundaries.

Forest Resources Monitoring

Forest inventory monitoring: EO and GNSS enable the monitoring of the timber inventories using various optical measurements, radar measurements and in-situ sensors.
Forest vegetation health monitoring: The health of forest vegetation can be monitored and managed using EO. Optical and radar data can be used to measure forest vegetation intensity (through the generation of various indices such as NDVI) to infer the health of trees and forest vegetation. Meanwhile, GNSS technology can be used to monitor parameters related to forest vegetation health, such as in mapping forest cover or measuring tree height.

Operations Management

Automatic steering: Automatic steering completely takes over steering of the forestry machinery from the driver allowing the operator to engage in core forestry tasks.

Forest asset management: GNSS provides insightful telematics data from forestry assets to help increase traceability/efficiency, monitor workforces and reduce costs.

Forest certification: EO can help in the verification and certification of forestry management and production activities. GNSS can also support field certification surveys, and operational monitoring by accurately locating plots, trees and harvesting sites.

Forest machinery guidance: GNSS positioning can assist drivers of forest machinery in following the optimal path when conducting activities, thus minimising risks of overlaps.

Annex 3: List of applications

Infrastructure

Environmental Impact Monitoring

Environmental impact assessment of infrastructure: EO can support the analysis of the impact of infrastructure (including during the construction phase) on the environment and ecosystem surrounding it. Relevant EO-based products and services include pollution monitoring (air, water, soil), vegetation and biodiversity monitoring, etc. This application focuses on the infrastructure itself in contrast to similar applications in Climate, Environment and Biodiversity that are more focused on natural or geologic changes.

Infrastructure Construction And Monitoring

Construction monitoring: Thanks to its capacity to detect surface changes, EO can support the monitoring of ground deformations in the vicinity of construction sites as well as the monitoring, in near-real-time, of the progress achieved anywhere on the construction site. GNSS is an ultimate supplier of positioning and orientation data for heavy machinery (graders, dozers, excavators, compactors), which can be used for either semi-automatic (GNSS serves as a guide to the operator) or fully automatic operations (GNSS data is directly fused into the machine hydraulic control). For the needs of BIM, GNSS can feed the model with high-accuracy positioning data of all relevant construction assets.

Monitoring of impact of human activities on infrastructure: EO enables the monitoring of the impact on buildings and infrastructure of land subsidence caused by a variety of human activities (e.g. aquifer overexploitation in urban areas).

Pipeline monitoring: EO can contribute to the monitoring of pipelines through the provision of ground deformation information across pipeline networks as well as through the provision of information related to vegetation encroachment or third-party interference. For above-ground pipelines, GNSS provides methods for stability monitoring similar to post-construction operations, while for underground assets it may feed high-accuracy positioning data into ground-penetration radars (GPRs) to map and detect leakages and other faults.

Post-construction monitoring: Critical infrastructure such as dams, bridges, factories etc. can be damaged in case of Earth's surface deformation. EO offers solutions for the monitoring of infrastructure stability and for the provision of situation awareness as it can accurately monitor land deformation and to detect minor changes (e.g. building subsidence). The stability of critical infrastructure is monitored also via high-precision GNSS methods, e.g. by post-processing of static relative GNSS observations at field control points (established directly into or in the vicinity of the object) with station data from local or global CORS networks. In addition, GNSS data may be utilised to feed various smart sensors, mounted into the infrastructure body for real-time stability monitoring.

Infrastructure Planning

Infrastructure site selection and planning: EO can contribute to the selection of sites (e.g. tailing dams) or routes (e.g. roads/rail) through the provision of products and services such as geological evaluation, topography mapping, historical data on land subsidence. Through applications like photogrammetry, laser scanning and remote sensing, GNSS can significantly speed up the accurate determination of site borders, while also providing adequate methods for development of detailed specialised maps, route planning or establishment of GIS database with accurate positions of all infrastructure site features. In addition, to high-accuracy GNSS devices (smart antennas or integrated mapping/GIS devices), GNSS chipsets can feed high-accuracy positioning data into LiDAR and imaging devices (drone or land-based), and augmented reality technologies for a-priori in-situ infrastructure visualisation.

Vulnerability Analysis: EO can contribute to the vulnerability assessment for locations prone to natural hazards for infrastructure planning purposes (in contrast to similar applications in Emergency Management that focus more on natural disaster preparedness). Relevant EO-based products and services include historical data on ground deformations, floods, droughts, and fires as well as climate projections enabling the assessment of the evolution of risks.

Timing & Synchronisation Of Telecommunications Networks

Data centre: A Data Centre is a dedicated space within a building, or a group of buildings used to house computer systems and associated components, such as telecommunications and storage systems. GNSS is used as a time source for network synchronisation of computing resources.

Digital Cellular Network (DCN): Telecom operators require accurate and consistent time and frequency at distant points of their networks to meet increasingly demanding broadband requirements. GNSS is used to provide consistent frequency and time alignment between all base stations within the network.

DTV Broadcast: GNSS timing receivers provide the means to ensure a continuous and tight synchronisation of the different media data. Timing and synchronisation, delivered by GNSS, is essential for a smooth and uninterrupted broadcasting experience.

Professional Mobile Radio (PMR): Telecom operators require accurate and consistent time and frequency at distant points of their networks to meet increasingly demanding broadband requirements. GNSS is used for the synchronisation of time slots and handovers between base stations.

Public Switched Telephone Network (PSTN): Telecom operators require accurate and consistent time and frequency at distant points of their networks to meet increasingly demanding broadband requirements. Originally a network of fixed-line analogue telephone systems, the PSTN is now almost entirely digital in its core network and in this report, it consists of fixed telephone networks. GNSS is usually a backup to atomic clocks to provide time slot management.

Satellite Communication (SATCOM): Telecom operators require accurate and consistent time and synchronisation, as well as frequency at distant points of their networks to meet increasingly demanding broadband requirements. GNSS is typically used in Satellite Control Stations and Telecommunications Gateways, mostly for frequency control.

Small cells: Telecom operators require accurate and consistent time and frequency at distant points of their networks to meet increasingly demanding broadband requirements. GNSS is used to provide frequency and phase alignment in small cell networks.

Annex 3: List of applications

Insurance and Finance

Finance

Commodities trading: Commodity trading involves the monitoring of goods production, natural resources (e.g. oil & gas, mineral resources) and shipping at key locations, providing investors/traders with information to predict supply and demand to develop their investment strategies. EO can contribute by providing more information on the calculation of indicators which can help to develop logistics and financing strategies. Beyond goods and natural resources, there is a growing interest in the food commodity market for which EO can provide vital information on crop conditions (e.g. the AMIS tool by the FAO).

ESG reporting: EO data can help providing indicators to improve ESG (Environmental, Social, Governance) measuring, monitoring and reporting, assessing investment's overall impact and financial returns. Differently from ESG application analysed under the Climate, Environment, and Biodiversity segment which helps verifying the fulfilment of environmental requirements, ESG reporting in Finance specifically focuses on the economic perspective of ESG and can help financial institutions to comply with regulation, assess risks and monitor physical assets. The revenues of this application are quantified in the Climate, Environment, and Biodiversity segment under the application Environmental impact assessment and ESG.

