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EU Space Programme User Uptake Status

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List of acronyms

ACER	European Agency for the Cooperation of Energy Regulators
ARD	Analysis Ready Data
ADIF	Administrador de Infraestructuras Ferroviarias
AEE	Agencia Espacial Española
AI	Artificial Intelligence
AIS	Automatic Identification System
ANSP	Air Navigation Service Providers
ARAIM	Advanced Autonomous Integrity Monitoring
ARD	Analysis Ready Data
ARTES	Advanced Research in Telecommunications Systems
ATM	Air Traffic Management
BAG	German Federal Office for Goods Transport
BELSPO	Belgian Science Policy Office
BEREC	Body of European Regulators of Electronic Communications
BIC	Business Incubation Center
C3S	Copernicus Climate Change Service
CAD	Connected and Automated Driving
CAMS	Copernicus Atmosphere Service
CANSO	Civil Air Navigation Services Organisation
CAP	Common Agriculture Policy
CAS	Commercial Authentitcation Service
CASTRA	Cluster of Aerospace Technologies, Research, and Applications
CBA	Cost Benefit-Analysis
CCAM	Cooperative, Connected and Automated Mobility
CCS	Command & Control Systems
CDS	Climate Data Store
CDSE	Copernicus Data Space Ecosystem
CEMS	Copernicus Emergency Management Service
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CER	Community of European Railway and Infrastructure Companies
CERTIFLIGHT	EU-funded new U-space service for the legal certification of fingerprints generated by UAS
CFP	Common Fisheries Policy
CHIME	Copernicus Hyperspectral Imaging Mission for the Environment
CLMS	Copernicus Land Monitoring Service
CMEMS	Copernicus Marine Environment Monitoring Service
COGECA	Comité Général de la Coopération Agricole
COMAP	Components and Macrocomponents Packaging For Space
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
COSPAS	Cosmicheskaya Sistema Poiska Avariynyh Sudov

CSDD	Corporate Sustainability Due Diligence
CSRD	Corporate Sustaunability Reporting Directive
CSS	Copernicus Security Service
CUT	Cyprus University of Technology
DAS	Driver Advisory Systems
DB	Deutsche Bahn (Group)
DCN	Digital Cellular Network
DG DEFIS	Directorate-General for Defence Industry and Space
DFMC	Dual Frequency Multi-Constellation
DIAS	Data and Information Access Services
DPS	Dynamic Purchasing Systems
EARSC	European Association of Remote Sensing Companies
EASA	European Aviation Safety Agency
EAV	Enabling Application and Validation
EBA	European Banking Authority
EC	European Commission
ECA	European Court of Auditors
ECAC	European Civil Aviation Conference
ECMWF	European Centre for Medium-Range Weather Forecast
ECTS	European Train Control System
EDAS	(EGNOS) European Data Access Service
EDO	European Drought Observatory
EEA	European Environmental Agency
EFAS	European Flood Awareness System
EFFIS	European Forest Fire Information System
EGMS	European Ground Motion Service
EGNOS	European Geostationary Navigation Overlay Service
EGNSS	European Global Navigation Satellite System
EIB	European Investment Bank
EIC	European Innovation Council
EIM	European Rail Infrastructure Managers
ELT	Emergency Locator Transmitter
EMS	Electromagnetic Spectrum
EMSA	European Maritine Safety Agency
ENTSO	European Network of Transmission System Operators
EO	Earth Observation
EPIRB	Emergency Position Indicating Radio Beacon
ERA	European Regional Airlines
ERATOSTHENES	Centre of Excellence of the Cyprus University of Technology
ERRS	Electronic Recording and Reporting System
ERS	Electronic Reporting Systems
ERSAT	ERtms + SATellite
ERTMS	European Railway Traffic Management System

ERTRAC	European Road Transport Research Advisory Council
ES	Emergency Service
ESA	European Space Agency
ESG	Environtment, Social, Governance
ESMA	European Securities and Markets Authority
ESRS	European Sustainability Reporting Standards
ETCS	European Train Control System
EU	European Union
EUDR	European Deforestation Regulation
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUMSS	European Union Maritime Security Strategy
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
EUSPA	European Union Space Programme Agency
EWAN	EGNOS Wide Area Network
FAO	Food and Agriculture Organization of the United Nations
FE	Fundamental Elements
FFO	Full, Free and Open
FIRE	European Forum for Earth Observation
FISE	Forest Information System for Europe
FLEGT	European Union Forest Law Enforcement, Governance and Trade Action Plan
FPA	Framework Partnership Agreement
FPCUP	Framework Partnership Agreement on Copernicus User Uptake
GADSS	Global Aeronautical Distress and Safety System
GBAS	Ground Based Augmentation System
GCS	Galileo Control System
GDA	Global Development Assistance
GEO	Geostationary Orbits
GHSL	(Copernicus) Global Human Settlement Layer
GIS	Geographic Information System
GMDSS	Global Maritime Distress and Safety System
GMES	Global Monitoring for Environment and Security
GMS	Galileo Mission System
GMS-R	Global System for Mobile communications - Railways
GNC	Guidance, Navigation and Control
GNSS	Global Navigation Satellite System
GOVSATCOM	European Union Governmental Satellite Communications
GPS	Global Positioning System
GS	Ground Segment
GSM	Global System for Mobile Communications
HAS	Galileo High Accuracy Service
HRL	Human Readiness Level
HSC	Hellenic Space Center

IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAM	Identity and Access Management
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICG	United Nations International Committee on GNSS
ICT	Information and Communication Technology
IEC	International Electro-technical Commission
IMO	International Maritine Organisation
INCUBED	Investing in Industrial Innovation
INSAR	Interferometric Synthetic Aperture Radar
IP	Intelectual Property
IREs	Instrument Runway Ends
IRIS	Infrastructure for Resilience, Interconnectivity and Security by Satellite
ITS	Information Technology Services
ITU	International Telecomunication Union
IUU	Illegal, Unreported and Unregulated fishing
IVS	In-Vehicle Systems
JRC	Joint Research Center
KCEO	Knowledge Center Earth Observation
LEO	Low-Earth Orbit
LKW	Lastkraftwagen (German tolling scheme for heavy goods vehicles)
LO	Lunar Orbit
LPV	Localiser Performance with Vertical guidance
LSA	Luxembourg Space Agency
LSTM	Land Surface Temperature Monitoring
LULUCF	Land Use, Land-Use Change and Forestry
MASS	Maritime Autonomous Surface Ships
MCC	Mission Control Centres
MEO	Medium-Earth Orbit
MFF	Multiannual Financial Framework
MOB	Man Overboard Beacon
MODI	EU-funded project to identify and address barriers in confined areas and on public roads for autonomous vehicles
MS	Member States
MSD	Minimum Set of Data
MSP	European Maritime Spatial Planning
NAVISP	Navigation Innovation and Support Program
NEO	Near Earth Objects
NEREUS	Network of European Regions Using Space Technologies
NGO	Non Governmental Organisation
NLES	Navigation Land Earth Stations
NMA	Navigation Message Authentication

NO	Navigation Overlay
NSIS	National Strategy Information System
NSO	Netherlands Space Office
NWO	Netherlands Organisation for Scientific Research
OBU	On Board Unit
OCRE	Open Cloud for Research Environment
ODA	Oracle Database Appliance
OECD	Organisation for Economic Co-operation and Development
OS	(Galileo) Open Service
OSNMA	(Galileo) Open Service Navigation Message Authentication
PBN	Performance Based Navigation
PCP	Pre-Commercial Procurement
PLB	Position Navigation and Timing
PMR	Professional Mobile Radio
PMU	Phasor Measurement Units
PND	Personal Navigation Devices
PNT	Position Navigation and Timing
POD	Precise Orbit Determination
POLSA	Polish Space Agency
PPI	Public Procurement of Innovation Solutions
PPP	Precise Point Positioning
PROTECT	Procuring Innovative Climate Change Services
PRS	(Galileo) Public Regulated Service
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
RAIM	Receiver Autonomous Integrity Monitoring
RAMS	Reliability, Availability, Maintainability and Safety and their interaction
RBA	Remote Beacon Activation
RENFE	Red Nacional de los Ferrocarriles Españoles
RFI	Rete Ferroviaria Italiana
RIMS	Ranging Integrity Monitoring Stations
RLS	Return Link Service
RNP	Required Navigation Performance
RPAS	Robotic Process Automation Software
RTCA	Radio Technical Commission for Aeronautics
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic (positioning)
RTN	Real Time Navigation
RUC	Road User Charging
SAR	(Galileo) Search and Rescue Service
SART	Search and Rescue (Radar) Transponder
SAS	(Galileo) Signal authentication Service

SATCOM	Satellite Communication
SBAS	Satellite-Based Augmentation System
SESAR	Single European Sky ATM Research and Development
SFDR	Sustainable Finance Disclosure Regulation
SGCI	Sub-directorate General for Control and Inspection
SME	Small and Medium Enterprise
SNCF	Société Nationale des Chemins de Fer français
SOLAS	International Convention for the Safety of Life at Sea
SOM	Scientific & Operational Missions
SORA	Specific Operation Risk Assessment
SSA	Space Situational Awareness
SST	Space Surveillance and Tracking
SSV	Space Service Volume
S-T&S	Space Timing and Synchronisation
STEM	Science, Technology, Engineering, and Mathematics
SWD	Staff Working Document
TAIEX	Technical Assistance and Information Exchange
TCFD	Task Force on Climate-related Financial Disclosures
TechD	Technology Demonstration
TLO	Translunar Orbit
TNFD	Task Force on Nature-related Financial Disclosures
TROPOMI	Tropospheric Monitoring Instrument
TS	(Galileo) Timing Service
TSO	(European) Transmission System Operator
TWC	Two-Way Communication
UCP	User Consultation Forum
UFN	National Copernicus User Forum
UITP	Union Internationale des Transports Publics
UN	United Nations
UNIFE	European Rail Industry Association
UNISIG	Union Industry of Signalling
US	United States of America
UTC	Coordinated Universal Time
UV	Ultraviolet
VDES	Very High Frequency Data Exchange
VFR	Visual Flight Rules
VMS	Vessel Monitoring Service
WWRNS	World Wide Radio Navigation System

1 Context

This Staff Working Document (SWD) provides the state of play of the **user uptake**[1] for three key elements of the EU Space Programme**: Galileo and EGNOS**, the satellite navigation components (European Global Navigation Satellite System, EGNSS), and **Copernicus,** the Earth Observation (EO) component.

The objective of the SWD is to highlight the state of user engagement and use across sectors and industries. The **SWD seeks to identify and evaluate existing gaps and obstacles to user uptake and in this way lay the ground for the development of a comprehensive strategy supporting user uptake of data and services provided by the flagship components Galileo, EGNOS and Copernicus**.[2]

Space has become an integral and essential component of our everyday lives. Today, the use of space data and services extends far beyond traditional applications, playing a **crucial role in different sectors, for instance energy, urban planning, insurance or environmental monitoring**. The Earth Observation (EO) market is expected to grow to almost 6 EUR billion in 2033. The Global Navigation Satellite Systems (GNSS) global downstream market revenues are expected to grow from currently around 260 EUR billion to almost 600 EUR billion in 2033.[3]

Space is key to protect the economic and security interests of the EU, its Member States and citizens. It contributes to a higher level of preparedness and a better targeted emergency response in crisis situations. It ultimately contributes to making our infrastructures and capabilities more resilient to evolving (cyber)threats. These activities stimulate innovation and generate vast amounts of data, with the increased use of Artificial Intelligence driving the development of previously unachievable systems or services.

