

- HEADING 1A: Competitiveness for growth and jobs

Implementation and exploitation of European satellite navigation systems (EGNOS and Galileo)

Lead DG: DEFIS

I. Overview

What the programme is about?

GALILEO is Europe's state-of-the-art global navigation satellite system, providing a highly accurate global positioning service under civilian control. Galileo consists of a satellite constellation and the necessary ground infrastructure to control the satellites and enable the provision of positioning, navigation and timing services. Galileo offers autonomous navigation and positioning services, but is also compatible with the US GPS satellite navigation system. Galileo is one of the European large infrastructure projects and is entirely financed by the EU budget. Galileo ensures Europe's autonomy in an area that is of strategic importance to both its economy and security. Galileo is already used, among others, in mobile phones and car navigation. Galileo could be used for a large number of purposes, including critical business processes that require uninterrupted navigation, and timing services needed for example for critical applications such as the synchronisation of electricity grids and telecommunication networks.

EGNOS, the European Geostationary Navigation Overlay Service, is a fully operational regional satellite navigation system, monitoring and correcting open signals emitted by the US GPS and – in the future – Galileo. It consists of several transponders installed on geostationary satellites and a network of ground stations. By improving the accuracy and reliability of the US GPS signal over the territory of Europe, EGNOS allows users in Europe to use GPS signals, for instance, for safety-critical applications such as operating aircraft. It allows users in Europe and beyond to determine their position to around 1 metre.

These programmes contribute to stimulating economic activity and technological innovation. They enable traffic management to be optimised whether on road, waterborne or aerial. Better managed traffic not only improves safety but also reduces pollution since travel is more efficient. Satellite navigation also enables emergency services to better carry out their duties (e.g. in case of fires, road accidents, mountain rescue). Another added-value is that the combined use of GPS and Galileo signals allows for better precision and availability and opens the door to new applications which are not possible by using GPS alone.

EU added value of the programme

The EU's action is based on Article 172 of the Treaty on the Functioning of the European Union and on the GNSS Regulation (EU) No 1285/2013 on the further implementation of the European satellite navigation programmes (EGNOS and Galileo). Today, about 11 % of the EU's GDP, i.e. about EUR 1300 billion, relies on satellite navigation signals, often controlled by third countries.

EGNOS and Galileo will not only ensure Europe's autonomy, but also provide additional benefits in combination with other GNSS (Global Navigation Satellite System). Such benefits will result from the additional services of the systems and the increased performance coming from additional satellites. Galileo is also the only GNSS specifically designed for civil purposes, i.e. it aims to satisfy the needs of the civil sector, in compliance with the most demanding security standards. Billions of users all over the world are expected to use Galileo, hence reaching an unparalleled level of outreach compared to any infrastructure owned by the EU.

Both programmes are complex projects, which exceed the financial and technical capacities of a single Member State. As such, they fully fall within EU competence. Considering their requirements in terms of security, all Member States must be involved in those programmes.

Implementation mode

The Commission adopts annually a work programme in the form of an implementation plan and funding of the actions required to meet the objectives of Galileo and EGNOS programmes. The European GNSS Agency (GSA) and European Space Agency (ESA) implement more than 98 % of the budget in indirect management in accordance with the provisions of the respective delegation agreements. The European Commission through procurements and grants implements the remaining budget in direct management.

II. Programme Implementation Update

Implementation status (2017-2019)

Galileo has been operational and providing initial services since 2016. While the exploitation phase was launched in 2016, the deployment phase continues in parallel. The Galileo initial services are being gradually improved to provide robust positioning and timing services with a high level of performance in terms of availability and accuracy.

a) *Galileo programme: deployment of space and ground infrastructure*

The deployment of the Galileo space infrastructure has continued with the aim of reaching full operational capability. The fully deployed Galileo system will consist of 24 operational satellites plus six in-orbit spares. At the end of 2019, there are 26 Galileo satellites in orbit and all of them are providing services. 22 of them are fully operational for all services. The two satellites

that were launched in the wrong orbit in August 2014 are already used for the Search and Rescue service. Furthermore they have undergone in-depth tests and modifications of their on-board software between 2016 and 2017 which will allow their operational use for the Open Service by the end of 2020. In parallel, the production of additional satellites of the first generation is on-going with the procurement of Batch#3 (12 satellites) which was signed in June 2017. The first Batch#3 satellites are contractually scheduled to be delivered by the August 2020. In order to initiate the transition between the first and the second generation of Galileo satellites and to ensure the maintenance of the Galileo constellation in the future, a procurement of additional (so-called transition) satellites was launched in May 2018 and is expected to be finalised in 2020, subject to the consolidation of the final requirements for these satellites by June 2020.. On the launch services, a contract for the development of a dispenser for carrying Galileo satellites on-board of an Ariane-62 launcher was signed with Ariane Group in summer 2019 and will deliver the first Ariane-6 dispenser flight model for Galileo by early 2021.