Risk assessment: Any investment decision is subject to some uncertainty and before embarking on a new business, investors need to better understand and assess the risks associated with this new business and quantify the potential for losses. Combined with other relevant data, EO data can help investors and asset managers to better understand current and future risks to their investments (e.g. flood risks, subsidence risk). Similarly, financial institutions increasingly need to consider climate risks in their assessments. EO constitutes a major source of data to feed their screening processes.

Stock exchange transactions: For stock exchanges, GNSS timing underpins ultra-low-latency trading environments where microsecond or even nanosecond accuracy can be required to verify the exact order of trades. GNSS receivers are used as timing and synchronisation sensors, ensuring that all interconnected servers apply a consistent time reference when matching buy and sell orders and recording each transaction in the order book.

Bank transactions: For bank network operations, GNSS time is mainly used to timestamp events such as payments, transfers, and system messages so they can be ordered correctly, and causal links can be reconstructed. GNSS signals are typically received via a rooftop antenna and fed into time servers (using PTP or NTP) that distribute a common, precise time reference across the bank's internal network.

Insurance

Event footprint: EO serves as a complementary source to support existing processes in assessing damage. Event footprint involves comparing the claims received from clients with the actual material damages that occurred in the field to determine the amount of compensation that should be paid. EO data provides a visualisation of the extent of the damage (production of delineation maps) and helps optimise intervention, reducing costs for insurers. Responsiveness and high resolution can be important factors in the choice of EO source. GNSS provides positioning for drones used for pre- and post-event for analysis and data gathering in the case of insurance claim assessments.

Index production: Computation of numerical indexes (part of parametric insurance products as a certain index level triggers a payment) based on image analyses. Using regular monitoring of areas to compute a numerical index, the application is particularly useful for crops and livestock insurance. These products are an alternative to traditional insurance approaches and allow new markets (farmers and pastors) to be addressed, especially in remote areas.

Risk modelling: EO can be used for the calibration of risk models and refinement of hypotheses as well as an input for digital models. Risk modelling involves the evaluation of potential losses that could arise due to natural disasters through a probabilistic assessment of events. By improving the accuracy of the predictions, (re)insurers can better forecast cash out-flows and reduce the financial risks, eventually reducing premiums. EO data is used as a complementary source of information to meteorological and geological data and generates a moderate added value.

Maritime and Inland Waterways

Inland Waterways

Autonomous Surface Vessels: ASVs rely on a combination of EO and GNSS data to navigate and perform various tasks. GNSS can provide precise positioning and autonomous navigation capabilities, while EO satellites can capture data related to water conditions and monitor the weather. As of now, this application is still under development and not fully operational yet.

Traffic management: In addition to GNSS receivers for navigation, most SOLAS-class vessels are required under IMO SOLAS regulations to carry an Automatic Identification System (AIS) transponder. AIS uses VHF radio to broadcast a ship's identity, position, course and speed, allowing nearby vessels and shore stations (e.g. VTS centres and ports) to share this information and improve traffic management and navigational safety. The VHF Data Exchange System (VDES) builds on AIS by adding higher-capacity, secure terrestrial and satellite links, and is being developed to extend and progressively replace many AIS functions in future e-navigation services.

GNSS vessel engine management system: GNSS supports remote monitoring of the ship's condition (e.g. engine diagnostics). This provides the vessel operators with the necessary information to perform routine checks on the engine and improves the overall maintenance of vital elements of the vessel.

Inland waterways navigation: EO data is used to detect periods of flood or low flow which may cause disruptions to waterway traffic, allowing the bodies responsible for the inland waterways to make informed decisions about traffic flows. GNSS is also used to ensure safe navigation in inland waterways (rivers, canals, lakes and estuaries).

Marine Engineering

Dredging: Satellite-derived turbidity data (stirred-up sediment from anthropogenic activities such as dredging) provide a reliable and cost-effective overview without the need for field deployment. GNSS, in combination with PPP/RTK Positioning Techniques, supplies high-accuracy real-time positioning needed for dredging operations.

Annex 3: List of applications

Marine surveying and mapping: Encompasses a wide range of GNSS-enabled activities (seabed exploration, tide and current estimation, offshore surveying, etc.) whose outcomes are key for maritime navigation. Satellite technology using radar and multi-spectral contributes to surveying and mapping with data on ocean heights and, as a result, helps to interpret gravity and bathymetry for the Earth's oceans. Satellite-derived bathymetry, in particular, is the most recently developed method of surveying shallow waters. In contrast to other survey methods, satellite-derived bathymetry requires no mobilisation of persons or equipment, provides rapid access to bathymetric data and saves costs.

Merchant Vessels

Maritime Autonomous Surface Ships: MASS refers to a ship which, to a varying degree, can operate independent of human interaction (i.e. degrees of automation are defined from Degree-1 to -2 by the IMO. The MASS are typically larger than AVS and are designed for ocean-going transport with different sets of requirements and equipment needed.

Collision avoidance: Similar with Inland Waterways. However, for Merchant Vessels, the technology is more complex and advanced as this would be required for ocean transport, as well as to comply with international regulations.

GNSS vessel engine management systems: Similar with Inland Waterways. However, for Merchant Vessels, as it entails a larger vessel and system, additional sensors and systems may be needed, especially with regard to long-distance ocean transport.

Merchant navigation: GNSS is the primary source of positioning information in sea navigation. In the case of Safety of Life at Sea (SOLAS) vessels: all passenger ships, and cargo ships larger than 500 gross tonnage or larger than 300 tons if engaged on international voyages are regulated and heavily rely on GNSS to support navigation activities. At least three devices are typically fitted on vessels for redundancy reasons.

Ship route optimisation including Navigation through sea ice: Real-time or near real-time monitoring of water depth, winds, waves and currents using EO data enables navigation applications to chart the best routes taking into consideration current ocean conditions, leading to time and fuel savings. GNSS positioning information constitutes an essential layer of information for the efficiency, safety and optimisation of maritime transportation. The application also includes

Navigation through sea ice: Combined with GNSS positioning information, ice maps generated using EO data enable navigation applications that automatically avoid waters with high iceberg concentrations, allowing ships to sail faster and more safely through open waters Reflections of satellite navigation signals collected in space can be used to accurately map the extent of sea ice in the Arctic and Antarctic oceans.

Ocean and Environmental Monitoring

Marine pollution monitoring: SAR-based and optical satellite data can detect and monitor oil spills and marine litter. EO also provides forecasts of sea currents and sea-surface heights (altimetry), sea-surface salinity, sea-surface temperature, ocean colour and sea-ice data – useful for monitoring and forecasting the course of the pollution. Moreover, remote sensing data can also contribute to identifying the polluters. This application is similar, although with due differences, to the coastal and water ecosystems application in Climate, Environment, and Biodiversity that encompasses a wider scope for ecosystem monitoring.