Traditionally, the space sector has been categorised into upstream space infrastructure, midstream space services and downstream space-enabled applications. Space upstream encompass building the infrastructure, including research, engineering support, supply of materials, and space launch activities. Midstream services involve the operations of space infrastructure leading to tangible products and services, such as EO domain specific services. **Downstream activities support end-user markets and play a critical role in processing and**

[1] For the purposes of this Staff Working Document, user uptake refers to the integration, utilisation, and implementation of the services and data provided by the Programme components into various sectors, industries, and decision-making processes. User uptake involves the incorporation of EU space-based resources into existing applications or newly developed ones. Space-based applications are those that use data and information from space-based systems for their functionality to serve a specific purpose, directly or in combination with other data, software, or hardware.

[2] The EU Space Regulation encompasses the SSA-SST and GOVSATCOM components. However, these components are not covered in this SWD. In a similar manner, IRIS2 is not covered as it is subsequent to the EU Space Regulation, and it does not deliver services yet.

[3] https://www.euspa.europa.eu/european-space/euspace-market/gnss-market/eo-gnss-market-report.

applying data from space infrastructure to practical solutions, supporting research and innovation in other sectors.[4] [5]

The EU is aware of the importance of space for fair economic growth and security. Ensuring strategic autonomy, supporting policy goals, and promoting industry competitiveness and innovation are key objectives. The EU Space Strategy[6], adopted in 2016, paved the way for the regulation establishing the EU Space Programme 2021-2027, including Galileo, EGNOS, Copernicus, and additional components (GOVSATCOM and Space Situational Awareness), demonstrating the EU commitment to fostering innovation, sustainability, and economic growth:

- **Ensuring open strategic autonomy**: The investment carried out by the EU in establishing a full set of space assets is largely driven by the need to ensure open strategic autonomy, including for climate and societal resilience[7], which relies on a well-developed and resilient downstream sector that is able to exploit the data and services delivered by space assets. By developing a strong downstream sector, the EU aims to ensure the continuity of the operations and increased resilience as currently more than 10% of the EU economy relies on space services and the EU companies make up for 25% of the space downstream market.[8]

- **Supporting the achievement of policy goals:** A strong downstream space sector is essential for the achievement of the EU twin transition towards a fair green and digital future, as well as ensuring security and resilience in the EU. Thus, policy goals related to sustainability, climate neutrality, societal resilience, and digital transformation are supported by a wide range of space-based services and solutions.

- **Promoting the competitiveness of EU industry and boosting innovation**: space technologies, in particular, downstream space-based solutions, can significantly contribute to the development of European industry. While Copernicus is expected to generate between EUR 35 billion to EUR 131 billion of socio-economic benefits by 2030, with 84% of those benefits coming from the downstream sector, Galileo and EGNOS are expected to generate socio-economic benefits of between EUR 60 and EUR 90 billion up to 2043.[9] The integration of space data in operational processes helps companies developing competitive solutions and maintain global leadership.

The establishment of the EU Space Programme created an exceptionally positive perspective for the EU's downstream space industry. There is a growing variety of applications across multiple segments that originate from EO- and GNSS-based data and value-added services. The 2024

[4] See the definitions in the OECD Handbook on Measuring the Space Economy, 2nd edition.
[5] Conceptual Framework for the assessment of the benefits from the EU Space Programme (2023).
6 Space Strategy for Europe.
[7] 'Open Strategic Autonomy means cooperating multilaterally wherever we can, acting autonomously wherever we must'.
[8] See note 3, page 10.
[9] See note 3, page 10.

EUSPA EO & GNSS Market Report[10], gives a detailed overview of revenues generated by the EU space components (hardware and service-related) in 15 market segments: agriculture; aviation and drones; climate, environment and biodiversity; consumer solutions, tourism and health; 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.[11]

Despite past investments and the work carried out to promote the uptake of EU Space data and services, **a comprehensive strategy supporting the uptake of space data and services by all relevant players and entities at EU, national and regional/local level needs to be developed**[12].

According to the Special Report adopted by the European Court of Auditors (ECA) in 2021,[13] there is a **need to clarify the objectives for the uptake of EU space services** as described in the 2016 Space Strategy by setting clear goals and priorities **for the maximisation of benefits and to support the uptake of data and services generated by the EU Space Programme**, including key performance indicators (KPIs) to measure performance. **A conceptual framework for measuring the benefits will be published alongside the SWD**, providing a **structured approach to assess the impact and effectiveness of EU space programme data and services across various sectors and applications.**

This SWD describes the components of the EU Space Programme (Galileo, EGNOS and Copernicus), identifies key players and stakeholders and provides an overview of the current state of user uptake, following the recommendations of the ECA Special Report. It also reflects on the barriers and opportunities for user uptake (**Annex 2** provides a high-level evaluation of the adoption of EGNSS and Copernicus per market segment). Thus, the SWD presents a comprehensive analysis of these two components of the EU Space Programme, covering the services provided by satellite navigation signals and earth observation data.

2 Space programme flagship components and user uptake stakeholders

In the early 2000s, the European Commission launched its flagship Space Programme components: Galileo and the European Geostationary Navigation Overlay Service (EGNOS) for satellite navigation and Copernicus for Earth Observation. As priorities expanded to include security, defence and space infrastructure resilience, additional components, namely Space Situational Awareness and the Governmental Satellite Communications programme (GOVSATCOM), were incorporated into the EU Space Programmme.

Until 2021, each component of the EU Space Programme operated under separate framework with independent governance. In 2021, the EU Space Programme Regulation consolidated these

[10] See note 3, page 10.
[11] For a detailed description of these segments, please see note 3, page 10.
[12] European Court of Auditors, EU space programmes Galileo and Copernicus: services launched, but the uptake needs a further boost.
[13] See note 3, page 10.

components under a single framework, fostering synergies and efficiency. In 2023, the Union Secure Connectivity Programme (IRIS²) was launched.[14]

The EU Space Programme reflects the EU commitment to maintaining a strong presence in the space sector, cooperation, and leveraging space for societal benefits.

This chapter explains **the roles and contributions of stakeholders, insights into their interests and collaborative efforts within the programme**. This analysis aims to provide an **understanding of the dynamics shaping EU advancements in satellite navigation and Earth Observation** through the adoption of Galileo, EGNOS, and Copernicus services.

2.1 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 consists of two elements: Galileo and EGNOS.

Galileo is the **first Global Satellite Navigation System (GNSS) designed specifically for civilian purposes**, which can be used by a variety of public and private actors worldwide. It provides Europe with independence from other GNSS systems but remains interoperable with them, to facilitate combined use of GNSS and to offer better performance.

EGNOS is the EU regional Satellite-Based Augmentation System (SBAS). It **improves the quality of open signals from the US Global Positioning System (GPS) and Galileo in the future**. Currently, around 500 European airports and helipads are using EGNOS, guaranteeing safe landing operations with satellite navigation. There are plans to further extend the EGNOS SoL-service to the maritime[15] and rail sectors.

Although built for civilian purposes, the range of Galileo users is wide: from citizens, non-governmental organisations, academic/research and business organisations to governmental and military bodies. In 2022, Galileo was present in 65% of receiver models worldwide, with the key market segment being consumer solutions (including smartphones, wearables, tablets). The estimated number of Galileo-enabled smartphones active worldwide accounts for around 2.7 billion, with more than 900 Galileo-enabled smartphone and tablet models available.[16] The global GNSS downstream market revenues, generated by both device sales and the added value services supported by such devices, has a growing trend, from EUR 260 billion in 2023 to around EUR 580 billion in 2033.[17]

[14] EUR-Lex - Document 32021R0696.

[15] In Q1 2024, EGNOS services dedicated to maritime will be declared to meet the requirements of Imp Res.1046.

[16] European Commission, EU Space Programme - Performance.

[17] See note 3, page 10.

2.2 Copernicus

Coordinated and managed by the European Commission, **Copernicus is the EU Earth Observation (EO) and monitoring programme.**

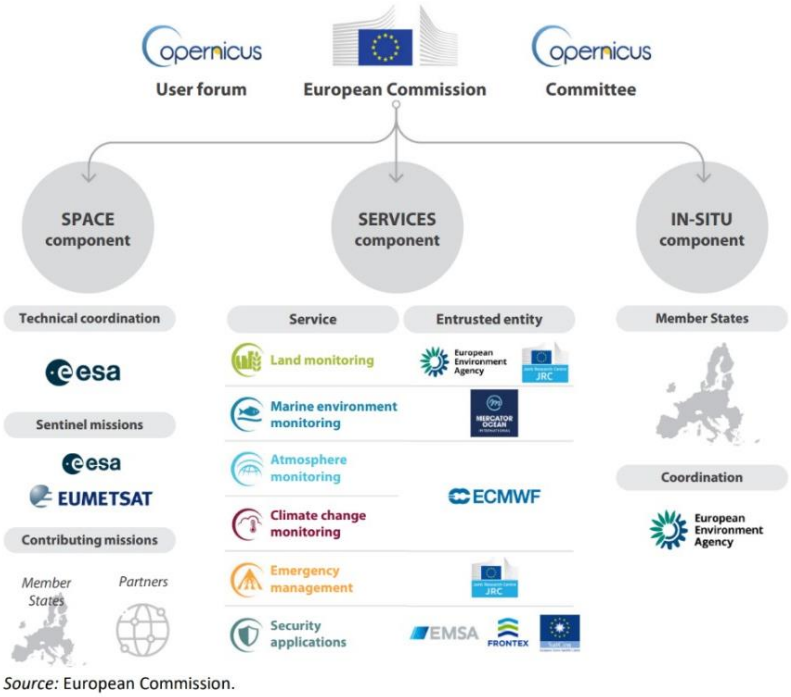

Figure 1 Copernicus services

Copernicus **relies on its own set of satellites (Sentinels), as well as contributing missions (existing commercial and public satellites), and a variety of technologies and in-situ measurement systems for atmosphere, land, and ocean**. The accurate and reliable data generated is turned into value-added information by the Copernicus Services for different thematic domains**: atmosphere monitoring; marine environment monitoring; land monitoring; climate change monitoring; and security and emergency management**. Most data generated by Copernicus is made globally **available to anyone based on a Full, Free and Open data policy**. The data is accessible through various services, initially by a **set of cloud-based platforms called Data and Information Access Services (DIAS) and more** recently launched Copernicus Data Space Ecosystem**.**

Various users benefit from Copernicus data and services based on their technical capabilities, position in the value chain, and operational needs. Academia and industry users directly access and process Copernicus data for information. Governmental, academic, and industry stakeholders utilise Copernicus services for decision-making and operations. Research institutions and industry develop Copernicus-enabled downstream services, combining data for advanced analytics. Distinguishing between intermediate and end-users is crucial. Intermediate users, from industry or academia, build solutions for end-users in specific market verticals. End-users include governmental organisations, corporations, research communities, NGOs, international institutions, and the public accessing Copernicus-generated information. The refinement process involves three tiers to generate this information.

- From raw to processed data (**Resources Tier**): All data acquired by EO satellites is systematically processed to a certain Level by the Ground Segment (GS). For instance, for Sentinel-2, the Level 1C[18] and Level 2A[19] products are released to users and therefore made available at the Resources Tier
- From processed data to EO services (**Exploitation Tier**): The processed data can be adapted through Platform Services and put into more convenient formats such as Analysis Ready Data (ARD), which can significantly reduce the burden on service providers who will exploit it to create EO services[20]. New tools providing pre-defined analysis algorithms further reduce exploitation barriers in platforms like the CDSE[21].
- From EO services to Information services (**Knowledge Tier**): at the Knowledge Tier, Information providers will combine several sources (including EO services) to deliver the information required by end-users when and where they need it[22].

The use of EO data and services is expected to grow, with global revenues forecasted to soar from more than 3 EUR billion in 2023 to almost 6 EUR billion in 2033[23]. The massive amount of data and information produced in the context of the Copernicus programme – representing petabytes – is made freely available and accessible to any citizen and any organisation around the world. As the data archives grow, it becomes more convenient and efficient to analyse data where it was originally stored, instead of downloading it locally.