With regard to the Galileo ground infrastructure, the ground mission and ground control segment continued operations of the Galileo satellites. In February 2019, a major upgrade of the Galileo ground infrastructure has started, aiming at improving the robustness of the system and its compliance to security requirements. The *European GNSS Service Centre* (GSC) in Madrid (ES) continued to provide a single interface between the Galileo system and Galileo users. To ensure independent monitoring of the Galileo services, the *Galileo Reference Centre* (GRC) started to operate in Noordwijk (NL) in May 2018. The GRC was requested to support the GNSS performance monitoring needs of the European Union Aviation Safety Agency (EASA) as well as to provide support to EUROCONTROL. The back-up site of the *Galileo Security Monitoring Centre* (GSMC) was transferred from the United Kingdom to Spain in 2019.

Regarding security, key actions included measures to improve cyber security, to obtain and maintain security accreditation for operations and for site infrastructure and development of operational concepts and procedures for the Public Regulated Service.

To ensure the continuity of services beyond 2020, the future Galileo services and high-level objectives for security were defined in the evolution High Level Definition document. In parallel, preparatory activities have started for a definition of new Galileo services to be developed as of 2021 such as an emergency service to broadcast warnings related to natural disasters.

b) Galileo programme: service provision

Since the declaration of Galileo Initial Services in December 2016, three services (Open Service, Public Regulated Service and Search and Rescue Service) were continuously provided most of the time throughout 2019. However, in July 2019, the provision of Galileo Initial Services was impacted by a technical incident, which occurred in the Galileo ground infrastructure. Despite intense recovery efforts, the incident led to a six-day interruption of the Galileo initial navigation and timing services. Nevertheless, the Galileo Search and Rescue Service was unaffected and remained operational. The Commission set up an independent Inquiry Board, which analysed the root causes of the incident and provided detailed recommendations. The Commission has put in place a process for implementation of these recommendations to ensure that Galileo is a stable, robust and resilient system. One of the priorities for 2020 is to carry out all necessary activities to deal with the impact of this technical incident and avoid the repetition of similar incidents in the future.

The performance levels of the Galileo Open Service and the Galileo Search and Rescue Service in terms of availability and accuracy continuously exceeded the Minimum Performance Level targets defined in the Service Definition Documents. The detailed performance reports of Galileo services are publicly available on the European GNSS Service Centre website ⁽¹⁾.

c) EGNOS programme: service provision

The continuity and quality of all three EGNOS services were successfully ensured in 2019. In order to guarantee the continuity of services beyond 2020, the development of a major EGNOS release version has continued in 2019.

EGNOS was designed for aviation, and aviation continues to be a key segment. EGNOS increases accuracy and integrity, improving accessibility, efficiency and safety to operators, pilots and airports across Europe. EGNOS allows lateral and angular vertical guidance during the final approach of a plane without requiring visual contact with the ground until a height down to only 200 feet above the runway. At the end of 2019, there are around 350 EGNOS-enabled airports in 23 countries in Europe. Thus, the objective of an annual increase in the number of airports has been achieved for each consecutive year since 2014. The figures are. 2014: 129 airports, 2015: 173, 2016: 230, 2017: 251 and 2018: 315. In agriculture, more than 80 % of European farmers using satellite navigation for tractor guidance rely on EGNOS.

The EGNOS service area was extended up to latitude 72 degrees north. To that end, an update of the EGNOS Safety of Life Service Definition Document was published in February 2019. Most of the Member States' European territories and the territories of Norway and Switzerland are fully covered, with the exception of the Azores (Portugal), Cyprus and Northern Norway. The Azores will not be covered until the ground segment is upgraded to EGNOS V3 that will be in place (around 2025). This is because the current technology (so-called EGNOS V2) and Ranging and Monitoring Stations (RIMS) network do not allow to cover such territories. Cyprus is expected to be covered in 2020 and Northern Norway in 2023 with the deployment of the EGNOS V2.4.2-B evolution.

d) Market uptake

⁽¹⁾ <https://www.gsc-europa.eu/>

In 2019, the estimated number of Galileo-enabled smartphones in use worldwide has reached one billion. Since the declaration of Galileo Initial Services in 2016, the market uptake of Galileo-enabled smartphones has been very rapid. In 2019, there were 156 Galileo-enabled smartphone models available on the market. The full overview of Galileo-enabled devices is available online ⁽²⁾. Other activities supporting the market uptake of Galileo included Galileo acceleration and hackathon initiatives to foster the developments of applications that use Galileo signals and standardisation activities to ensure that Galileo is properly considered in standardisation bodies. When it comes to European GNSS downstream standardisation, the Commission aims to facilitate the development and promote the inclusion of Galileo and EGNOS in the ongoing relevant work of the standardisation organisations, in particular with voluntary measures.