Ocean monitoring buoys: GNSS provides precise positioning and timing for oceanographic buoys measuring waves, currents, temperature, salinity and sea-level variations. Accurate geolocation is essential to ensure that in-situ measurements are correctly referenced, in order to track buoy drift and to integrate buoy data with satellite observations and numerical models. GNSS also supports real-time data transmission for ocean forecasting, climate monitoring and maritime safety.

Ports

Automated port operations: GNSS positioning supports the automation of operations at ports and inte modal hubs.

Pilotage and docking: GNSS-based technologies improve safety, efficiency and precision during port approaches and manoeuvring. This application covers port navigation systems used to monitor transit progress, docking and loading/unloading operations; Portable Pilot Units (PPUs) used by maritime pilots to guide vessels through confined waters; and vessel docking systems that provide the precise position and speed information needed for controlled manoeuvres at berths and constant monitoring of moored vessels. EO data on port traffic and metocean conditions complements in situ sensors and radar within Vessel Traffic Management, helping to plan safe approaches, manage congestion and anticipate weather-related constraints. Real-time GNSS-based navigation information, particularly via PPUs, gives pilots greater control, situational awareness and accuracy during port entry, turning, berthing and unberthing.

Port safety: EO data provides an overview of port traffic and berth estimations, allowing for risk models to be created. These assess the risk of damage at the port caused by adverse events such as extreme weather, congestion or oil spills. This enables port officials to take risk mitigation measures and to plan for safety when developing port infrastructures. The safety of port terminal operations is ensured by GNSS positioning information, using collision avoidance devices.

Port security: EO data contributes to enhanced situational awareness with the goal of preventing crime or any illicit good entering or exiting the country. High-resolution SAR data for instance enables port authorities to access the most recent information on changes in cargo and passenger ports, tracking vessels, and estimating the amount of stored goods.

Recreational Craft

Recreational navigation: GNSS-based systems for maritime navigation are widespread not only across commercial but also recreational vessels. They are used both for overseas and high-traffic areas.

Vessel Tracking

Vessel monitoring: GNSS-enabled Long-Range Identification and Tracking (LRIT) as well as AIS or VMS provide the means to monitor and track suspicious vessels. When those vessels turn off or disable their own AIS or VMS, EO data is able to provide enhanced situational awareness that can be used by dedicated maritime authorities to monitor and track ‘dark vessels’ through EO imagery and SAR data.

Annex 3: List of applications

Rail

Attractiveness Enhancement

Passenger information systems: GNSS is used to provide enhanced passenger services such as real-time location and speed of trains along their route during a journey. Increasingly, GNSS location of trains is also supporting platform and online passenger information services.

Public transport – tram and light rail: Currently, GNSS is mainly used in smart mobility applications to optimise the network capacity by managing tram locations or to provide real time information to passengers such as the estimated arrival time of a tram at a designated station. GNSS has started to be used for advanced applications, such as automatic speed limitation, ensuring that the tram speed is lower than a customer-defined speed limit in a specific area. It is also used for maintenance or onboard energy management, ensuring that the tram's on-board battery has sufficient energy level before passing a section without external power supply.

Maintenance Improvement

Condition-based maintenance: Continuous monitoring of assets movement, performance and potential damage is used to detect when specific item maintenance is needed based on the defined conditions. GNSS is increasingly seen as a standard source of location and timing information in these systems.

Infrastructure monitoring: Very high resolution EO satellites data are used in order to detect encroaching vegetation, landslides or track deformation.

Predictive maintenance: Models relying on continuous location and asset performance monitoring are developed in order to fine-tune maintenance schedules. GNSS is increasingly seen as a standard source of location and timing information in these systems.

Safety Related

Enhanced Command & Control Systems (CCS): In main lines with high traffic density, GNSS can be an additional source of data to improve train command and control systems such as the European Train Control System (ETCS) and the Positive Train Control (PTC). In low density lines, GNSS can support the provision of a signalling system. For both, it allows cost saving which can be vital to ensure the viability of the rail service.

Trackside personnel protection systems: Workers must be warned of an approaching train. GNSS location information is used as a complement to existing procedures for enhanced tools deployed alongside the train tracks or added information provided to the stakeholders.

Train Driving Optimisation

Driver Advisory Systems (DAS): The real-time location provided by GNSS is used to help drivers operate their trains. The goal of DAS is to enable train operation optimisation by providing driver assistance.

Asset management: Train location provided by GNSS could be used to perform fleet analysis in order to optimise the use of locomotives and railway cars and to properly size rail fleets.

Road and Automotive

Asset Management

Bike sharing: Bike sharing and especially free-floating bike sharing systems rely on GNSS to locate the bike across the city by both end users and the bike-sharing service provider.

Public transport – buses: Public transit agencies use GNSS receivers in buses to track their location in real- time to display their position on a map in the control centre and their expected arrival times on digital displays at bus stops.

Road asset management: Asset management on-board units (OBUs) and systems transmit GNSS positioning information through telematics to support transport operators in monitoring the logistics activities and their performance, as well as to help monitoring vehicles. This application is used within cars that form a so-called fleet such as taxi's rental cars and cars used for sharing schemes. It is also adopted by commercial vehicle fleet owners. As subset, dangerous goods tracking is done by transmitting GNSS-based positioning data on the vehicles carrying them, together with other information about the status of the cargo.

Liability and Enforcement

Insurance telematics: Black boxes rely on GNSS data to increase the fairness of motor insurance for both insurers and subscribers. The basic idea behind such schemes is that in combination with other sensor data, GNSS positioning information is used by insurance companies to monitor the distance driven as well as driver's behaviour and related risk (e.g. of having an accident) in order to calculate the insurance premium that should be charged to each individual.

Road User Charging (RUC): GNSS-OBUs support toll operators in charging levies for the use of roads and potentially for congestion control. GNSS-based solutions are designed to charge motorists for the actual distance travelled, without barriers or gantries, and provide interoperability between national cross-border schemes.

Smart tachograph: Smart tachographs leverage GNSS positioning to support road enforcers by recording the position and time of the vehicle at different points during the working day.

Safety Related

Connected and Automated Driving (CAD): CAD enabled by GNSS positioning information feeds technologies allowing road vehicles to exchange information between other vehicles and their surroundings. This contributes to the creation of integrated connected platforms supporting mobility services. In the upcoming years, these will become automated, removing the driver from the driving seat and having a set of technologies including GNSS to guide and operate the vehicle.

Emergency assistance: The pan-European eCall and other systems, such as the ERA-GLONASS in Russia, as well as non-regulated solutions developed by OEMs and device vendors send a message including location to emergency response centres in case of accident, accelerating assistance to drivers.

Annex 3: List of applications

Smart Mobility

Congestion control: Satellite road traffic monitoring services collect floating car location data from vehicles through PNDs, IVS and mobile devices. The traffic information is then processed and distributed to users and other interested parties. Remote sensing data can be used as an additional layer of information for monitoring traffic flows.