2.3 Stakeholders in the EU Space Programme downstream ecosystem

The EU Space Programme is **implemented through collaboration involving the European Commission, the Member States, the European Union Space Programme Agency (EUSPA), the European Space Agency (ESA), and various entrusted entities**. These entities contribute to the implementation and jointly manage the use of EU Space data and services.

Within the EU Space Programme downstream ecosystem, stakeholders comprise a variety of organisations, and entities with a vested interest in or direct impact on the utilisation of space-based data and services in the EU. [24] This diverse group includes government agencies, private companies, research institutions, end-users, and the public. It is crucial to make a clear distinction between oversight entities and users when addressing the stakeholders of the EU Space Programme.

Key stakeholders, such as **public authorities, industry players, and end-users**, play a pivotal role in actively **influencing user uptake within the framework of the EU Space Programme**. It is

[18] Geographically corrected data, allowing the superposition of data observed over the same area.
[19] Atmosphere corrected data, providing surface reflectance values.
[20] At this stage, EO services include 50% to 100% information derived from EO data, with the rest coming from other data sources (geospatial, statistics, etc.).
[21] Copernicus Data Space Ecosystem.
[22] At this stage, information services could include 5 to 50% information derived from EO data.
[23] See note 3, page 10.
[24] Including the entities to whom the European Commission has delegated the implementation and operation of the Copernicus services.

important to differentiate between the entities responsible for user uptake and the users' influencers when discussing the stakeholders of the EU Space Programme.

The European Commission's Directorate-General for Defence Industry and Space (DG DEFIS) coordinates and implements the EU space policy and programmes, overseeing the EU Space Programme, promoting its data and services, managing Galileo with EUSPA and coordinating Copernicus with the Entrusted Entities. EUSPA manages the EU Space Programme, handling security accreditation, promotion, and downstream market development, and executes Commission-assigned tasks. ESA collaborates closely with the Commission, focusing on Galileo deployment, Sentinel satellite operation for Copernicus, and advancing space capabilities through research and innovation. Copernicus services and some satellite operations are managed by Entrusted Entities and ESA, respectively. Member States collaborate under the EU Space Regulation and through public-private collaboration at national level to expand uptake of data and services.

The key players influencing the uptake of EU Space-based solutions are detailed in the GNSS and EO Market Report[25]. Public authorities[26], such as policymakers and administrations at various levels, act as both stakeholders and end users, integrating space data to enhance public services. Industry players, including GNSS receiver manufacturers and EO service providers, play a crucial role in developing and integrating space solutions for end users. Academia and innovation ecosystems support innovation, while end users, ranging from companies to citizens, benefit directly from Galileo and Copernicus data and drive uptake.

2.4 The funding of user uptake

The EU space flagship components are funded through various instruments, covering all activities and contributing to the user uptake budget. The **EU Space Programme** was established under the 2021-2027 Multiannual Financial Framework (MFF) with a budget allocation of EUR 14,880 billion (in current prices[27]. This budget was distributed across the different components:

25 See note 3, page 10.

[26] The term public authority refers to *any government or public administration, including public advisory bodies, at national, regional, or local level.*

[27] Official Journal of the European Union, COUNCIL REGULATION (EU, Euratom) 2020/2093 of 17 December 2020.

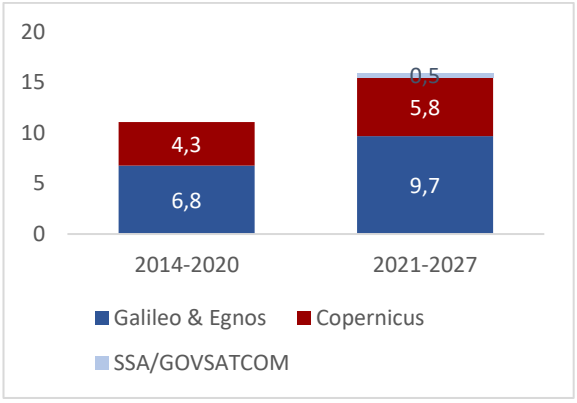

Figure 2 - EU Space Programme budget (In €billion)

The Programme provides funding through several methods such as prizes and procurement, which allows for a diverse range of funding options to support its objectives.

Horizon Europe Cluster 4 "Digital, Industry and Space", with a total budget of EUR 1755 million for space activities in the current MFF 2021-2027**,** offers a mechanism for funding research and the development of cutting-edge technologies in the field of space. For the downstream space industry, this translates into the opportunity to harness emerging technologies and applications based on space, such as EO data analytics. It also encourages cross-sectorial collaboration, which allows the downstream space industry to integrate into broader initiatives and find solutions applicable to multiple domains. The Horizon Europe eligibility criteria clarify that "If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used)"[28]. EUSPA is in charge of activities related to the development of downstream applications and manages part of the Horizon Europe budget of up to EUR 122.5 million for the period 2021-2027, initially allocated to development of downstream space applications.

As an illustration of Horizon Europe's commitment to supporting EO data uptake, beyond Cluster 4, over the past three years, significant investments exceeding EUR 125 million have been directed towards projects in this domain. Most of these projects found their place under Destination 7 of Cluster 6, focusing on "Innovative governance, environmental observations, and digital solutions in support of the Green Deal." Nonetheless, supplementary funding was also allocated to projects falling under various other destinations within the same cluster. Althought, numbers for 2024 are not yet known as proposals are currently under evaluation, it is expect an additional EUR 62 million including the new Horizon Europe Partnership on Agriculture of Data.

InvestEU programme supports sustainable investment, innovation and job creation in Europe. With an EU budgetary guarantee of EUR 26.2 billion provided to National Promotional Banks and Institutions and International Financial Institutions, the InvestEU programme aims to trigger more than EUR 372 billion in private and public investments to high EU policy priority areas.

[28] Strategic Autonomy in Developing, deploying and using global space-based infrastructures, services, applications and data 2024.

InvestEU aims to support investments in space, in particular in relation to the development of the space sector in line with the objectives of the Space Strategy for Europe. As such, InvestEU provides a source of funds for user uptake of space-based solutions through risk-sharing mechanisms between the EU and the InvestEU Implementing Partners, which deploy debt and equity financial products to support financing and investment operations with the market in a wide range of Space-related eligible areas.

CASSINI Space Entrepreneurship Initiative supports entrepreneurs, start-ups and small to medium-sized enterprises involved in the space industry, including New Space.

The Entrusted Entities ensure the availability and continuity of Copernicus, which includes the improvement and expansion of data collection systems and the development of new applications and services through several financial mechanisms. This includes collaboration with the Member States, Copernicus participating states and other countries.

3 Understanding user uptake

The need to improve the uptake of space-based solutions, in particular Galileo, EGNOS and Copernicus, is **driven by the objective to maximise return on public investment and generate significant socio-economic** benefits for users among governmental organisations, academia, industry, NGOs and the broader society. Adopting the solutions enabled by Galileo, EGNOS and Copernicus is also closely tied to policies at the EU and national levels.

In examining the current level of uptake and crafting strategies to increase it, it is essential to **understand what uptake means**, what is being used, by whom and in which operational scenarios.

In both satellite navigation and EO, the uptake of **Galileo/EGNOS services and Copernicus services and data by the market is not guaranteed.** The long-term dissemination of EU space services and data relies on the effectiveness of these services and data when integrated into applications. Their **success depends on meeting user needs and satisfying requirements**, with the goal of surpassing alternative solutions in terms of performance, cost-effectiveness, or both. Alternatively, these services may complement other solutions, particularly for intensive data-based applications. It is imperative to emphasise the provision of 'differentiators' compared to other space service providers, such as Galileo's Open Service Navigation Message Authentication (OSNMA) High Accuracy Service (HAS) functionalities. Due to their **characteristics**, the **concept of uptake** for Copernicus and Galileo/EGNOS partially **differs**, as shown below.

Table 1 Copernicus and Galileo/EGNOS: what is adopted by users

Copernicus uptake	EGNSS uptake
Copernicus data are directly accessed by technically advanced users (often referred to as intermediate users), typically from academia or industry, who can process them and extract informatoin.	**Navigation services** are the services offered by Galileo and EGNOS respectively. The use of these services is possible through navigation receivers supporting the various navigation-enabled applications is essential to secure the adoption of EGNSS.

Copernicus services and their products are used by a large community of governmental, academic and industry stakeholders in support of their decision-making and operational needs.	**Navigation-enabled applications** in a range of different segments use GNSS services and data for their functionality, thanks to GNSS receivers that serve a specific purpose, directly or in combination with other data, software or hardware.
Copernicus-enabled downstream solutions are developed by research institutions, industry and public service bodies, who combine Copernicus data together with other data sources to deliver advanced analytics solutions tailored to the needs of other end-users.	

3.1 User uptake scenarios

Users of Galileo, EGNOS and Copernicus seek to exploit the provided world-class data and services that support them in making informed decisions, taking coordinated actions and effective interventions across a wide range of thematic domains. Galileo, EGNOS and Copernicus provide added value in various use scenarios that can be grouped into two broad categories:

- **Policy monitoring, enforcement, implementation, and reporting**: This concerns activities carried out by public service bodies in direct connection to legislation and regulation. For instance, the Water Management Authorities may use Copernicus-based solutions to monitor the water quality of a lake in connection with responsibilities under the Water Framework Directive. Law enforcement authorities may use Galileo/EGNOS positioning to determine, through the smart tachograph, the position of vehicles at certain points during the daily work period. Agencies managing agriculture support programmes may use **Galileo/EGNOS** or Copernicus-enabled solutions to manage subsidy claims under the Common Agricultural Policy.
- **Business and operational processes**: This concerns activities that form part of a broader operational workflow. For instance, offshore wind farm developers may use Copernicus-enabled solutions to assess the annual energy potential of a given site. Farmers may use EGNSS-powered solutions to support automatic steering of their tractors. Insurance companies may use Copernicus-enabled solutions to assess flood risks. The use of Copernicus and EGNSS-enabled solutions in such operational processes may create new business opportunities thanks to new insights acquired.

In both cases, **user uptake is motivated by the ability of Galileo, EGNOS or Copernicus-enabled solutions to meet user needs[29] and realise associated benefits** (e.g. improved productivity, cost-avoidance, time or efficiency gains, safety gains, reduced environmental impact, objective evidence of compliance with environmental regulations, increased resilience, including societal resilience, thrust worthiness, etc.). A deeper insight into relevant adoption scenarios of Galileo, EGNOS or Copernicus-based solutions is provided in the segment-specific analysis in **Annex 2**.[30]

3.2 How does user uptake take place?

Uptake of Galileo, EGNOS or Copernicus data and services takes place when an organisation uses the different outputs described in Table 1 above. There is merit in distinguishing between *initial*

[29] For more information on the processes established to capture user requirements please see section 4.2.1.

[30] For more extensive descriptions of operational scenarios in different sectors, please consult the Reports on User Requirements by EUSPA.

users and *operational* users. In the first case, governmental, academic, or corporate stakeholders encounter Galileo, EGNOS- or Copernicus-based solutions in the context of a pilot activity, an EU-funded project, a demonstrator, or a feasibility study. In such cases, whilst the use of these solutions may already exhibit associated benefits, it does not always translate into regular use. Operational users, on the other hand, have established adequate processes and technical interfaces to make regular use of the outputs of Galileo, EGNOS or Copernicus in such a way that they form an integral part of their operational workflow. In such cases, users have earmarked dedicated budgets for the use of EGNSS- or Copernicus-enabled solutions, may have signed service level agreements with the selected service providers, and have put in place performance monitoring methodologies and reporting processes.