A major step in enhancing the market uptake of EGNOS was the adoption of measures laying down airspace usage requirements and operating procedures for performance-based navigation in 2018. In a nutshell, the Regulation requires the publication of Localizer Performance with Vertical guidance (LPV procedures) delivered by EGNOS in all European instrument runway ends before January 2024. This underlines the importance and role of EGNOS as a key enabler for performance-based navigation for modernisation of the aviation in Europe.

In the field of *international cooperation*, negotiations with the US and Norway for access to the Galileo Public Regulated Service continued. Progress was made with regard to the extension of EGNOS to European Neighbourhood Policy countries (South). The Commission approved 9 million EUR funding for infrastructure needed to provide the EGNOS Safety of Life signal in the ENP South countries.

Concerning *radio frequency and spectrum management activities*, a Commission delegation participated at the 2019 World Radio Communication Conference. With regard to Galileo, the main issue was a better protection of the Galileo E6 frequency band against unintended interference from radio amateurs in the same frequency band.

e) Management of Intellectual Property Rights

The Commission has granted extended licences to Galileo-related intellectual property rights (IPR), thus enabling industry to make use of European knowledge and assets generated under the EU Space programme. The Commission has further secured several inventions generated by the industry and applied for patents generated by the Commission staff and in direct procurement. Finally, the Commission has licensed several patents from the industry and sublicensed them subsequently for free use of the general public.

f) Project management and risk management

Since 2014, the Galileo programme management processes are described in the Programme Management Plan, which is common for the European Commission, European GNSS Agency and European Space Agency. It sets up a framework for the decision-making (boards and meetings), programme management (procurement management, schedule control, budget, cost and cash management, risk management) and related regular reporting (monthly, quarterly and annually). The Risk Management Plan details the way the risks are identified, classified and treated until their reduction or mitigation.

Key achievements

Over the past years, the key priority has been ensuring the continuity of Galileo and EGNOS services, continuing preparations for full operational capability of Galileo services and promotion of market uptake of Galileo and EGNOS services. These achievements can be highlighted as follows:

1. Continuity of Galileo and EGNOS services

Galileo Initial Services were declared operational on 15 December 2016 and have been continuously provided and have gradually improved since then. Galileo is operational which gives the Union a strong position on the world stage of satellite navigation where the US and Russian systems are being modernised and the Chinese system is rapidly being developed.

Galileo Initial Services are fully interoperable with GPS, and their combined use is bringing more accurate and reliable positioning for end users. Navigation in cities, where tall buildings can often block satellite signals, particularly benefits from the increased positioning accuracy of Galileo and GPS combined. In addition, Galileo's accurate timing contributes to enabling more resilient synchronisation of banking and financial transactions, telecommunication and energy distribution networks to help them operate more efficiently. Finally, Galileo is helping to save lives. **Galileo's Search and Rescue service reduces drastically the time to detect emergency distress beacons from up to three hours to just ten minutes.** As the location of the distress beacon is determined more accurately, people lost at sea or in the mountains can be rescued more quickly. Furthermore since January 2020, Galileo is also offering a unique functionality to Search and Rescue, called the Return Link, which provides an acknowledgment message back to users in distress, confirming the correct localization of their distress.

2. Market uptake

The number of Galileo-enabled smartphones in use has soared to 1 billion in just 3 years. The majority of smartphone producers have included and enabled Galileo on their chipsets. Europe's investment in Galileo is bringing daily benefits to millions of people.

⁽²⁾ <http://www.usegalileo.eu>

Another key achievement is the use of satellite signals for locating people calling the EU-wide emergency number 112. Location information based on Galileo provides an accuracy of only a few meters in contrast to the current Cell ID technology where the accuracy varies from 2 km to 10 km. In 2019, public services dealing with the location information during a 112 emergency call in several EU Member States were supported from the EU funded Help 112 project. The currently ongoing Help 112 II project is supporting seven Member States: Denmark, Sweden, France, Germany, Portugal, Hungary, and Croatia.