Infotainment services: Mobility platforms combine various data sources to provide real-time information and predictions to road users, enabling them (through the vehicle navigation system) to plan and navigate the most optimal routes. EO supported information include road condition status, real-time traffic and congestion updates, and weather information.

Navigation (IVS & PND): Navigation is the most widespread application, providing turn-by-turn indications to drivers through portable navigation devices (PNDs) and in-vehicle systems (IVS) built in cars.

Space

Guidance, Navigation and Control Subsystem

Attitude Determination (AD): Space missions' success often rely on the pointing accuracy and the stability of its payloads (e.g. precise communication data link among satellites, precise pointing direction of a camera to acquire images of a determined area, etc.). Being accurately aware of the vehicle's orientation in space allows to apply – if needed – the necessary torques to obtain the desired attitude. As primary attitude sensor, GNSS can be an excellent option for satellites whose accuracy requirements are not so stringent. GNSS is also used to complement, or serve as back-up, of more precise systems such as star trackers.

Precise Orbit Determination (POD): the most accurate determination of the absolute Position, Velocity and Time (PVT) of the vehicle, whose initial position is unknown, allows potential correction of its orbital trajectory. GNSS POD has grown in importance and established itself as one of the common techniques to determine precise trajectories of satellites in LEO. Such GNSS-based information can also be used to perform "Rendezvous & Docking", "Formation Flying" or "GEO Station keeping".

Real-Time Navigation (RTN): Real-time navigation onboard an orbiting vehicle is based on the use of an orbit propagator; a model that allows predicting the orbital characteristics of the vehicle given the current orbital characteristics. GNSS is an enabler of real-time navigation by feeding these orbital propagators with its PVT information, contributing to an increased autonomy and orbital accuracies in the decametric range when based on multi-constellation and multi-frequency receivers.

Space Timing and Synchronisation (S-T&S): The need for highly precise timing information obtained through GNSS is relevant in space both for data time stamping (providing a direct and accurate access to the UTC) and synchronisation (e.g. between receivers at different locations), reducing dependency on very expensive on-board clocks. These two applications serve as core of data collection in most satellite missions, including EO or communication. Similar to positioning information, timing can be used both independently and in conjunction with other data to support more complex tasks.

Deep Space Applications

Lunar Orbit (LO): Past the TLO, GNSS will be used to obtain position fixes and velocity vectors once the vehicles will be established in lunar low orbits. GNSS can reduce tracking and operations costs, provide a backup/redundant navigation means, or support hosted payloads if it is used as a timing source.

Moon Surface Positioning (MS): With a recent demonstrating mission succeeding in acquiring signal, it is expected that GNSS will be used as a source of coarse positioning on the Moon's surface (or part of it) in earlier stages until the currently conceptualised GNSS-like constellations around the Moon become a reality.

Translunar Orbit (TLO): GNSS can be used as a means of orbital monitoring and determination during Translunar Orbits (or Moon Transfer Orbits), during which the spacecraft is manoeuvred via propulsive injections to raise it from a circular Earth orbit to a highly-eccentric orbit, and later to a Lunar Orbit.

Supporting or acting as mission payloads

Scientific & Operational Missions (SOM): In the case of scientific missions, GNSS receivers can be used as a mission payload, providing input to study physical elements, through characteristics of the GNSS SIS measurements (e.g. radio occultation, altimetry analyses, TEC assessment). In the case of operational missions, GNSS receivers can be used to support the acquisition of information for commercial purposes (e.g. taking and selling Earth Images/Observation Data).

Technology Demonstration (TechD): Using GNSS aboard a spacecraft to demonstrate its scientific interest is the first step to assess its potential use with respect to other conventional technologies. An example of this type of use is the so called GNSS Reflectometry (GNSS-R), which consists of making measurements of the reflections of navigation signals from GNSS from the Earth.

Annex 3: List of applications

Urban Development and Cultural Heritage

Environmental Monitoring

Urban greening: EO and GNSS can be used for monitoring vegetation cover, the health of green space vegetation as well as for precise definition, positioning, and monitoring of green space infrastructure.

Urban climate: EO can support mapping urban temperature patterns and climate variability, for example to help alert health authorities to related risks affecting specific demographic groups.

Smart Cities Operations

Smart utilities: Satellite data, including GNSS and EO, can support the monitoring and management of urban utility networks (e.g. water, gas, energy, telecommunications, sewage) by enabling asset positioning, supporting remote performance assessment, detecting anomalies or faults, and facilitating near–real-time alerts when combined with in-situ sensors.

Smart waste management: GNSS can be used in smart waste management by precisely positioning waste containers, thereby helping in the monitoring and collection planning of waste. EO can be utilised to monitor landfills, in order to detect illegal landfills or methane emissions coming from landfills for example.

Urban Planning

Surveying and mapping of urban areas: Using satellite imagery and precise GNSS positioning, comprehensive geographic data can be collected and analysed, enabling the creation of accurate maps and spatial information for urban planning, infrastructure development, cultural heritage monitoring and management, and resource management in cities.

Urban modelling and planning: Leveraging satellite data fused with other digital information, cities can develop 3D urban models and Digital Twins that provide data-driven insights to support sustainable and resilient planning. These tools enable the analysis of urban form and dynamics, and support infrastructure management, scenario modelling, and informed decision-making

Cultural Heritage Monitoring

Ground deformation: EO techniques such as InSAR enable for the detection and monitoring of subtle ground movements that may threaten cultural heritage sites, supporting early risk identification and preservation efforts.

Change in built and natural environment: Geospatial data supports the monitoring of changes in the surrounding built and natural landscape of cultural heritage sites. EO provides wide-area observation of land use and structural change, while GNSS ensures precise positioning and georeferencing, improving the consistency and reliability of long-term change detection and site management.

Risk Mapping: EO data support the assessment, mapping and forecasting of natural risks such as soil subsidence, erosion, flooding, and extreme weather impacting cultural heritage. EO-derived risk maps, enhanced by AI/ML, support preventive conservation, early warning, rapid damage assessment, and restoration planning.

Conflict-related damage and looting: In areas difficult to access, EO can be the only available tool to monitor damage to cultural heritage. Multi-temporal analysis of EO data, increasingly supported by AI/ML, allows for the identification of looting patterns, damage classification, evidence generation, and the prioritisation of restoration actions.

Air quality impact: EO supports the monitoring of air pollutants and atmospheric conditions around cultural heritage sites, helping to assess potential impacts on material degradation and to inform conservation strategies.

3D modelling, Digital Twins: The combined use of EO and GNSS supports the creation and updating of accurate 3D models and Digital Twins of cultural heritage sites. EO provides spatial and surface information at scale, while GNSS ensures precise positioning and alignment, enabling consistent documentation, monitoring, and informed conservation planning over time.

Visitor management: Satellite data supports the analysis of visitor access, movement patterns, and pressure on cultural heritage sites. EO provides contextual information on site layout and surrounding environment, while GNSS-enabled data help improve positioning, routing, and capacity planning to support sustainable and safe site management.