The **user uptake of the EU space programme components varies** across organisations, from only a few entities having embraced the technologies to a scenario where widespread use is evident. Based on years of market analysis conducted by EUSPA and insights from the EO & GNSS Market Report providing comprehensive coverage of the global EO and GNSS market trends and developments updated biennially, and for the purpose of this document, the uptake of the EU Space Programme has been categorized into three main levels of uptake:

- **Minor uptake:** uptake is considered minor when only a small subset of organisations has embraced Galileo, EGNOS or Copernicus. Overcoming barriers such as market knowledge, cost concerns and technology complexity is essential at this stage. Advocacy efforts, collaborative initiatives, and showcasing success stories become crucial drivers for broader acceptance.
- **Medium uptake:** A medium uptake involves a moderate penetration of EU space data, services, and technologies across a larger segment of the market or various public sector operations. At this stage, it is important to focus on creating momentum, leveraging successful case studies, and fostering collaboration. Demonstrations, pilot initiatives and the development of standards in particular areas play a crucial role in showcasing tangible benefits and encouraging widespread adoption.
- **Major uptake:** In the scenario of major adoption, the usage of EU space technologies is almost universally integrated within a market or multiple facets of governance. The focus is on optimising these technologies for specific needs, ensuring interoperability, and integrating them seamlessly into applications and decision-making processes.

3.3 Current State of Uptake, Overview

The success of the EU Space Programme, encompassing Galileo, EGNOS, and Copernicus, in garnering user uptake is **primarily attributed to the users' recognition of the tangible value these systems bring to their specific needs**. The realisation of the added value provided by these space-enabled solutions has been a crucial catalyst in fostering user uptake. A key factor contributing to uptake of space data and services is showing clearly how space data and services add value and match important policy goals.. The existence of conducive regulatory frameworks further facilitates adoption, ensuring a seamless integration process. Furthermore, the commitment of **governmental entities to invest significantly in the integration** of cutting-edge solutions from Galileo, EGNOS, and Copernicus has played a pivotal role in encouraging user uptake.

Another positive aspect influencing user uptake is the **capacity of different user communities to exploit space-based solutions.** The tech-savvy nature of professional users, such as surveyors and air navigation service providers, who incorporated satellite data, services, and solutions into

their operational workflows. This adaptability and successful integration underscore the diverse capacity of user communities to exploit space-based solutions, contributing to the overall success and impact of the EU Space Programme.

The exploitation of Copernicus, Galileo and EGNOS data and downstream services at EU and national levels is a prerequisite for the full realisation of the socio-economic benefits by the various users. A huge effort was made to **support the user uptake of the EU space components by all relevant stakeholders**, with the Commission and EUSPA taking the lead. As described in the previous section while introducing the EU Space programme, the uptake for all components progressed and significant results were reached.

Galileo experienced significant growth. In 2023, Galileo was present in 67% of receiver models[31] worldwide while the number of Galileo-enabled smartphones increased from zero in 2015 to around 2.85 billion in 2023. Key sectors benefiting from Galileo include agriculture, drones, consumer solutions, emergency management, fisheries, forestry, maritime, rail, public transport, and automotive.

In the area of road and automotive applications, Galileo has achieved widespread penetration, integrated into every European car purchased after 2019 for their eCall emergency system. The Intelligent Transport Systems Directive, in force since November 2023[32], mandates compatibility with Galileo unique features. In aviation and drones, the use of Galileo is projected to rise, with an estimated 49 million GNSS units expected to be shipped by 2031[33]. Integration of Galileo in drone commercial receivers is already prevalent.

The recognition of Galileo as a global navigation system in the maritime sector dates back to 2016[34]. In Search and Rescue (SAR), major manufacturers incorporate Galileo-enabled beacons since 2018, introducing Return Link Service since 2021.

Uptake of EGNOS services, primarily serving aviation, experienced substantial progress, boasting over 900 approaches and over 27% fleet equipped by the end of 2023[35]. The Performance Based Navigation Regulation mandates EGNOS approach procedures on all EU instrument runways by 2024[36]. EUSPA's support extends to tailored operations for helicopters, especially in emergency and medical operations during the COVID crisis. EGNOS also plays a role in maritime and rail transport, supporting plans for a maritime service for merchant vessels and cost reduction for

[31] The statistics are based on EUSPA's independent analysis, which assesses the capabilities of more than 500 receivers, chipsets and modules currently available on the market. For the analysis, each device is weighted equally, regardless of whether it is a chipset or receiver and no matter what its sales volume is. The results should therefore be interpreted as the split of constellation support in manufacturers' offerings rather than what is in use by end users. The analysis includes the majority of major receiver manufacturers in Europe and worldwide.

32 Revision of the Intelligent Transport Systems Directive - November 2023.

33 See note 3, page 10.

[34] Maritime Safety Committee (MSC), 96th session, 11-20 May 2016.

[35] EGNOS Procedures Availability | EGNOS User Support (essp-sas.eu).

36 EUR-Lex - Document 32018R1048.

the European Rail Traffic Management System. Agriculture relies on EGNOS for guidance applications, with more than 85% EGNOS-enabled GNSS devices in agriculture [37].

Copernicus has a steadily growing user base. The Space Component has seen a significant increase in registered users from 385,000 in 2020 to 638,000 in 2022, with 6 800 Terabytes of Sentinel data generated in 2022. Copernicus focuses on developing unique products and engaging with businesses, leading to high industry involvement and start-up participation in various initiatives.

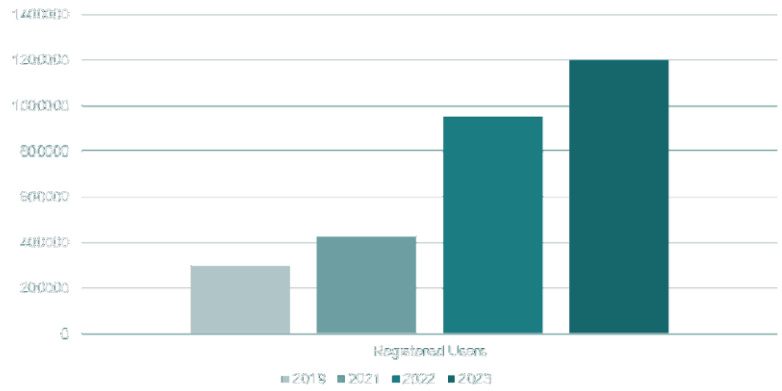

Figure 3 - Number of registered users downloading Copernicus data and information

The uptake of Copernicus services demonstrates a dynamic engagement across platforms and users. The success of Copernicus services is evident in the widespread uptake across various platforms and user communities, highlighting a growing interest in Earth observation data.

The demand for various monitoring services grew between 2022 and 2023, which indicates growing interest and needs in space data, on the one hand, and confirming significant opportunities for growth and development. In the reference period, the user base of the Land Monitoring Service expanded from 171 317 to 186 812, reflecting an increasing need for land-related data and analysis. Similarly, the Marine Environment Monitoring Service experienced a notable increase in use, with the number of registered users climbing from 48 916 to 65 969, demonstrating the growing interest in marine ecosystem monitoring. The Atmosphere Monitoring Service also saw substantial increases in users from 27 070 to 32 258, and the Climate Change Service from 163 550 to 267 083 highlighting the escalating demand for environmental data and insights.

37 See note 3, page 10.

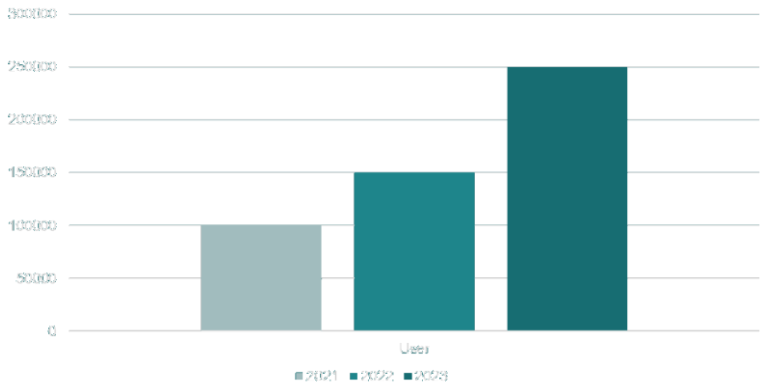

Figure 4 - Number of Users of Copernicus Climate Change Service

The observation data provided by both ESA and EUMETSAT witnessed significant uptakes in user engagement, indicating a growing reliance on these sources for essential information. Despite a slight decrease in generated data volume[38], the overall trend suggests a growing demand for observation data services.

The Emergency Management Service saw a growing demand in the number of users (from 158 367 registered users at the end of 2022 to 199 969 in Q3 2023). In 2023, it was activated 107 times. Activations of services such as Emergency Management and Security displayed consistent interest, with fluctuations likely reflecting evolving needs and priorities within these sectors.

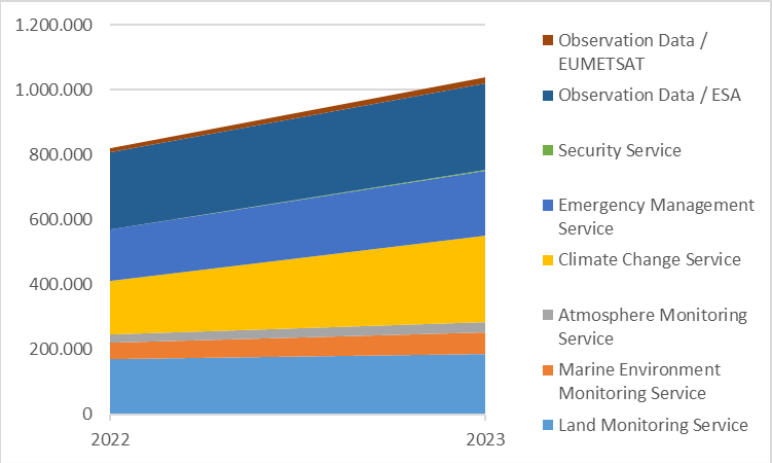

Figure 5 - Figure 3 - Number of registered users per Copernicus Service.
(Source reporting of Entrusted Entities to EC)

[38] Which could be explained by the decreasing need to download data as a result of the increasing processing of data in cloud environments

Overall, the constantly increasing number of users demonstrate a robust and expanding market for monitoring services, presenting abundant opportunities for innovation and growth in the coming years and highlights Copernicus' role in facilitating access to crucial Earth observation data and services, catering for a wide range of user needs.

Both Galileo and Copernicus showcase stable growth of user uptake across different sectors and high level of user satisfaction, which makes them integral components of global navigation and Earth observation systems. It is also important to highlight the possible synergies between Copernicus and Galileo that bring additional significant benefits and use cases. For instance, in precision agriculture Galileo provides accurate positioning, complemented by Copernicus data for insights into crop health and weather patterns, thereby enhancing farming efficiency. Similarly, in disaster management, Galileo provides support to emergency responders, while Copernicus data help disaster monitoring and improve response efforts. These examples illustrate the power of combining precise positioning with comprehensive Earth observation data for societal benefit, stressing Copernicus' pivotal role in facilitating access to crucial Earth observation data and services, catering to a wide range of user needs and interests.

Despite the very advanced progress of the overall uptake levels, the operational use of Galileo, EGNOS and Copernicus varies across market segments, application areas, geographies, and user communities. Geographic disparities in uptake are linked to investments in space-related activities and a broader focus on innovation in different value chains.

This **summary of the dynamics characterising the current state of uptake** is complemented by Table 2 below and further details in **Annex 2**. However, the **differences between Copernicus, on the one hand, and Galileo and EGNOS, on the other hand, add a layer of complexity when assessing user uptake.** These distinctions highlight the limitations of grouping them together when summarizing the diverse range of technologies and their adoption levels across organizations. Each component carries unique features and applications, necessitating a nuanced understanding of their individual contributions to the EU space program.