3. Environment and climate change

Global navigation satellite systems Galileo and EGNOS contribute towards tackling climate change by supporting environmentally friendly transport solutions, sustainable agriculture and meteorological monitoring. For example:

- Reduced fuel consumption: satellite navigation enables optimal routes for cars, buses, boats and airplanes by providing accurate positions. This allows significant reduction of the fuel required to go from A to B and thus contributes to the reduction of CO2 emissions.
- Sustainable agriculture: As the centrepiece of precision farming, use of satellite navigation reduces the need for fertilisers. In turn, this means a reduction of greenhouse gases such as CO2, nitrous oxide and ammonia in the atmosphere.

Evaluation/studies conducted

In 2017, an interim evaluation of the European GNSS programmes (EGNOS and Galileo) and evaluation of the European GNSS Agency ⁽³⁾ was carried out. Since then no further evaluations or studies were conducted.

In 2018, the Commission adopted an Impact Assessment accompanying the Proposal for a Regulation of the European Parliament and of the Council **establishing the space programme of the Union and the European Union Agency for Space Programme** ⁽⁴⁾.

In 2020, the Commission is undertaking an impact assessment study on an initiative to foster the use of Galileo in critical infrastructure that depends on space services for timing and synchronisation (in energy, telecommunications and bank/finance transaction networks). The initiative considers awareness actions on Galileo and EGNOS's features, specific industrial or R & D support, or the preparation of specific legislation. An open public consultation will be part of the input to the impact assessment.

Forthcoming implementation

The priorities for 2020 are to:

1. Ensure service continuity for Galileo and EGNOS services, and their continuous improvement, robustness and security of the system and in particular the redundancy of the ground segment;
2. Continue preparations for the full operational capability of Galileo services;
3. Promote the market uptake of Galileo and EGNOS services by continuing the ongoing activities and by implementing the actions proposed in the Space Strategy for Europe;
4. Prepare for the further implementation of the programmes after 2020.

Galileo service provision

The main priority for 2020 is to ensure service continuity of Galileo services and their continuous improvement.

With regard to Galileo infrastructure, the key actions in 2020 are the following:

- a) Space segment: signature of the contract for the transition satellites;
- b) Ground segment: reinforce the redundancy of the ground mission segment, upgrade of the ground segment and deployment of System Build version 2.0;
- c) Carry out necessary activities to deal with the impact of the Galileo service incident of July 2019.

With regard to Galileo services, the key actions in 2020 are the following:

- a) Ensure the continuity of Galileo Initial Services according to the service level commitments published in the Service Definition Documents; ensure stability, availability and reliability of services;
- b) Continue gradual Galileo service improvements including by updating the minimum performance levels in the Service Definition Documents and by introducing the Galileo Search and Rescue service Return Link Service functionality;
- c) Continue development of the Galileo Commercial Service in its two distinct functionalities: High Accuracy Service and Commercial Authentication Service;
- d) Continue development of new functionalities of the existing Galileo services (such as Open Service Navigation Message Authentication) and continue preparation for new Galileo services (such as the emergency service);
- e) Independently monitor and report on the Galileo performance through the Galileo Reference Centre;

⁽³⁾ SWD (2017) 346

⁽⁴⁾ SWD(2018) 327 final

With regard to security, key actions will include measures to ensure the accreditation of the system, in particular cybersecurity issues.

EGNOS service provision

Continuity of EGNOS services and their continuous improvement are the key objectives for EGNOS in both medium and long term. On this basis and to guarantee the continuity of services beyond 2020 by managing obsolescence, the activities of the system (V2.4.2-A) will be finalised with the qualification of new Central Processing Facility (CPF) technology. This is the most critical EGNOS subsystem in terms of obsolescence. Additionally, the development of another system evolution (V242-B) will continue. It will include new technology for the channel-C of the Ranging and Integrity Monitoring Stations (RIMS-C), and will deploy three new RIMS (in Finland, Ukraine and Jordan) to ensure full Member States' European territories coverage (except possibly Azores).

The new generation of EGNOS, EGNOS version 3, will be the first satellite-based augmentation system implementing dual frequency and multi-constellation, augmenting both GPS and Galileo systems. The development activities for EGNOS version 3 will continue in 2020, notably:

- a) EGNOS version 3 system development activities;
- b) Finalisation of standards for dual frequency multi-constellation satellite-based augmentation system;
- c) Finalisation of the procurement of the new EGNOS Service Provider, the EGNOS service data access facility (SDAF) (i.e. EDAS version 3) and an EGNOS GEO-4 contract;
- d) Follow-up of the EGNOS V3 security accreditation process;

Activities will continue for preparing the extension of EGNOS to the partner countries of the European Neighbourhood Instrument South and for the evolution roadmap for EGNOS.