Annex 4: List of acronyms

2D	Two-dimensional	ANCEN	Aviation Non-CO_2 Experts Network	CAD	Connected and Automated Driving
3D	Three-dimensional	ANSP	Air Navigation Service Provider	CAGR	Compound Annual Growth Rate
3GPP	3rd Generation Partnership Project	API	Application Programming Interface	CAMS	Copernicus Atmosphere Monitoring Service
4D	Four-dimensional spacetime	APV	Approach with Vertical Guidance	CANSO	Civil Air Navigation Service Organisation
5D	Fifth-dimensional - Real-time extraction in virtual model	AQGs	Air Quality Guidelines	CAP	Common Agricultural Policy
5G	Fifth-generation of mobile telecommunications technology	AR	Augmented Reality	CAS	Cooperative Applications Satellite
5GAA	5G Automotive Association	ARAIM	Advanced Receiver Autonomous Integrity Monitoring	CAS	Commercial Authentication Service
6G	Sixth-generation of mobile telecommunications technology	ARI	Advanced Air Mobility (AAM) Reality Index	CASA	Centre for Advanced Spatial Analysis
A4E	Airlines for Europe	ASC	Aquaculture Stewardship Council	CAT 1	Category 1
A-SMGCS	Advanced Surface Movement Guidance and Control Systems	ASI	Agricultural Stress Index	CCAM	Cooperative, connected and automated mobility
AAM	Advanced Air Mobility	ASIL	Automotive Safety Integrity Level	CCM	Copernicus Contributing Missions
AAQS	Ambient Air Quality Standards	AsSiSt	Aircraft Support & Maintenance Services	CCO	Continuous Climb Operations
ACI	Airport's Council International	ATC	Air Traffic Control	CCS	Command and Control Systems
AD	Attitude Determination	ATIS	Alliance for Telecommunications Industry Solutions	C-DAS	Connected Driver Advisory Systems
ADAS	Advanced Driver Assistance Systems	ATM	Air Traffic Management		
ADS	Automated driving system	AUV	Autonomous Underwater Vehicles	CDO	Continuous Descent Operations
ADS-B	Automatic Dependent Surveillance - Broadcast	AWS	Amazon Web Services	CDSE	Copernicus DataSpace Ecosystem
ADS-L	Automatic Dependent Surveillance - Light	B2B	Business-to-Business	CDS	Climate Data Store
AED	Automated External Defibrillator	BBNJ	Biodiversity Beyond National Jurisdiction	CEMS	Copernicus Emergency Management Service
Agtech	Agricultural technology	BDPS	Beacon Distress Positioning Sharing Service	CEN	European Committee for Standardisation
AI	Artificial Intelligence	BDS	BeiDou Satellite System	CENELEC	European Electrotechnical Committee for Standardisation
AIRAC	Aeronautical Information Regulation and Control	BDSBAS	BeiDou Satellite Augmentation System	CFP	Common Fisheries Policy
AIRE	Airlines International Representation in Europe	BIC	Biodiversity Impact Credits	CGA	Competent GOVSATCOM Authority
AIS	Automatic Identification System	BIM	Building Information Modelling	CH	Cultural heritage
AIS-MOB	Automatic Identification System Man Overboard Beacon	BSGN	British Space Group Network	CHIME	Copernicus Hyperspectral Imaging Mission for the Environment
AIS-SART	Automatic Identification System Search and Rescue Transmitters	BVLOS	Beyond Visual Line of Sight	CI	Critical Infrastructure
AMC	Acceptable Means of Compliance	C2	Control and Command	CIMR	Copernicus Imaging Microwave Radiometer
AMIS	Agricultural Market Information System	C3S	Copernicus Climate Change Service	CIS	Common Information Services
ANAS	The Italian Road Authority	C4EC	Copernicus for EC	CISP	Common Information Services Provider

Annex 4: List of acronyms

CIVMIL	Civil-Military	DAS	Driver Advisory Systems	ECAVA	European Connected and Autonomous Vehicle Alliance
CLMS	Copernicus Land Monitoring Service	DCN	Digital Cellular Network	ECARO	EGNOS Civil Aviation Roadmap
CLUG	Certifiable Localisation Unit with GNSS	DEM	Digital Elevation Model	ECB	European Central Bank
CMEMS	Copernicus Marine Service	DFMC	Dual Frequency Multi-Constellation	ECDIS	Electronic Chart Display and Information System
CMSI	Consolidated Mining Standard Initiative	DG MARE	Directorate-General for Maritime Affairs and Fisheries	ECF	European Competitiveness Fund
CNS	Communication, navigation and surveillance	DGNSS	Differentiated Global Navigation Satellite System	ECITP	Electronic Conspicuity Interoperability Test Programme
CO2	Carbon dioxide	DIAS	Data and Information Access Services	ECMWF	European Centre for Medium-Range Weather Forecasts
CO2M	Copernicus Anthropogenic Carbon Dioxide Monitoring	DL	Deep Learning	ECTL	EUROCONTROL
cOBC	Constellation On-Board Computer	DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)	EDAS	EGNOS Data Access Service
CODA	Copernicus Online Data Access	DLT	Dominant Leaf Type	EDO	European Drought Observatory
COP	Conference of Parties	DLT	Distributed Ledger Technology	EEA	European Environment Agency
COP15	Conference of the Parties to the United Nations Convention on Biological Diversity	DME	Distance Measuring Equipment	EFAS	European Flood Awareness System
COP27	Conference of the Parties to the United Nations Framework Convention on Climate Change	DO	Drought Observatory	EFCA	European Fisheries Control Agency
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation	DSM	Digital Surface Model	EFFIS	European Forest Fire Information System
COSPAS-SARSAT	Cosmicheskaya Sistyema Poiska Avariynich Sudov/ Search And Rescue Satellite Aided Tracking	DSO	Distribution System Operators	EFRAG	European Financial Reporting Advisory Group
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space	DSP	Data Service Provider	EGMS	European Ground Motion Service
COTM	Communications On The Move	DSRC	Dedicated Short-Range Communications	EGNOS	European Geostationary Navigation Overlay Service
COTS	Commercial-Off-The-Shelf	DTO	Digital Twin of the Ocean	EGNSS	European Global Navigation Satellite System
COVID19	Coronavirus disease	DTSC	Digitial Twins of Smart Cities	EGPWS	Enhanced Ground Proximity Warning System
CPDLC	Controller-Pilot Data Link Communications	E112	GNSS-supported emergency call	EHA	European Helicopter Association
CRCF	Carbon Removal Certification Framework	E2E	End-to-End	EHT	Enhanced Human Technologies
CRMA	Critical Raw Materials Act	EARSC	European Association of Remote Sensing Companies	EIA	Environmental Impact Assessment
CRPA	Controlled Reception Pattern Antenna	EASA	European Union Aviation Safety Agency	EISF	EU Industry and Start-ups Forum
CSCDA	Copernicus Space Component Data Access system	EBA	European Banking Authority	ELT	Emergency Locator Transmitter
CSDDD	Corporate Sustainability Due Diligence Directive	EBAA	European Business Aviation Association	ELT-DT	ELT Distress Tracking
CSDP	Common Security and Defence Policy	e-bikes	Electric bicycle	EMAid	Emergency Management and Humanitarian Aid
CSRD	Corporate Sustainability Reporting Directive	EC DRMKC	European Commission Disaster Risk Management Knowledge Centre	EMODnet	European Marine Observation and Data Network
CSRISTAL	Copernicus Polar Ice and Snow Topography Altimeter	EC	European Commission	EMS	Emergency Medical Service
CSS	Copernicus Security Service	EC	Electronic Conspicuity	EMSA	European Maritime Safety Agency
DAA	Detect & Avoid	ECA	European Compliance Assurance	EN	European harmonised standard