Table 2 Overview of Copernicus and Galileo, EGNOS level of uptake

Segment / uptake	Agriculture	Aviation and Drones	Climate, environment, and biodiversity	Consumer Solutions, Tourism, and Health
Copernicus	One of the most advanced segments but **uptake varies depending on the use cases and target user group.** Major uptake for policy, nation- and regional-wide monitoring (e.g. food security monitoring), Uptake polarisation amongst farmers for precision farming: Big farmers with higher uptake, and full awareness vs small to medium size farmers with low uptake. While Copernicus data is essential and widely used by Member States for CAP monitoring and subsidy checks, including climate-environment indicators, there is a potential for the further uptake of CAP-related applications and CAP-compliance tools at the farmer level and within regenerative agriculture.	**Minor uptake** by aviation and drone stakeholders. Some airports use it to support their compliance with ICAO Standards and Recommended Practices for aeronautical information and aerodrome mapping. Copernicus Sentinels, together with CAMS and C3S services can be used to support atmosphere composition monitoring and detect hazardous weather conditions. Airlines show interest in using Copernicus for predictive maintenance. Pioneer drone operators and ANSPs use Copernicus to support understanding of the dwellings and population density, which helps planning the routes to avoid densely populated areas and for developers to strategically plan infrastructure such as vertiports.	***Major* in climate services** where Copernicus data is a key input for climate models and climate risks assessments. Major for atmospheric monitoring, for example for daily air quality forecasts broadcasted to the broad public. In the environment segment, EO major use by public authorities, researchers, and downstream services (e.g. Sustainable Development Goals). However, further standardisation is encouraged by standardisation bodies like the Task Force on Climate-related Financial Disclosures (TCFD) and Task Force on Nature-related Financial Disclosures (TNFD), facilitating the integration of EO data into financial and business frameworks. At corporate level, large companies are starting to use Copernicus to disclose various types of information for environmental reporting and impact assessment, considering also the CSRD, CSDD, and ESRS. In the biodiversity segment, uptake is at the initial stages, seeing use cases such as ecosystem monitoring in conservation and restoration projects.	**Minor uptake**. There is small, but growing, awareness of the potential of EO data, including Copernicus, with growing number of applications under development.
Galileo, EGNOS	**Major uptake.** Farmers are relying on satellite-based technologies, alongside other innovative technologies, to optimise the efficiency and effectiveness of the various daily activities they perform on their fields.	**Major Galileo uptake in drones**, included in most receiver models supporting navigation and electronic conspicuity. Best use of EGNSS support higher risk operations under development. All instrument runways to implement EGNOS by 2024. Galileo will be used as part of DFMC scenario, augmented by EGNOS next version, and as part of A-RAIM concept. **Major EGNOS uptake** in drone and aviation applications, coupled by pervasive implementation of EGNOS procedures by airports and heliports, driven mainly by the PBN regulation.	**Minor uptake with limited applicability of GNSS** to this segment. Very specific techniques, such GNSS reflectometry and radio occultation are used for the support of climate modelling. GNSS is also used for biodiversity animal tracking.	**Major uptake**. Galileo managed (because of its performance and supported by the E112 legislation) to become rapidly the constellation alongside the pre-existing ones onboard smartphones. Limited relevance of EGNOS in the segment.

Segment / uptake	Emergency Management and Humanitarian Aid	Energy and Raw Materials	Fisheries and Aquaculture	Forestry
Copernicus	**Major uptake**. The components of the Copernicus Emergency Monitoring Service and related systems (On-demand mapping component and Early Warning component, compiled from the Forest Fire Information System (EFFIS), the Flood Awareness System (EFAS) and the Drought Observatory (EDO), see significant uptake in Europe.	**Varied depending on domains and sub-domains**. **Major** in solar energy, as practically all solar energy stakeholders use Copernicus in their day-to-day operations. **Medium** uptake in wind energy, as only a handful of the wind practitioners are convinced of the added value. **Medium uptake** in the Raw Materials segment, with some mines using Sentinel-1 and Sentinel-2 to support monitoring e.g. slope stability. The Critical Raw Materials Act and the Battery Regulation are setting goals for more transparency on metals value-chains and the need to measure independently the environmental impact of mining activities. Those two legislations will represent an important driver for uptake in the coming years.	**Minor uptake.** At institutional level, authorities understand that EO is key in sustainable fish stock management. At commercial lever, the use of EO data is becoming more important in catch optimisation, fish stock detection and aquaculture operations productivity improvement, as the fishing and aquaculture industries are under efficiency and sustainability pressure.	**Medium uptake.** Copernicus supports forest monitoring for the benefit of the climate, the environment and natural resources Uptake of solutions by several early adopters, expected to lead to more widespread uptake by the industry. Wildfire detection is particularly well advanced, while other applications (e.g., disease monitoring) are less prominent. In addition, the EUDR is impacting widely the market driving the uptake for deforestation free supply chain monitoring of several commodities including cocoa, soy, coffee, rubber and palm oil. Another promising area for uptake, is the carbon removal certification for nature-based solutions such as forest restauration.
Galileo, EGNOS	**Major uptake.** Galileo is an essential contributor to the COSPAS-SARSAT Programme. Galileo differentiators such as the search and rescue service, and the Return Link Service (RLS), as well as the upcoming Remote Beacon Activation (RBA) and Two-Way Communication (TWC) services provide essential contributions to the global network of emergency response. From a device point-of-view, the estimated penetration of Galileo amongst new shipments is growing towards 100% in the various categories of Search and Rescue beacons.	**Varied depending on domains.** *Major* in energy, with penetration of Galileo in the units (PMUs) used to support energy grid synchronisation. *Progressing* in raw materials, as the uptake of EGNSS across the world in open pit mine applications is expected to grow over the next decade.	**Major uptake, with room for increase**. Galileo is widely adopted in Automatic Identification System (AIS) receivers, whilst it sees a much lower uptake in the Vessel Monitoring System (VMS) (2023 figures are estimated at +60% vs. +15%).	**Major uptake**, driven by machinery guidance applications. The uptake of Galileo in new shipments is prominent and soon expected to reach 100% by 2026.

Segment / uptake	Infrastructure	Insurance and Finance	Maritime and Inland Waterways	Rail
Copernicus	**Medium uptake**. The use of EO data is progressively penetrating infrastructure management activities at all stages of the infrastructure life cycle, from the initial site selection and planning to the assessment of infrastructure environmental impact and the regular monitoring of construction operations. EO is also instrumental to ensure proper situational awareness (e.g. for natural/man-made disasters, threats of any nature.) once the infrastructure is operational, which is key for a reliable management of critical infrastructures. Several public authorities and constructions companies have already adopted InSAR solutions powered by Copernicus Sentinel-1.	**Medium uptake**. Some service providers in this segment use the Climate Change Service (C3S), more specifically the Climate Data Store (CDS), to assess climate change impacts on biodiversity, risk management for commodity trading, and sustainable water management. The Copernicus Atmosphere Service (CAMS) and Land Service (CLMS) are also used by the insurance sector for support on climate, weather-related footprint, drought, agriculture index-based insurance and risks assessment.	**Major uptake.** Copernicus sees significant uptake in specific application such as ship routing, inland waterway navigation, surveillance, detection of offshore 'dark vessels', and oil spill detection.	**Minor uptake.** There is a reasonable degree of initial awareness of EO within the industry, for infrastructure monitoring purposes, However, the level of actual uptake is low, and limited to a few prototypes and use cases.
Galileo, EGNOS	**Major uptake** of Galileo across both subsegments within this segment (construction monitoring and synchronisation). All applications related to the construction and monitoring of infrastructures are assumed to be around 50% enabled by Galileo, at least as a back-up timing provider. The same holds for telecom infrastructure relying on GNSS for their timing and synchronisation.	**Major uptake.** Driven by the MiFID II directive, the uptake of EGNSS across European shipments of GNSS receivers for timing has gone up steadily over the past years and is foreseen to grow to full penetration. Another driver of the interest in EGNSS amongst users are found in the Galileo differentiators such as OSNMA.	**Major uptake.** Since 2016, Galileo has been recognised by the International Maritime Organisation (IMO) as a part of the World-Wide Radio Navigation System (WWRNS), earning Galileo the necessary IMO wheel mark as a GNSS that can be used for maritime navigation. Since then, Galileo uptake has steadily increased. Uptake is also high for EGNOS-enabled receivers for SiS, as well as equipment receiving EGNOS retransmission via shore infrastructure. The new EGNOS maritime service supports IMO Res 1046.	**Major** Galileo uptake amongst rail non-safety critical applications such as passenger information systems and asset management, as well as for the safety critical applications such as driver advisory systems (DAS) and trackside personnel protection systems. EGNOS is also widely supported across all non-safety critical applications.

Segment / uptake	Road and Automotive	Urban Development and Cultural Heritage	Space
Copernicus	**Medium uptake** of the use of Copernicus for the infrastructure management, where early adopters among road network operators and construction companies use the CLMS EGMS component and Sentinel-1 data through InSAR techniques to support ground motion monitoring. High interest in Copernicus for infrastructure planning and climate informed decision-making process. Further, the Copernicus Climate Change (C3S) weather forecasts are used by in-vehicle infotainment systems providers to provide weather alerts.	**Medium uptake** of Copernicus data and services. Specifically, Copernicus supports urban planning and monitoring through its satellite and in situ data as well as through its services such as the Copernicus Land Monitoring Service (CLMS) (i.e., with its Urban Atlas). Beyond this, various European municipalities are monitoring the air quality in cities through products powered by CAMS.	**Not relevant**
Galileo, EGNOS	**Major uptake.** The adoption of EGNSS as we have seen in Europe is very widespread in Europe and worldwide. Car manufacturers using GNSS applications relying on a multi-constellation and multi-frequency is considered for connected and automated driving. Galileo is included in almost all new vehicles being put on the market due to a combination of legislation (e-Call and Smart Tachograph) and commercial interest. The ITS Directive refers to Galileo, EGNOS and Copernicus.	**Major uptake** due to the need for high accuracy positioning information across all surveying activities, EGNSS is estimated to have reached 100% penetration across annual shipments for any surveying-related application.	**Major uptake.** Galileo is expected to see an increased uptake amongst GNSS receivers for high navigation requirements and scientific payloads. High interest in Galileo differentiators such as HAS, for precise orbit determination. An upcoming differentiator compared to other GNSS is the upcoming Galileo Space Service Volume (SSV).

3.4 The importance of user uptake in the context of the Green Deal

The EU space program data and services contribute to the achievement of various political priorities. However, given the political importance and the high level of ambition of the European Green Deal policies, this chapter focuses on the use of space data and services for achieving the environmental and climate objectives. Initiatives like Copernicus, Galileo, and EGNOS play a crucial role in advancing the EU's fair twin transition towards a more sustainable and digitally driven future. The use of EU Space data and services is often instrumental to advancing the objectives of the Green Deal, as explained below.

Reaching the EU's climate ambition for 2030 and 2050: Copernicus provides key information for climate neutrality and resilience. All Copernicus Services contribute to this objective, but the Copernicus Climate Change Service (C3S) is of particular relevance in this context. This Service provides unique climate information, covering the past, present, and future situation to support adaptation and mitigation strategies. The Copernicus Land Monitoring Service (CLMS) provides essential input for the updated Land Use, Land-Use Change and Forestry (LULUCF) Regulation, e.g. serves as a means of monitoring and verification of land-based EU carbon removal certificates. Moreover, the use of Galileo-enabled navigation and routing can contribute to reducing emissions not only in road but also in aviation, maritime and rail transport.

Supplying clean, affordable, and secure energy: The Copernicus atmosphere monitoring, marine environment monitoring, land monitoring, and climate change services deliver state-of-the-art information for potential location of renewable energy generation, such as solar radiation, waves and currents, winds, or hydrology. The combined information from these various sources enables an efficient management and planning of solar generation, wind farms or wave energy locations and help optimising the energy mix in near real time as well as informing long-term investments.