Market uptake

The market uptake of Galileo and EGNOS is a priority of the Space Strategy for Europe. The Commission will continue its activities to achieve this goal, with an increasing number of actions that GSA will also carry out within its field of competence. Various measures are planned for 2020 with a focus on:

- a) Pursuing market uptake, standardisation and research and development activities, notably in three priority domains: intelligent transport, intelligent infrastructures and intelligent interconnectivity;
- b) Strengthening Europe's role as a global actor in space: promote worldwide use of Galileo and EGNOS, foster cooperation with strategic partners and ensure system interoperability with other systems, pursue economic diplomacy and outreach activities, and continue international negotiations on PRS access and EGNOS coverage extension, notably to partner countries of the European Neighbourhood Instrument South and East;
- c) Pursuing radio spectrum coordination and frequency protection activities.

Outlook for the 2021-2027 period

For the next long-term EU budget 2021-2027, the Commission proposed to help maintain and further enhance the EU's leadership in space. The Commission's proposal brings all existing and new space activities under the umbrella of a single EU space programme. The proposal for the EU space programme maintains existing infrastructure and services and introduces a number of new features such as fostering a strong and innovative space industry in Europe, maintaining Europe's autonomous access to space and a unified system of governance.

III. Programme key facts and performance framework

1. Financial programming

Legal Basis	Period of application	Reference Amount (EUR million)
Regulation (EU) No 1285/2013 of the European Parliament and of the Council of 11 December 2013 on the implementation and exploitation of European satellite navigation systems and repealing Council Regulation (EC) No 876/2002 and Regulation (EC) No 683/2008 of the European Parliament and of the Council	2014 – 2020	7 071,7

	Financial Programming (EUR million)							
	2014	2015	2016	2017	2018	2019	2020	Total Programme
Administrative support	3,4	2,1	3,4	2,5	3,0	3,0	3,5	20,8
Operational appropriations	1 322,8	1 058,5	848,2	895,0	804,9	687,7	1 203,5	6 820,6
Total	1 326,2	1 060,6	851,6	897,5	807,9	690,7	1 207,0	6 841,4

2. Implementation rates

2019				2020			
CA	Impl. Rate	PA	Impl. Rate	CA	Impl. Rate	PA	Impl. Rate

Voted appropriations	690,718	100,00 %	992,971	99,77 %	1 207,028	0,03 %	953,500	4,92 %
Authorised appropriations (*)	818,757	94,38 %	1 248,091	83,37 %	1 325,919	0,03 %	1 228,101	4,28 %

(*) Authorised appropriations include voted appropriations, appropriations originating from assigned revenues (internal and external) as well as carried-over and reconstituted appropriations; the execution rate is calculated on 15 April 2020

3. Performance information

Programme performance

The performance of the Galileo programme to develop and provide global satellite-based radio navigation infrastructures and services by 2020 progressed but was impacted by the Galileo service incident of July 2019. The Commission set up an independent Inquiry Board, which analysed the causes of the incident and provided recommendations. In particular, those actions cover the review of Galileo’s operational management, including interactions between the Commission, the GSA and ESA, in order to achieve a system and an organisation that will always ensure uninterrupted service provision. For example, some measures establishing a unique end-to end maintenance and configuration management are being introduced and operational procedures and processes have been updated. The Commission has put in place a process for implementation of these recommendations to ensure that Galileo is a stable, robust and resilient system. One of the priorities for 2020 is to carry out all activities to deal with the impact of this incident.

With regard to the ground infrastructure, a deployment of the new system release Galileo System Build 1.5.1 (SB1.5.1) has progressed significantly despite delays incurred due the Galileo incident. This system release includes improvements in the infrastructure in order to support the provision of Galileo Services with increased availability. On the satellites, the last launch of Galileo satellites took place in July 2018 and the in-orbit test review took place early 2019, increasing the total count of operational satellites in-orbit to 26. The manufacturing of additional satellites to complete the constellation and provide sufficient spare for ensuring its continuity has continued according to the planned schedule. The current planning assumes that the first satellites shall come out of the production chain by third quarter of 2020 for a launch date to be planned afterwards as soon as all conditions are met including on ground segment and operations side. As the programme intends to use the Ariane-6 launcher in a near future, development of a specific dispenser to carry the Galileo satellites on-board Ariane-6 has also been initiated in 2019 and shall be completed by mid-2021.