Annex 4: List of acronyms

ENSPACE	Enhanced Navigation in Space Project	eVTOL	Electric Vertical Take-off and Landing	GAST-F	GBAS Approach Service Type F
ENVISAT	ENVIronmental SATellite	EWS	Emergency Warning System	GAUSSIAN	GNSS/INS platforms for Secure and Safe services In Air Navigation and mobility
EO	Earth Observation	EWSS	Emergency Warning Satellite Services	GBAS	Ground-Based Augmentation System
EO4EA	Earth Observation for Ecosystem Accounting	FA	Flagship Area	GBFF	Global Biodiversity Framework Fund
EO4I	Earth Observation Best Practice for Agro-Insurance	FADA-CATEC	Fundación Andaluza para el Desarrollo Aeroespacial (Andalusian Foundation for Aerospace Development) Spain	GDO	Global Drought Observatory
EO4SD	Earth Observation for Sustainable Development	FAO	Food and Agricultural Organisation of the United Nations	GDOP	Geometric Dilution of Precision
EOD	Explosive Ordnance Disposal	FCC	Federal Communications Commission	GDPR	General Data Protection Regulation
EOGS	Earth Observation Governmental Service	FCD	Floating Car Data	GEF	Global Environment Facility
EPIRBs	Emergency Position Indicating Radio Beacons	FCI	Flexible Combined Image	GEO	Group on Earth Observations
ERA	European Regions Airline Association	FFO	Full, Free and Open	GEO	Geosynchronous Equatorial Orbit (geostationary orbit)
ERCC	Emergency Response Coordination Centre	FINRA	Financial Industry Regulatory Authority	GEOSAR	Geostationary Orbit Search and Rescue
ERTMS	European Railway Transport Management System	FIs	Financial Institutions	GEOSS	Global Earth Observation System of Systems
ESA	European Space Agency	FISE	Forest Information System for Europe	GERICS	Climate Service Center Germany
ESG	Environmental, Social, and Governance	FLARM	Flight alarm	GHG	Greenhouse Gases
ESMA	European Securities and Markets Authority	FMC	Fishing Monitoring Centre	GHSL	Global Human Settlement Layer
ESRS	European Sustainability Reporting Standards	FMS	Farm Management System	GIEWS	Global Information and Early Warning System on Food and Agriculture
ESSP	European Satellite Services Provider	FP6	Sixth Framework Programme	GIS	Geographic Information System
ETC	Electronic Toll Collection	FRAC	Final Review and Comment	GISTM	Global Industry Standards on Tailings Management
ETC/CCA	European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation	FRMCS	Future Railway Mobile Communication System	GloFAS	Global Flood Awareness System
ETCS	European Train Control System	FRONTEX	European Border and Coast Guard Agency	GLONASS	Global'naya Navigatsionnaya Sputnikovaya / GNSS by the Russian Federation
EU	European Union	FTY	Forest Type	GLU 2100	Ground & Landing Unit (Multi Mode receiver)
EU ETS	EU Emissions Trading System	GADSS	Global Aeronautical Distress and Safety System	GM	Guidance Material
EU SatCen	European Union Satellite Centre	GAGAN	Indian SBAS	GMES	Global Monitoring for Environment and Security
EUCRA	European Climate Risk Assessment	GAEC	Good Agricultural and Environmental Conditions	GMP	Global Methane Pledge
EUDR	European Union Deforestation-Free Products Regulation	Galileo SAR	Galileo Search and Rescue	GMR	Governmental Market Report
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites	GALITS	Galileo Localization In Train Signalling	GNC	Guidance, Navigation and Control
EUROCAE	European Organisation for Civil Aviation Equipment	GAST	Ground-Airborne System Test	GNSS	Global Navigation Satellite System
EUSPA	European Union Agency for the Space Programme	GAST-D	GBAS Approach Service Type D	GNSS-RO	GNSS Radio Occultation
EV	Electric Vehicle	GAST-E	GBAS Approach Service Type E	GOFC-Fire IT	Global Observation of Forest Cover - Fire Implementation Team

Annex 4: List of acronyms

GOFC-GOLD	Global Observation of Forest Cover - Global Observation of Land Dynamics	HTS	High-Throughput Satellite	IOPA	International Aircraft Owners and Pilots
GOVSAT COM	Governmental Satellite Communications	HVAC	Heating, ventilation and air conditioning	IoS	In-Orbit Satellite
GPR	Ground Penetration Radar	IACA	International Air Carrier Association	IoT	Internet of Things
GPS	Global Positioning System	IADC	Inter-Agency Space Debris Coordination Committee	IoV	In-Orbit Validation
GSM	Global System for Mobile Communications	IAGOS	In-service Aircraft for a Global Observing System	IPCC	Intergovernmental Panel on Climate Change
GTOS	Global Terrestrial Observing System	IAM	Innovative Air Mobility	IPM	Integrated Pest Management
GVA	Gross value-added	IATA	International Air Transport Association	IRIDeS	International Institute of Disaster Science
GWIS	Global Wildfire Information System	ICAO	International Civil Aviation Organization	IRMA	Initiative for Responsible Mining Assurance
H2020	Horizon 2020 (Research and Innovation Programme by the European Commission	ICD	Interface Control Document	ISM	Integrity Support Message
H2H	Hull-to-Hull	ICT	Information and Communication Technology	ISO	International Organization for Standardization
HAB	Harmful Algae Bloom	IDD	Internet Data Distribution	ISR	Intelligence, Surveillance and Reconnaissance
HAOs	High-Airspace Operations	IDPs	Internally displaced persons	ISSB	International Sustainability Standards Board
HAPS	High Altitude Platform Systems	IEC	International Electrotechnical Commission	ITS	Intelligent Transport Systems
H-ARAIM	High Availability Advanced Receiver Autonomous Integrity Monitoring	IEEE	Institute of Electrical and Electronics Engineers	ITU	International Telecommunications Union
HAS	High Accuracy Service	IFC	In-flight Connectivity	IUCN	International Union for Conservation of Nature
HASHTAG	High Accuracy Service Harnessed Trusted Application and Governance	IGS SSR	International GNSS Service standards	IUU	Illegal, Unreported, and Unregulated fishing
HD	High-Definition	IIoT	Industrial Internet of Things	IVS	In-Vehicle Systems
HEMS	Helicopter Emergency Medical Services	IISD	International Institute for Sustainable Development	IWES	Fraunhofer Institute for Wind Energy Systems
HERA	Health Emergency Response Authority	ILS	Instrument Landing System	IWW	Inland waterway
HFT	High-Frequency Trading	IMO	International Maritime Organisation	JARUS	Joint Authorities for Rulemaking on Unmanned Systems
HPC	High Performance Computing	IMPEL	Implementation and Enforcement of Environmental Law	JAXA	Japan Aerospace Exploration Agency
HPC	High Performance Computing	IMUs	Inertial Measurement Units	JRC	Joint Research Centre
HQ	Headquarters	INI	Own-Initiative Procedure	KIC	Knowledge and Innovation Community
HR	High Resolution	INS	Inertial Navigation System	L3	Level 3
HRAP	Holistic Resilience Assessment Platform	InSAR	Interferometric Synthetic Aperture Radar	LaaS	Logistics-as-a-Service
HR-VPP	High Resolution Vegetation Phenology and Productivity	IOC	Initial Operational Capability	LANDSAT	"land" and "satellite."