Galileo contributes to a safe and efficient functioning of energy infrastructure. Energy companies are increasingly using smart grids to improve efficiency and reduce costs. The smart grids are based on the integration of digital communication, sensors, and process automation. Accurate synchronisation is essential for the correct functioning of the grids, and this is where Galileo plays a fundamental role in supporting real-time monitoring of the grid. Moreover, leveraging the services of Galileo and EGNOS alongside other tools, such as drones or inspection operations of wind farms, can be carried out remotely, which has benefits in terms of speed, cost-effectiveness and enhanced safety for the personnel.

Mobilising industry for a clean and circular economy: Multispectral image analysis from the Copernicus Sentinel imagery, and in the future hyperspectral images from the CHIME mission, can be used for the identification and localisation of raw materials at the Earth's surface, supporting the EU objectives set out in the Critical Raw Materials Act. The Copernicus Atmosphere Monitoring Service (CAMS) provides near real-time detection of unwanted methane leaks over fossil fuel production sites and basins. Sentinel imagery can be used to detect waste dumps by spectral anomalies of the outgassing. These Copernicus contributions are mentioned in the Commission's proposal for the Net-Zero Industry Act as relevant for

accelerating a circular economy and assessing the impact on the global greenhouse gas concentrations and fluxes.

Galileo-enabled location-based services can be used throughout the industry to track and optimise operations (e.g. fleet management). This leads to emission reduction and cost saving.

Building and renovating in an energy and resource efficient way: Copernicus comprehensive data allow optimised building design resilient to climate change. Copernicus surface temperature and wind data help analyse the heat losses and related insulation efforts over built areas, supporting the EU's environmental impact assessment directive, which requires that the impact of infrastructure projects on the environment be thoroughly assessed and monitored. Emissions from buildings can also be estimated based on Copernicus data and can be mapped at high resolution with the aid of the future thermal satellite mission (LSTM).

Furthermore, Copernicus Sentinel imagery allows identifying buildings at risk due to coastal erosion and coastline changes, landslides, storm surges, extreme winds, or flooding. The images can also be used for the identification and analysis of green roofs in an urban environment. This way, Copernicus supports the New European Bauhaus initiative launched in 2020 aiming at creating sustainable and inclusive living spaces.

Accelerating the shift to sustainable and smart mobility: Space-enabled smart mobility became an important aspect of the EU transport system. The Copernicus Maritime Service (CMEMS) provides shipping companies with up-to-date information on sea ice, allowing for more efficient maritime transport routes. Similarly, the Copernicus Atmosphere Monitoring Service (CAMS) provides information on the precise location of high wind speed zones, allowing planes to benefit from more efficient travels. The monitoring of vegetation growth using Copernicus data allows for good management of railway tracks and protects trains from derailing. The maritime surveillance by the Copernicus Security Service (CSS) supports clean and safe navigation at sea by detecting oil spills and combatting marine pollution.

Galileo facilitates the monitoring of mobility across a variety of networks, thus contributing to the reduction of emissions and the optimisation of resources. In the road transport sector, GNSS applications are already widely adopted, as they improve the performance of vehicles in terms of safety, costs, and sustainability. The use of satellite navigation systems has shown potential to reduce journey times by around 10%, contributing to the reduction of emissions. In addition, Galileo services are leveraged by the automotive industry to ease the fair transition towards connected and automated driving. In the aviation sector, GNSS-enabled Performance-Based Navigation (PBN) has been a breakthrough as EGNOS allows to draft more direct paths between destinations, prioritising performance, hence, lower use of fuel and emissions.

Preserving and restoring ecosystems and biodiversity: The Copernicus Land Monitoring Service (CLMS) and the Copernicus Marine Environment Monitoring Service help monitoring the state of terrestrial and marine ecosystems and biodiversity at global and European scale. Copernicus

supports the implementation of the EU Biodiversity Strategy for 2030[39] by ensuring systematic monitoring of important biophysical parameters such as the dynamics of vegetation and the evolution of ecosystems. The EU Forest Strategy for 2030[40] highlights the role of Copernicus in ensuring high-quality and timely data on forests. It also commits the Commission to develop its own geospatial intelligence capacity for environmental compliance assurance, which will contribute to the implementation of the future monitoring framework for resilient European forests. Copernicus satellite data can provide information on vegetation cover and land cover changes, which can help identify areas of deforestation or forest areas impacted by disturbances and stressors. This data helps implement a variety of policies, such as the EU Regulation on deforestation-free supply chains[41] that requires the suppliers to present the geolocation coordinates of the land plot where the product is harvested or produced.

The **Sustainable Blue Economy Strategy**[42] represents a crucial framework for sustainable development, emphasising the responsible use of ocean resources to foster economic growth. Copernicus, Galileo, and EGNOS play pivotal roles by providing advanced EO, satellite navigation, and positioning services. Copernicus offers accurate and timely data on marine environments, supporting maritime surveillance, environmental monitoring, and resource management. Galileo ensures precise positioning and navigation capabilities at sea, enhancing the safety and efficiency of maritime transport and activities. Additionally, EGNOS contributes by augmenting GPS signals, further improving the accuracy of positioning information in maritime applications. Together, these EU Space Programme components contribute significantly to the realisation of the Maritime and Blue Economy Strategy[43], promoting sustainable practices and unlocking the full potential of our oceans for economic prosperity.

A zero-pollution ambition for a toxic-free environment: Copernicus contributes to monitoring air pollution, improving air quality, and implementing the overall "Zero Pollution" Strategy[44]. The recently proposed Revision of the Ambient Air Quality Directive[45] invites Member States to exploit the information products and additional tools provided by the Copernicus Atmosphere Monitoring Service (CAMS). Copernicus data furthermore supports efforts towards zero urban pollution and Copernicus is widely used in reporting and analysis, such as the European environment and health atlas: CAMS data is already used as part of the European Air Quality Index hosted by the EEA. European-level remote sensing data also has the potential to assess natural contributions to air pollution, as well as forecasting peak pollution events (especially where these result from reactions in the atmosphere).

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[39] European Union Biodiversity Strategy for 2030.
[40] New European Union Forest Strategy for 2030.
[41] European Union Regulation on Deforestation-free products.
[42] EUR-Lex – Document 52021DC0240.
[43] See note 40, page 31.
[44] European Union Zero pollution action plan.
[45] Revision of the Ambient Air Quality Directive.

4 Promoting user uptake at EU level

A successful and widespread adoption of Galileo, EGNOS or Copernicus-based data, services and solutions relies on the active involvement and collaboration of the key stakeholders. These stakeholders have been striving to catalyse adoption by working closely with both the demand (understanding user requirements, documenting barriers for adoption, developing capacity, raising awareness, etc.) and the supply (fostering innovation, providing means for better exploitation of the programmes, etc.) sides. Moreover, the uptake of EU Space data and services by stakeholders was instrumental in fostering the emergence and growth of an environment overall conducive to uptake, the establishment of a well-developed ecosystem of stakeholders and the creation of new markets. The roles and responsibilities for promoting the user uptake of Copernicus, Galileo and EGNOS data and services are presented below.

4.1 Key enabling actors, Copernicus

For Copernicus, the efforts to promote the adoption of data, services and downstream solutions are conducted by the actors involved in the implementation of the programme (EC, ESA, EUSPA and the Entrusted Entities), by Member States, by associations and within individual projects or initiatives. In addition, industry is promoting EO-based solutions across the various market verticals.

- **European Commission**

The EC has been driving many activities aimed at promoting the uptake of Copernicus data. This includes the implementation of Annual Work Programmes that lay out budgets and actions dedicated to support user uptake (e.g. Copernicus Support Office, the Copernicus Relays and Copernicus Academy Networks). This entails the supervision and coordination of the work of the Entrusted Entities as well as close collaboration with ESA and EUSPA; and liaison with the Member States through the Copernicus User Forum.

Commission services collaborate to incorporate space in sectorial regulatory initiatives (e.g. on Deforestation-free supply chains or Carbon Removals), launches platforms that facilitate the use of Copernicus data and studies user uptake by public administrations and other users through the Knowledge Centre on Earth Observation (KCEO)[46][47].

Finally, the Commission promotes the EU Space Programme internationally via space diplomacy initiatives and industry cooperation, such as the EU Global Action on Space or the Global Gateway, to address shared challenges and promote a cooperative, sustainable, and responsible use of space.

[46] https://knowledge4policy.ec.europa.eu/earthobservation_en

[47] THE KCEO is co-led by DG DEFIS and the JRC, and steered by a steering group comprising (13) additional policy DGs

- **EUSPA**

EUSPA has the leading responsibility for market development of Copernicus with primary focus on "other Copernicus users", meaning commercial users in the downstream industry. In this capacity, EUSPA has recently launched new activities such as the Copernicus Demonstrators, achieving initial adoption in most downstream market segments. EUSPA is also managing a part of the portfolio of Horizon Europe calls supporting the development of innovative solutions based on Copernicus, with an important business and market focus, reaching a significant number of proposals in recent calls. EUSPA carries out regular market analysis, published through documentation including the periodic EO & GNSS Market Report,[48] with the objective of monitoring the development of EO and the related downstream market segments. The market intelligence reports support the investments in the EO downstream segments, enabling the forecasting of revenues of companies active in this area. Moreover, EUSPA implements the actions stemming from the entrepreneurship initiative Cassini that supports start-ups and Small and Medium-sized Enterprises that use of Copernicus data. This includes actions such as prizes[49], competitions, hackathons, matchmaking and capacity building focused on entrepreneurship. Within Cassini a dedicated prize was launched in 2022 for the detection and removal of plastic in waters using Copernicus data. The annual Cassini Challenges award up to 40 companies developing the most innovative solutions using Copernicus data.

- **Entrusted Entities**

The Entrusted Entities are responsible for the management and implementation of the Copernicus services. They promote user uptake at the level of services and cross-cutting (e.g. Mercator Ocean International promoting CMEMS for aquaculture, ECMWF running demonstrators to attract non-space actors). Since 2021 their focus is on the core users.

- **ESA**

ESA launched numerous initiatives and projects supporting uptake of Copernicus services and EO-based solutions in general. For instance, through the programmes falling under EO Science for Society and under Space Solutions, ESA supported the demonstration of operational EO services and their uptake by different users across a wide variety of application areas (e.g. vegetation monitoring, climate forecasting or air quality monitoring).

- **Member States**

Whether through their own funds and programmes, or through EC-coordinated initiatives, Member State authorities have been driving a number of activities with a clear focus on promoting the user uptake of EO and Copernicus. This includes the COP4SDG in Germany, COMAP in Italy or the G4AW in the Netherlands. As an example, based on the COP4SDG,

[48] https://www.euspa.europa.eu/european-space/euspace-market/gnss-market/eo-gnss-market-report.
[49] A dedicated Cassini prize was launched in 2022 for the detection and removal of plastic in waters using Copernicus and the annual Cassini Challenges award up to 40 companies developing the most innovative solutions using Copernicus data.

Copernicus would be beneficial for the completion of several UN SDGs such as those related to access to food, water, health, energy, to the development of sustainable cities and climate action, and to the protection of marine and on-land biodiversity.

- **Non-Governmental Organisations and industry associations**

The European Association of Remote Sensing Companies (EARSC) is the most active association in market development activities. It launched multiple activities with a great impact to serve the interests of its members. They are often supported by EU R&D Framework Programmes or ESA funds. Similarly, NEREUS and EURISY support "softer" activities, such as workshops and publications, which help to open doors for the engagement of user communities. Several associations with sectorial focus are also actively involved in the promotion of EO solutions for their own application areas (e.g. COPA-COGECA, Wind Europe).

- **Projects and Initiatives**

Coordination and Support Actions (e.g. FIRE) and large flagship projects (e.g. e-shape, NextGEOSS) fostered the engagement of non-space actors who can benefit from the use of EO solutions, are developing platforms, marketplaces, fora that can help market development, or are supporting the evolution of Copernicus services in light of new user needs. Moreover, many of the Innovation Actions explicitly seek to bring certain solutions to the market. .