With regard to the Galileo services, gradual service improvements took place: a new Service Definition Document for the Open Service of Galileo providing minimum performances levels in positioning and timing was published in 2019 and a new Search and Rescue functionality called the Return Link Service which was declared operational in January 2020. By the end of 2021, the High Accuracy Service with 20cm positioning accuracy should be provided in Europe, its implementation schedule is linked to the deployment of Galileo ground and space infrastructure as outlined here above.

The Programme has also progressed on the preparation of the Galileo Second Generation with the procurement of ‘Transition Satellites’ through a competitive dialogue with industry that started in 2018. The procurement process has proceeded according to schedule and shall result in a contract award in the second half of 2020. The main challenges encountered with this procurement were linked to the consolidation of the technical specifications for these satellites as the work on the Galileo 2nd Generation requirements definition was not completed yet.

EGNOS programme

The performance of the EGNOS programme to provide satellite-based services improving the performance of GPS to gradually cover all EU Member States has steadily improved and just few territories remain uncovered. The coverage of these territories is envisage to be achieved with the launch of the EGNOS V3 technology around 2025..

The continuous delivery of EGNOS services was successfully achieved by efficient implementation of recurrent activities and preparation of system updates. To guarantee the continuity of services beyond 2020, work has continued on the development of a major EGNOS release (V2.4.2-A) and the completion of the study phase of an additional EGNOS evolution (V2.4.2-B), which will improve the coverage Member States’ European territories. The implementation phase of this latter evolution was procured in 2019 and is expected to deliver its services around 2023.

The EGNOS service area was extended up to latitude 72 degrees north. To that end, an update of the EGNOS Safety of Life Service Definition Document was published in February 2019. Most of the Member States’ European territories and the territories of Norway and Switzerland are fully covered, with the exception of the Azores (Portugal), Cyprus and Northern Norway. Northern Norway is expected to be covered in 2023 with the deployment of the EGNOS V2.4.2-B evolution.

Activities for the development of a new generation of EGNOS, EGNOS version 3, continued. In October 2019, a satellite hosting the GEO-3 payload for EGNOS version 3 was successfully launched.

Market share of the EU GNSS industry in worldwide downstream market

With regard to the general objective of for supporting European presence in space and the development of satellite-based positioning, navigation and timing services, and in particular the programme performance for the market share of EU GNSS industry in worldwide GNSS downstream market, steady progress was achieved.

In 2018 and 2019, the presence of EGNOS in receiver models stabilised at 68 % of the total number of receiver models worldwide. Contrary to the expectations in 2014 when a trend of steady growth was predicted and the milestones were set, the market penetration of EGNOS is lower than expected, in particular in the location based services. This is because the early uptake of dual frequency in receiver models outperformed by far the benefit of EGNOS. Also, a rapid development in many GNSS constellations as well as commercial augmentations of the signals increased the performances of the GNSS to the level where the EGNOS benefits are less competitive than assumed in 2014. With regard to the 2020 target, it can be assumed that the number of EGNOS enabled receivers will not grow beyond 70 % of receiver models worldwide.

In 2019, the presence of Galileo in receiver models was at 42 % of the total number of receiver models worldwide. In 2014 when the 2020 target was set, it was expected that the number of Galileo enabled receivers will double in 7 years. There has been a tremendous uptake of Galileo-enabled smartphones, at the end of 2019 there were more than one billion of them on the market. However, in other market segments such as rail, maritime or internet of things the market penetration of Galileo is lower. This is due to various reasons: long lifetime of receivers in the market (5-10 years models still on market), missing certification or standardisation, constraint in energy consumption of the chips on the connected objects, cost of optimisation (still many GPS-only models available) and receiver models serving only regional markets (e.g. Chinese or US manufacturers). Also, main manufacturers were all equipping their devices with Galileo as preparation for Galileo Initial Services and in the years 2016-2020 the activities will concentrate more on activation and optimisation of Galileo use which is not reflected in the statistics.

In the coming years, the market share shall increase mainly due to phasing out of old models, increasing use of Galileo in the US and use of Galileo signals in safety-critical applications in aviation or rail segments. Nevertheless, the 2020 target seems to be optimistic. For both indicators, the data are based on models in the offering of 31 largest market players over all segments, where, due to mergers and acquisitions and new entrants (mainly from China) to the data sample, resulted in decrease of the overall SBAS/EGNOS and Galileo penetration.