Annex 4: List of acronyms

LANS	Lunar Augmented Navigation Services	MOB	Man OverBoard	NPA	Notice of Proposed Amendment
LDACS	L-band Digital Aeronautical Communications System	MODIS	Moderate Resolution Imaging Spectroradiometer	NRT	Near real-time
LEO	Low Earth Orbit	MON	Minimum Operational Network	NSF NCAR	National Science Foundation National Center for Atmospheric Research
LEOSAR	Low Earth Orbit Search and Rescue	MOPS	Minimum Operational Performance Standards	NSP	Navigation System Panel
LEO-PNT	Low Earth Orbit Positioning, Navigation and Timing	MoU	Memorandum of Understanding	NTN	Non-Terrestrial Networks
LGBTQ+	Lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual, and more	MPLs	Minimum Performance Levels	NTRIP	Networked Transport of RTCM via Internet Protocol
LI	Lightning Imager	MRV	Monitoring, Reporting and Verification	NWP	Numerical Weather Prediction
LiDAR	Light Detection and Ranging	MS	Moon Surface positioning	OCHA	United Nations Office for Coordination of Humanitarian Affairs
LLR	Low Level Routes	MSAS	Japanese Satellite Based Augmentation System	ODA	Official Development Assistance
LO	Lunar Orbit	MSC	Maritime Safety Committee	OEMs	Original Equipment Manufacturers
LRIT	Long-Range Identification and Tracking	MSP	Maritime Spatial Planning	OS	Open Service
LS	Location Sharing	MTG-S	Meteosat Third Generation (Sounding)	OSNMA	Galileo Open Service Navigation Message Authentication
LPV	Localiser Performance with Vertical Guidance	MUAC	Maastricht Upper Area Control Centre	OT	Operational technology
LSTM	Copernicus Land Surface Temperature Monitoring	MUGG	MUlti-mode Global positioning system (GPS) and Galileo	OTA	Over-the-air
LTE	Long Term Evolution	NASA	National Aeronautics and Space Administration	OSOs	Operational Safety Objectives
LUCAS	Land Use/Cover Area frame Survey	NavIC	Navigation with Indian Constellation/Indian Regional Navigation Satellite System	PBN	Performance-based navigation
LuGRE	Lunar GNSS Receiver Experiment	NBS	Nature-based Solutions	PDOP	Position Dilution of Precision
LULUCF	Land Use, Land-Use Change, and Forestry	NDVI	Normalized Difference Vegetation Index	PHAR	PBN for HEMS in the Italian Apulia Region
MaaS	Mobility-as-a-Service	NEO	Near-Earth Objects	PinS	Point-in-Space
MASS	Maritime Autonomous Surface Ships	NeRF	Neural Radiance Field	PLB	Personal Locator Beacon
MBDs	Mosquito-Borne Diseases	NFMS	National Forest Monitoring System	PMR	Professional Mobile Radio
MEOLUT	Medium Earth Orbit Local User Terminal	NG112	New Generation of E112	PMU	Phasor Measurement Unit
MEOSAR	Medium Earth Orbit Satellites Search and Rescue System	NGeCall	Next Generation eCall	PND	Personal Navigation Device
MET	Meteorological (services)	NGO	Non-Governmental Organisation	PNT	Positioning, Navigation, and Timing
Metop-SG	Meteorological Operational Satellite - Second Generation	NIR	Near-infrared	POCs	Proof-of-Concepts
MiFiD II	Markets in Financial Instruments Directive	NIRE	Non-Instrument Runway End	POD	Precise Orbit Determination
ML	Machine Learning	NOAA	National Oceanic and Atmospheric Association	PPAs	Power Purchase Agreements

Annex 4: List of acronyms

PPP	Precise Point Positioning	ROV	Remotely Operated Vehicles	SEA	Copernicus Service in Support to EU External Action
PPPs	Public-Private Partnerships	ROSE-L	Copernicus L-band Synthetic Aperture Radar	SEC	U. S. Securities and Exchange Commission
PPU	Power Processing Unit	RRA	Risk Readiness Assessment	SESA	Support to EU External and Security Actions
PPUs	Portable Pilot Units	RTCA	Radio Technical Commission for Aeronautics	SESAR	Single European Sky ATM Research
PRC	People's Republic of China	RTCM	Radio Technical Commission for Maritime Services	SFDR	Sustainable Finance Disclosure Regulation
PRO	Polarimetric Radio Occultation	RTK	Real-Time Kinematics	SIB	Safety Information Bulletin
PRS	Public Regulated Service	RTN	Real-Time Navigation	SIS	Sectoral Information System
PSD2	Directive of Payment Services	RUC	Road User Charging	SiS	Signal-in-Space
PSTN	Public-Switched Telephone Network	SaaS	Synchronisation-as-a-Service	SLAM	Simultaneous Localisation and Mapping
PVs	Photovoltaics	SAE	Society of Automotive Engineers	SME	Small and Medium-sized Enterprise
PVT	Position, Velocity and Time	SAE levels	Society of Automotive Engineers setting levels for autonomous driving	SNAS	Satellite Navigation Augmentation System (PRC)
QKD	Quantum Key Distribution	SAR	Search and Rescue	SNCF	Société Nationale des Chemins de Fer Français
QNH	Question Nil Height (measurement; pressure at sea-level; aviation)	SAR	Synthetic Aperture Radar	SOC	Security Operation Centre
QZSS	Quasi-Zenith Satellite System/regional navigation satellite system commissioned by the Japanese Government	SARPs	Standards and Recommended Practices	SoL	Safety of Life Service
R&D	Research and Development	SATCEN	Satellite Centre	SOM	Scientific and Operational Missions
R&I	Research and Innovation	SARSAT	Search and Rescue Satellite Aided Tracking	SORA	Specific Operations Risk Assessment
RACE	Rapid Action on COVID-19 and EO	SATCOM	Satellite communications	SRTM	Shuttle Radar Topography Mission
RAIM	Receiver Autonomous Integrity Monitoring	SB	Service Bulletin	SSA	Space Situational Awareness
RIS	Reconfigurable Intelligent Surfaces	SBAS	Satellite-Based Augmentation System	SST	Space Surveillance and Tracking
RLM	Return Link Message	SCADA	Supervisory Control and Data Acquisition	SSV	Space Service Volume
RLS	Return Link Service	SDA	Space Domain Awareness	S-T&S	Space Timing and Synchronisation
RLSP	Return Link Service Provider	SDCM	System for Differential Corrections and Monitoring (Russian SBAS)	STC	Supplemental Type Certificate
RMT	Rule Making Task	SDFs	Software-Defined Vehicles	STM	Space Traffic Management
RNP	Required Navigation Performance	SDG	Sustainable Development Goals	SUGUS	Solution for EGNSS U-Space Service
RNP VPT	RNP Visual Flight Procedures with Prescribed Track	SDI	Spatial Data Infrastructures	SVS	Synthetic Vision Systems
RNSS	Radio Navigation Satellite Services	SDR	Software Defined Radio	SWaP-C	Size, Weight and Power - Cost
RNTF	Resilient Navigation and Timing Foundation	SDRs	Software-defined Receivers	SWE	Space Weather