- **Industry**

EO service providers and Information Providers promote the adoption of solutions that rely on EO data in different user communities. This entails direct business-to-business promotion and sales but also capacity development activities (e.g. organising webinars for practitioners within user communities). Often such efforts are supported by associations such as EARSC or by projects and initiatives funded by Copernicus implementing actors.

4.2 Key Enabling actor Galileo and EGNOS

- **European Commission**

The Commission played a key role in the development and implementation of legislative or regulatory initiatives to introduce the use of Galileo/EGNOS in various segments, as well as in participating in international regulatory and standardisation fora. To ensure the adoption of EGNSS in different domains. The Commission ensures the necessary coordination, for instance, on the eCall legislation to address the update of type approval, Safety Answering Points (PSAPs), the message format and the telecom network.

As for Copernicus, the Commission also drives the international adoption of Galileo and EGNOS through Global Gateway and the EU Global Action, but mainly through cooperation with international regulatory and standardisation organisations, looking to promote the interoperability of Galileo/EGNOS with other systems (see section 4.2.2).

- **EUSPA**

EUSPA supports Galileo and EGNOS user uptake through different actions, by providing market intelligence, and technical know-how to innovators, academia, start-ups, and SMEs. The agency leverages Horizon Europe, other EU funding, as Fundamental Elements and innovative procurement mechanisms. As with Copernicus, EUSPA's market analysis cover Galileo/EGNOS, mainly through the EO & GNSS market report which analyses the state of the GNSS downstream market to spread knowledge among users about innovative and effective GNSS applications. A major level of EGNSS adoption was achieved across most market segments in downstream via the integrated market development actions implemented by EUSPA in cooperation with the Commission.

- **Member States**

Member States can promote user uptake of Galileo and EGNOS either through their own projects or by participating in larger scale EU projects. Examples of these actions include DGT3.0 in Spain, the Lkw-Maut in Germany, SESAR and Smart-Agro monitoring in the Netherlands, and many others. Despite not being a solely EU project, the International Cospas-Sarsat Programme is worth mentioning as Galileo plays a role there in providing support for the Search and Rescue service (SAR).

4.3 Measures in support of user uptake

There is a large variety of actors involved in the promotion of user uptake of Copernicus, Galileo and EGNOS with a wide range of measures. Whilst all measures work towards the same direction, they have a specific **scope**, dedicated **means** deployed to support this scope and different **outcomes** (expected or achieved).

EUSPA follows a focused user-centric approach fostering the synergies between the EU Space Programme components. The measures to increase user uptake are tailored to the needs of each market segment and the potential benefits that Galileo, EGNOS or Copernicus can bring. This approach is based on three pillars:

- **Market and User Knowledge**: It covers a deep understanding of the market and technology trends per market segment, user needs and assessment of user satisfaction on the services provided, that lead to the identification of priority applications where EU space services/data provide most added value and benefits for European citizens. Examples of the actions under this pillar include the market analysis and monitoring activities implemented through the publication of EUSPA EO and GNSS Market Report and the user needs and requirements analysis implemented through the User Consultation Platform (UCP).
- **Demand support**: It implements measures to aggregate demand with tailored strategy per vertical market, fostering large scale adoption, through the development of pilot projects demonstrating suitability, scalability and replicability; identification of gaps and

opportunities; addressing standards, certifications, regulations and fostering best practices; facilitating access to EU space data and services; and the creation of dedicated user/industry groups that promote, among others, awareness raising actions.

- **Offer creation**: Supporting the creation of products and services made in Europe, for applications (and receivers in the case of Galileo and EGNOS) via the EU funding programs and opportunities made available to companies and start-ups, with the objective to strengthen the positioning of the EU industry through innovation and early uptake. These programmes include Horizon Europe, Fundamental Elements, grants, Cassini entrepreneurship tools and innovative procurement.

A summary table below presents examples of measures implemented to support user uptake. The measures are grouped by activity area.

- **User centred development of the EU Space Programme components:** encompasses actions with primary focus on identifying the needs and requirements of the downstream sector of end-users, with the objective to ensure the development of effective and user-driven services and applications. The overall user and policy needs have been set out by the Commission. For Copernicus, the user policy and needs are outlined in the SWD (2019) 394 final[50], the Commission Implementing Decisions (EU) 2018/620[51] and 2018/621[52]
- **Legislation**: groups actions that involve the development and implementation of measures that introduce space-based services and applications into relevant regulations, promoting compliance and alignment with societal or strategic objectives
- **Standardisation**: encompasses activities directed towards establishing and maintaining agreed specifications. This effort aims to improve the interoperability, a crucial aspect of standards development, for space-based applications and services provided by Galileo/EGNOS and Copernicus. Standards play a pivotal role as essential tools for applications that are vital for safety.
- **Support to industry**: brings together those activities focused on boosting the use of space-based services and applications among the industry players.
- **Support to users and awareness**: activities focused on bringing the applications closer to the end-users, including raising awareness and knowledge how to use them.

Each type of activity is discussed in the section below, followed by an overview with examples.

[50] Commission Staff Working Document (2019) 394 final.
[51] EUR-Lex - Document 32018D0620.
[52] EUR-Lex - Document 32018D06201.

Activity area	Objective	Activities	Examples of outcomes (expected or achieved)
User centred development	Develop and update space data and services based on user needs and requirements	Documentation of user requirements (via dedicated studies and surveys, User Fora, User Consultation Platform, FPCUP, etc.)	Development and specification of new space data services based on collected inputs (from new features in existing services to new satellite missions)
Legislation	Support adoption of space data and services by means of legislative requirements	Creation of new legislation or update of existing legislation to include requirements for the use of Copernicus	Full perspective adoption of EGNOS and Galileo achieved through road and emergency legislation (eCall, Tachograph, E112). Copernicus soon required to be used for the implementation and monitoring of national Common Agricultural Policy (CAP).
Standardisation	Integrate space data and services in key societal or business processes	Collection of best practices on how to integrate space data in operational processes	Promotion of the operational use of Navigation solutions (e.g. Galileo/EGNOS-based positioning for ITS) and EO (e.g. by ESA for Global Development Assistance activities).
Support to industry	Facilitate the integration of space-based technologies within the industry	Support SMEs and industry in their development by facilitating the utilization of data and providing funding for the advancement and implementation of space-based solutions.	Entrepreneurship support through e.g. CASSINI EU Global Action on Space and Global Gateway for internationalisation ESA BICs Innovation procurement programmes e.g. BROADGNNS
Support to users and awareness	Analyse and promote the value of space data and services in different contexts and convey information relevant for all stakeholders	Cost benefit analyses (e.g. ESA SeBS), communication products, demonstration activities, programmes for skills development, targeted engagement.	Information dissemination e.g. Thematic Workshops, DEFIS Factsheets, EUSPA media library Demonstration of the real applications e.g. EGNSS4CAP Activities under the Pact for Skills Cross-Industry Reports, Value Chain Analyses

Figure 6 Summary of selected measures in support of uptake for Copernicus, Galileo and EGNOS

4.3.1 Documenting User Needs and Requirements

An essential step towards eventual adoption is the documentation of User Needs and Requirements, i.e. the users' needs, expectations, and preferences in relation to a system's performance and capacity. This process stems from understanding first the user needs in consumer, business or policy processes and activities, to determine if and how space solutions can have a role in fulfilling them. If this is the case, the more detailed assessment of user requirements enables to tune the value proposition of EU space data, products, and services to meet the business and technical expectations of users.

For Copernicus, the user needs of core users are being collected in the Copernicus User Forum. They have been captured by various study activities by DG DEFIS and the Commission's Knowledge Centre for Earth Observation co-led by DG DEFIS and the Joint Research Centre (KCEO)[53]. The resulting specifications have been prescribed in Commission Implementing Decisions (EU) 2018/620[54].

This process is typically at the basis of EU Space analysis and has been conducted in a systematic manner across different avenues. This entails dedicated studies for specific programmes (e.g. NextSpace on Earth Observation and studies on EGNSS evolution), analyses across all components tailored to each market segment (e.g. EUSPA Reports on User Needs and Requirements), individual sectors (ESA as part of Best Practices), service level efforts (e.g. by the

[53] See note 46, page 32. Add here a link to the KCEO.

[54] See note 45, page 31.

Entrusted Entities for the different components of the Copernicus Services). In particular, the User Consultation Platform (UCP) organised by EUSPA since 2017, systematically collects users' needs and requirements for EGNOS, Galileo and for Copernicus non-core users (as well as GovSatcom, IRIS, SST) in all target market segments. The UCP gathers users in annual meetings to agree on priority application areas and the required evolution of the services to meet the business expectations. The results and agreed conclusions are published into dedicated Reports, updated after each UCP edition, and assessed by the programme to feed new services.

The imperative for adoption is underscored by the necessity to align services with the evolving needs of various sectors. A crucial aspect involves continual updates to these services to ensure they effectively address user requirements. For instance, the development of the Galileo High Accuracy Service (HAS) is essential to meet the specific needs of the automotive industry in advancing autonomous vehicle technologies. The challenge of power consumption in consumer platforms discussed in the UCP led to the conceptualisation of a Galileo *quasi pilot* signal, that is under development. The increased need for reaction to emergency and natural disasters led to Galileo evolutions proposals, such as Emergency Warning satellite service and Search and Rescue remote beacon activation. In EGNOS, the UCP looked at the specific needs of rotorcraft users and approaches to non-instrument runways, which was reflected in updates of the Service Definition Documents. Longer term needs and evolution, such as the timing and drones that were also raised at the UCP are under analysis.

This commitment to user uptake is reflected in the R&D for evolution budget planning (e.g. through EU Research Framework Programme funded activities looking into the evolution of Copernicus Services or EGNSS offerings[55]), as well as R&D for User segment (e.g., the Fundamental elements[56] programme for EGNSS receivers).

4.3.2 Engagement of user communities and their key representatives

This entails activities that focus on the engagement of organisations within a user community that is or could benefit from Copernicus, Galileo or EGNOS powered solutions. The work may focus on engaging representatives of Member States to collect user feedback (e.g. Copernicus User Forum), establishing communities of practice (e.g. Copernicus Thematic Hubs), engaging first movers in different market segments (e.g. work done by EUSPA to promote Galileo, EGNOS and now Copernicus with key accounts), liaising with “gatekeepers” (e.g. industry associations that can open doors to a market or community) and conducting capacity building activities such

[55] Under Horizon2020, the European Commission established a dedicated budget for service evolution. This covers the H2020 mission evolution studies which focus on the development of Galileo and Copernicus (e.g. H2020 mission evolution studies to assess how the future evolution of European GNSS (EGNSS) could be beneficial for innovative and demanding autonomous applications).

[56] Fundamental Elements is an EU R&D funding mechanism supporting the development of EGNSS-enabled chipsets, receivers and antennas. Further information is available at the EUSPA website.

as workshops or trainings (e.g. all the "Copernicus for X" workshops where X can be raw materials, forestry, fisheries, etc., or the EU Space academy implemented by EUSPA).

EUSPA and the European Commission participate in user community events (e.g. Agritechnica, Mobile World Congress, ITS European Congress) and often organise events, such as the EU Space Week and the User Consultation Platform (UCP). Moreover, EUSPA is active member of dedicated sectorial user associations and working groups (e.g. European Regional Airlines-ERA, International Association of Marine Aids to Navigation and Lighthouse Authorities-IALA, International Association for Public Transport Authorities-UITP). The EU Space Week is an annual event that brings together key players in the space sector, including public authorities, industry representatives and end users. The UCP consists in a series of meetings between the users of the space-based services per market segment and EUSPA with the objective to collect user needs and requirements to guide the evolution of the EU Space Programme.