General objectives

General Objective 1: Supporting European presence in space and the development of satellite-based positioning, navigation and timing services

Indicator 1: Market share of EU GNSS industry in worldwide GNSS downstream market								
Baseline	2014	2015	2016	2017	2018	2019	2020	Target
2012	Milestones foreseen							2020
EGNOS present in number of receiver models: 63 %	63 %	63 %	75 %	75 %	78 %	82 %	85 %	85 %
	Actual results							
	63 %	63 %	68 %	68 %	68 %	68 %		
2012	Milestones foreseen							2020
Galileo present in number of receiver models: 35 %	35 %	35 %	45 %	40 %	42 %	44 %	70 %	70 %
	Actual results							
	35 %	35 %	38 %	41 %	42 %	42 %		

Comment: The market share indicator is based on the percentage of Galileo and EGNOS receivers in the total number of receiver models worldwide. The baseline for this indicator was established in 2014 and the data is included in the 2014 market report of the European GNSS Agency and is measured annually. The trend of the production of Galileo and EGNOS enabled model receivers suggests that receiver manufacturers are gradually integrating Galileo and EGNOS into their products and the milestone target for this indicator is likely to be reached. Total number of receiver models in the GPS survey in 2012: 483. In 2018 and 2019, the presence of EGNOS in receiver models stabilised at 68 % of the total number of receiver models worldwide. Contrary to the expectations in 2014 when a trend of steady growth was predicted and the milestones were set, the market penetration of EGNOS is lower than expected, in particular in the location based services. This is because the early uptake of dual frequency in receiver models outperformed by far the benefit of EGNOS. Also, a rapid development in many GNSS constellations as well as commercial augmentations of the signals increased the performances of the GNSS to the level where the EGNOS benefits are less competitive than assumed in 2014. With regard to the 2020 target, it can be assumed that the number of EGNOS enabled receivers will not grow beyond 70 % of receiver models worldwide.

Specific objectives

Specific Objective 1: To develop and provide global satellite-based radio navigation infrastructures and services (Galileo) by 2020

Performance

The programme performance to meet the objective to develop and provide global satellite-based radio navigation infrastructures and services (Galileo) by 2020 was stable although with some resulting delays.

The infrastructure and the number of operational satellites (all services considered) for the fully deployed Galileo system will consist of 24 operational satellites plus six in-orbit spares. At the end of 2019, there are 26 Galileo satellites in orbit and all of them are providing services. 22 of them are fully operational for navigation services. The deployment of the constellation could not reach 30 satellites by the end of 2020 as initially anticipated. This is due to the signature date of the Batch#3 contract in June 2017. It took place a few months later than anticipated, in order to properly assess all implications on the programme of the decision and award of the contract. The 30 satellites in-orbit (including the two satellites on the elliptical orbit) will be reached by mid-2021.

The upgrades of the Galileo global terrestrial infrastructure and the system upgrade so-called System Build 1.5.1 which will improve the operability, robustness and security of the system was slightly delayed in 2018 due to changes in the composition of the industry consortium. The System Build 1.5.1 was expected to be implemented in 2019 but the migration was prolonged due to the impact of the Galileo service incident of July 2019. The complete System Build 1.5.1 is now expected to be fully in operations by mid-2020. The System Build 2.0, which is the baseline for Galileo Full Operational Capability will only be deployed in Q3/Q4 2021 instead of end of 2020, which is directly linked to the incident in July 2019.

With regard to the Galileo services, the Galileo initial services were declared operational on 15 December 2016. These include the Galileo Initial Open Service, the Galileo Initial Public Regulated Service, the Galileo Initial Search and Rescue Service. By the end of 2021, the High Accuracy Service with 20cm positioning accuracy should be provided in Europe. The Mission Requirements for Galileo Open Service for Safety of Life applications should be agreed in 2020. The delay for the implementation of the additional Galileo Service (HAS and CAS) is directly linked to the delays in the achievement of a system configuration for Galileo FOC (System Build 2.0) and 30 satellites deployed.