Annex 4: List of acronyms

SWIR	Short-Wave Infrared	UN ICG	United Nations International Committee on GNSS	WFD	Water Framework Directive
T&S	Timing and Synchronisation	UN	United Nations	WG- C	Working Group C
TaaS	Transportation-as-a-Service	UNCLOS	United Nations Convention on the Law of the Sea	WG	Working Group
TaaS	Time-as-a-Service	UNEA	United Nations Environment Assembly	WHO	World Health Organisation
TAWS	Terrain Awareness Warning Systems	UNESCO	United Nations Educational, Scientific and Cultural Organisation	Wi-Fi	Wireless Fidelity
TCD	Tree Cover Density	UNIDO	United Nations Industrial Development Organisation	WUI	Wildland-Urban Interface
TCFD	Task Force on Climate-related Financial Disclosures	UNOOSA	United Nations Office for Outer Space Affairs		
TechD	Technology Demonstration	UNWTO	United Nations World Tourism Organization		
TEWS	Tsunami Early Warning Systems	US	United States		
TGV	High-Speed Train	USA	United States of America		
TISA	Trade in Services Agreement	USGS	United States Geological Survey		
TIS-B	Traffic Information Service - Broadcast	U-space	Unmanned Aircraft Systems Airspace Management		
TLO	Translunar Orbit	USSPs	U-space Service Providers		
TPEG	Transport Protocol Experts Group	UTC	Universal Time Coordinated		
TPEG2-EAW	Emergency Alerts and Warnings technology	UTM	Unmanned Traffic Management		
TSI	Technical Specifications for Interoperability	UV	Ultraviolet (UV) radiation		
TSO	Transmission System Operators	V2X	Vehicle to everything		
TSM	Towards Sustainable Mining	VAAC	Volcanic ash advisory centres		
TSN	Time-Sensitive Networks	VAS	value-added Service		
TTFF	Time To First Fix	VBDs	Vector-Borne Diseases		
TWC	Two-Way Communication	VDES	Very High Frequency Data Exchange System		
QPS	Quantum Positioning Systems	VFR	Visual Flight rules		
UAM	Urban Air Mobility	VHF	Very High Frequency		
UAS	Unmanned Aircraft Systems	VHR	Very High Resolution		
UAT	Universal Access Transceiver	VHTS	Very High Throughput Satellites		
UAV	Unmanned Aerial Vehicle	VIIRS	Visible Infrared Imaging Radiometer Suite		
UBI	Usage-Based Insurance	VLL	Very Low Level		
UCP	User Consultation Platform	VMS	Vessel Monitoring System		
UHI	Urban Heath Island	VR	Virtual Reality		
UITP	International Association of Public Transport	WAAS	Wide Area Augmentation System		
UK	United Kingdom	WAM	Wide Area Monitoring		

Annex 5: About the authors

The European Commission

European Commission (EC), specifically the Directorate General for Defence Industry and Space (DG DEFIS) develops and implements the EU space policy and programmes, the Secure Connectivity Programme and the space part of Horizon Europe to address Europe's most pressing challenges, including competitiveness, security and defence, technological sovereignty and sustainable growth. It is at the centre of Europe's space ambition, shaping and enforcing the regulatory framework for EU space activities. It ensures that Europe's space policy remains aligned with broader Union priorities.

The EU Space Programme is the first integrated space programme in the fields of Earth Observation, Satellite Navigation, Secure Communications and Space Safety.

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The European Union Space Agency for the Space Programme

EUSPA is the operational European Union Agency for the Space Programme. It adopts a user-oriented approach to promote sustainable growth and improve the security and safety of the European Union. EUSPA's mission revolves around three core principles: service provision, market growth, and security.

The EU Agency for the Space Programme:

- Provides state-of-the-art, safe and secure positioning, navigation and timing services based on Galileo and EGNOS, cost-effective satellite communications services for GOVSATCOM and soon IRIS², and Front Desk services of the EU Space Surveillance Tracking whilst ensuring the systems' service continuity and robustness.
- Promotes and maximises the use of data and services offered by Galileo, EGNOS, Copernicus, GOVSATCOM and soon IRIS² across a broad range of domains.
- Fosters the development of a vibrant European space ecosystem by providing market intelligence, and technical know-how to innovators, academia, start-ups, and SMEs. The agency leverages Horizon Europe, other EU funding, and innovative procurement mechanisms.
- Implements and monitors the security of the EU Space Programme components in space and on the ground with the aim to enhance the security of the Union and its Member States; EUSPA operates the Galileo Service Monitoring Centre.

The Security Accreditation Board established within the Agency is the security accreditation authority for all of the Programme's components, where Member States take accreditation decisions in a strictly independent manner from the Programme.

EUSPA Mission Statement

The mission of the Agency is defined by the EU Space Programme Regulation.

EUSPA's mission is to be the user-oriented operational Agency of the EU Space Programme, contributing to sustainable growth, security and safety of the EU. In the execution of its mission, EUSPA counts on strong partnerships with the European Commission, European Parliament, Member States, European Space Agency, and private actors across the EU.

EUSPA:

- Provides state-of-the-art, safe and secure positioning, navigation and timing services based on Galileo and EGNOS, cost-effective satellite communications services for EU GOVSATCOM and soon IRIS² and Front Desk services of the EU Space Surveillance Tracking whilst ensuring the systems' service continuity and robustness.
- Promotes and maximises the use of data and services offered by Galileo, EGNOS, Copernicus, EU GOVSATCOM and soon IRIS² across a broad range of domains.
- Fosters the development of a vibrant European space ecosystem by providing market intelligence, and technical know-how to innovators, academia, start-ups, and SMEs. The Agency leverages Horizon Europe, other EU funding, and innovative procurement mechanisms.
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- The EU Space Programme Security Accreditation Board is established within the Agency, representing the security accreditation authority for all of the EU Space Programme's components.

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