Indicator 1: Galileo infrastructure_Cumulative number of operational satellites								
Baseline	2014	2015	2016	2017	2018	2019	2020	Target
2013	Milestones foreseen							2020
		12					30	30
	Actual results							
	3	9	18	22	26	26		

Indicator 2: Galileo infrastructure_New terrestrial infrastructure deployed version								
Baseline	2014	2015	2016	2017	2018	2019	2020	Target
June 2011	Milestones foreseen							2020
	IOV final configuration	Ground Segment Version 2.0	System Build 1.5.0	System Build 1.5.0	System build 1.5.1	System build 1.5.1	System Build 2.0	System Build 2.0
	Actual results							
		GSM Version 2.1/GCS 2.0	SystemB 1.5.0	SB 1.5.0	SB 1.5.0	Migration ongoing to system build 1.5.1		

Indicator 3: Galileo services provision_Number of services implemented								
Baseline	2014	2015	2016	2017	2018	2019	2020	Target
	Milestones foreseen							2020
			3	3	3	3	5	5
	Actual results							
		0	3	3	3	3		

Expenditure related outputs

Outputs	Budget line	Draft Budget 2020	
		Number	EUR million
Galileo – services	02 05 01		957.5

Outputs		Number of outputs foreseen (F) and produced (P)						
		2014	2015	2016	2017	2018	2019	2020
Galileo – services	F			3	3	3	3	5
	P	0	0	3	3	3	3	

Specific Objective 2: To provide satellite-based services improving the performance of GPS to gradually cover the whole ECAC (European Civil Aviation Conference) region by 2020 (EGNOS) and European neighbouring countries

Indicator 1: Progress of the EGNOS coverage extension versus agreed coverage extension

Baseline	2014	2015	2016	2017	2018	2019	2020	Target
2015	Milestones foreseen							2020
		Establish EGNOS service evolution plan v2.0	Advancement in coverage	Advancement in coverage	Advancement in coverage	Advancement in coverage	Coverage of EU -28 with EGNOS in line with the EGNOS Service – Evolution plan	Coverage of EU-28 with EGNOS in line with the EGNOS Service Evolution Plan
	Actual results							
		EGNOS Service Evolution Plan v2.0 was established	98.98 % coverage of EU28-NO-SW land masses for APV-I	98.9 % coverage of EU28-NO-SW land masses for APV-I	98.7 % coverage of EU28-NO-SW land masses for APV-I	99.1 % coverage of EU 28-NO-SW land masses for APV-I		

Comment: According to the legal base (Regulation (EU) No 1285/2013) the specific objectives of EGNOS cover the following 3 services. Open Service (OS), EGNOS Data Access Service (EDAS) and Safety-of-Life Service (SoL). In 2015, the EGNOS Service Evolution Plan (SEP) was agreed between the Commission and the European GNSS Agency and it constitutes the baseline for the implementation of the EGNOS mission and security requirements. It defines the extension of EGNOS services over the European territory in terms of their availability, which is depicted in a form of ‘availability maps’. The progress of EGNOS APV-I coverage extension versus the Programme objective to cover EU28 states (plus Norway and Switzerland) is reported through the percentage of EU28-NO-CH land masses which effectively achieve APV-I 99 % availability coverage (i.e. observed EGNOS performance). APV-I = Approach procedure with vertical guidance, category 1.

Indicator 2: EGNOS service availability index based on the number of airports with EGNOS-based approach procedures with an operational status versus the total number of airports with EGNOS – based approach procedures

Baseline	2014	2015	2016	2017	2018	2019	2020	Target
	Milestones foreseen							2020
Service availability index: 100 %			Maintain the service availability: 99 %	Maintain the service availability: 99 %	Maintain the service availability: 99 %	Maintain the service availability: 99 %	Maintain the service availability index constantly at least on 99 %	Maintain the service availability index constantly at least on 99 %
	Actual results							
		98 %	100 %	> 99 %	100 %	100 %	> 99 %	
2013	Milestones foreseen							2020
Total number of airports with EGNOS procedures: 93							Increase the number of airports with EGNOS procedures	Increase the number of airports with EGNOS procedures
	Actual results							
		132	174	230	251	315	342	
2014	Milestones foreseen							2020
Total number of airports with an operational status: 93							Increase the number of airports with EGNOS procedures	Increase the number of airports with EGNOS procedures

	Actual results						
	129	173	230	251	315	342	

Expenditure related outputs

Outputs	Budget line	Budget 2020	
		Number	EUR million
EGNOS – services	02 05 02		246
Total			

Outputs		Number of outputs foreseen (F) and produced (P)						
		2014	2015	2016	2017	2018	2019	2020
EGNOS – services in operation:	F	3	3	3	3	3	3	3
	P	3	3	3	3	3	3	

4. Contribution to Europe 2020 Strategy and mainstreaming of policies

Table Contribution to Europe 2020 headline targets

75 % of the population aged 20-64 should be employed
3 % of the EU's GDP should be invested in R & D
The '20/20/20' climate/energy targets should be met (including an increase to 30 % of emissions reduction if the conditions are right)