4.3.3 Legislation and standardisation

The integration of EO and GNSS in informing EU policy and legislation often results in the inclusion of specific provisions regarding the role of EGNSS or Copernicus. This approach facilitates compliance with regulatory requirements and alignment with legal standards. Legislators collaborate with competent authorities at the Member State level (e.g., paying agencies, environment agencies, road authorities) and providers who demonstrate the capabilities of EO and GNSS through projects and demonstrators.

Some **non-exhaustive examples** of legislative initiatives that encourage businesses and public entities to use EO and GNSS are:

- **Monitoring Framework for resilient European forests.**[57] The objective is to establish an EU-wide integrated forest monitoring framework, using remote sensing technologies and geospatial data integrated with ground-based monitoring, which will improve the accuracy of monitoring.
- **Forest Monitoring Law**[58]: The Regulation on a Monitoring Framework for Resilient European Forests is one of the first legal acts that requires for forest monitoring systems the collection of forest data based on aerial or space-borne ortho-imagery, by Copernicus Sentinel satellites or other equivalent systems.
- **EU Regulation on deforestation-free supply chains**[59]**.** This legislation guarantees the consumption of products coming from deforestation-free supply chains. It requires

[57] Register of Commission Documents.
[58] Commission Proposal for a Regulation on a Monitoring Framework for Resilient European Forests, COM(2023) 728 of 22 November 2023.
[59] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1115&qid=1687867231461

economic operators to present due diligence statements before placing relevant products on the EU market. These statements should contain information about sources, suppliers, and the geolocation coordinates of the land plot where the relevant product was harvested or produced. Thus, geolocation coordinates that rely on timing, positioning or Earth observation could make use of space data and services delivered under the EU Space Programme.

- **Farm to Fork Strategy[60]:** This strategy links the Common Agricultural Policy and the EU Strategy for Data by promoting the use of EU space services for the achievement of the set objectives. The use of nature-based, technological, digital, and space-based solutions can help deliver better climate and environmental results, increase climate resilience, and optimise the use of inputs, for instance by use of space technologies for the application of precise fertilisation techniques and sustainable agricultural practices, measures that will be included in the Member States CAP Strategic Plans. The Bioeconomy Strategy[61]also recognises the benefits of the use of Copernicus data.

- **CAP Strategic Plans and the provision of information for monitoring and evaluation Regulation[62]:** The regulation establishes a standardized framework for monitoring and assessing the accomplishments of the Common Agricultural Policy (CAP). It outlines precise guidelines regarding the data Member States must gather to facilitate the development of suitable IT tools and collection systems. As of January 1, 2023, Member States are mandated to adopt an Area Monitoring System for all area-based aid interventions, predominantly relying on Copernicus Sentinel satellite data. This system is of extreme importance as effectively tracks a substantial portion of EU expenditure.

- **Maritime Security Strategy Action Plans[63]**: These plans have as one of the priorities the promotion and creation of an extensive maritime situational awareness framework at national and EU level. This would be achieved by enhancing connectivity among various existing surveillance systems, which would also involve maximising the capabilities provided by Copernicus, Galileo and EGNOS to align with the specific needs and standards established for the activities related to maritime security.

- **Common Fisheries Policy[64]**: several technologies and digital tools have been implemented in the fisheries sector such as national Electronic Reporting Systems (ERS) and satellite and non-satellite-based tracking of vessels.

- **eCall[65]:** It is an in-vehicle 112-based emergency system, which places a 112-emergency call automatically to the nearest emergency centre when a vehicle suffers a serious road

[60] European Union Farm to Fork Strategy.
[61] A sustainable bioeconomy for Europe Updating Bioeconomy Strategy.
[62] Common framework for monitoring and evaluating the Common Agricultural Policy (CAP)
[63] Maritime security strategy - European Commission (europa.eu)
[64] Common fisheries policy (CFP) - European Commission (europa.eu)
[65] EUR-Lex - Document 32015R0758.

accident or activated manually by pushing a button. Thanks to GNSS positioning (compatible with EGNOS and Galileo), a minimum set of data (MSD) containing vehicle location information is sent to the nearest Public Safety Answering Point. The eCall system is mandatory for all new type cars and light vans since 31 March 2018.

- **E112[66]:** It is a location-enhanced version of the 112-emergency service, in which when a call to the 112-emergency number is placed from a smartphone, the location information of the caller, based on at least EGNSS, is automatically transmitted to the nearest PSAP. Using Galileo significantly improves the accuracy of the caller location (up to 16 metres with GNSS versus approx. 1,6 kilometres with Cell-ID). Given that most emergency calls in the EU are made from smartphones, the EU mandated Galileo compatibility of all smartphones placed on the EU market from 17 March 2022

- **Smart Tachograph[67]:** The Mobility Package I[68] introduced the second-generation tachographs with new features, including the Open Service Navigation Message Authentication (OSNMA). Powered by Galileo and EGNOS, new tachographs automatically record the position and time of border-crossing and have ITS interface to enhance communication possibilities with external transportation systems. Now vehicles weighing over 3.5 tonnes used for transport of goods or vehicles designed to carry more than nine people (including driver), must be equipped with a tachograph. From 1 July 2026, this will apply also to lighter vehicles between 2.5 and 3.5 tonnes.

- **PBN Regulation[69]**: sets the obligation for all Instrument Runway Ends (IREs) to publish RNP Approach Procedures before 25 January 2024, including LPV minima line enabled by EGNOS. The regulation requires exclusive use of PBN after 6 June 2030, thus EGNOS will be the normal means to enable approach operations to CAT I minima.

- **A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe[70]**, lays out EU policy on large-scale commercial drone operations while offering new opportunities in the sector. The strategy makes specific reference to use EU space services and data (EGNOS, Galileo, Copernicus, Secure Connectivity).

- **Intelligent Transport Systems Directive[71]**: lays the framework for the deployment of Intelligent Transport Systems in the field of road transport and interfaces with other modes of transport, supporting the integration of EGNOS, Galileo and Copernicus.

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[66] EUR-Lex - Document 32019R0320.
[67] EUR-Lex - Document 32016R0799.
[68] https://transport.ec.europa.eu/transport-modes/road/mobility-package-i_en
[69] EUR-Lex - Document 32018R1048.
[70] A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe.
[71] EUR-Lex - Document 32023L2661.

Building upon existing successes, more initiatives are underway whereby EO- and Galileo/EGNOS-based solutions are acknowledged as key enablers for relevant policies.

4.3.4 Integration of EO or GNSS in operational processes and standards

The aim of these activities is to integrate EO or GNSS in societal or business processes. To do so, stakeholders are launching projects or collecting best practices of effective integration of EO or GNSS in operational workflows. A prime example is the sector-wide effort to promote the operational use of EO solutions[72] in official statistics, thus empowering the reporting of progress against the SDGs. Another example is the flagship activity carried out by ESA for the adoption of EO in Global Development Assistance activities.[73] The GNSS effort often involves standardisation initiatives, such as Galileo's recognition by IMO in the worldwide radio navigation system and the GNSS EN16803[74] series for positioning in Intelligent Transport Systems. Downstream standards focus on integrating GNSS signals into devices, services, and applications, ensuring compatibility and interoperability with other constellations and technologies. These standards play a crucial role in safety-related applications across various transport modes, including maritime, aviation, rail, and road (e.g. eCall).

4.3.5 Support to industry

4.3.5.1 Support to Entrepreneurship

Support to entrepreneurship entails activities that promote incubation of start-ups developing or implementing space data and services-based solutions, acceleration of their growth and scaling-up. Multiple initiatives are currently ongoing supported by the European Commission, EUSPA, ESA, the European Investment Bank (EIB) and the European Innovation Council (EIC). Many of the activities take place under the umbrella of the CASSINI Space Entrepreneurship Initiative, implemented by EC and EUSPA. The objective is to mobilise a budget of EUR 1 billion between 2021 and 2027 to invest in SMEs developing space technologies and digital services using space data.[75] The programme is open to companies active in upstream and downstream activities related to products and services driven by space data. It is implemented through hackathons, mentoring programmes, prizes and business accelerator.[76]

[72] See for instance the work done by UNECE, or the SEN4STAT project.
[73] Accelerating Impact, GDA, ESA.
[74] EN 16803-1:2016 - Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1.
[75] EU Space: Further cooperation to support space entrepreneurship in Europe.
[76] Space Entrepreneurship Initiative – CASSINI.

4.3.5.2 *Internationalisation Support*

Galileo and Copernicus, with their global coverage, are invaluable resources for businesses venturing beyond Europe. In recent years, numerous initiatives have emerged to assist companies in expanding their activities to international markets. The European Commission plays a pivotal role in fostering global collaboration in the space sector, engaging in activities such as supporting trade missions (e.g. TAIEX), capacity building (e.g. EU Technical Assistance Facilities) and set up the EU Global Action on Space and Global Gateway.

To enhance international relations, the European Commission actively deepens connections with non-EU states and other global players in the space domain. Strengthening these ties is crucial for operational reasons, ensuring the worldwide functionality of Galileo and Copernicus. Moreover, it facilitates the expansion of new EU Space Program components (IRIS2) to non-EU countries, supporting the global competitiveness of the EU Space ecosystem.

Concrete initiatives by the European Commission include:

- Space dialogues with major partners at both multilateral (African Union) and bilateral level (US, Canada, Japan).
- International actions under the Framework Partnership Agreement for Copernicus User Uptake (FPCUP), aiding companies in internationalising products and services based on Copernicus data.
- Foreign Partnership Instrument-funded actions like the 'Global Action on Space[77],' promoting EU space capabilities globally and facilitating market entry.
- Support for trade missions and capacity building efforts in non-EU countries.
- The Group on Earth Observations (GEO) co-chaired by the European Commission on behalf of the European Union together with the USA, South Africa and China connects government institutions, academic and research institutions, data providers, businesses, engineers, scientists and experts to create innovative earth observation derived solutions to global challenges[78]. With more than 115 countries and over 250 participating organisations, it represents a unique forum to promote Copernicus data and services.
- The EU Global Gateway[79] program, a significant instrument for fostering international cooperation by financing joint projects between EU and non-EU partners to address challenges in non-EU countries using EU space capabilities, encompassing the capacity building efforts carried out at national and regional level in partner countries with Neighbourhood, Development and International Cooperation Instrument (NDICI)[80].

[77] Connecting EU Space Globally.
[78] https://earthobservations.org/index.php
[79] Global Gateway.
[80] Neighbourhood, Development and International Cooperation Instrument – Global Europe (NDICI – Global Europe)

In parallel, ESA actively contributes through initiatives like the EO4SD programme for Copernicus data uptake, while EUSPA manages projects promoting industrial cooperation, through its involvement in the Horizon Europe topic 'Designing space-based downstream applications with International Partners'.

4.3.5.3 Implementation of innovation procurement

Innovative procurement is a catalyst of development and adoption of EO or navigation-based solutions, as well as for the growth of the industry. In recent years different types of innovative procurement including Pre-Commercial Procurement (PCP) and Dynamic Purchasing Systems (DPS) have been developed. For EO, prime examples of such efforts are the recent projects Marine-EO (concluded, funded by Horizon 2020) and PROTECT, a preparatory Horizon Europe action to be followed in 2024 by a Pre-Commercial Procurement (PCP) on end-user services in the area Climate Change Adaptation and Mitigation[81] ; the EC-driven H2020 OCRE which managed the procurement in bulk of cloud services (incl. for EO actors) and EO services for the research community; the DPS for the procurement of commercial EO data from Copernicus Contributing Missions[82]. For navigation, EUSPA manages the PCP BROADGNSS, a project that investigates exploiting the distinguishing features of EGNOS and Galileo signals to develop applications and monitor critical communication structures for emergency situations. EUSPA launched also a new PCP topic in 2022 within Horizon Europe call 'Public sector as Galileo and/or Copernicus user' and awarded in 2023 the project SPACE4CITIES that has the objective to make cities more resilient to climate challenges and more agile in reacting to constant changes using Galileo and Copernicus.

4.3.5.4 Platforms that facilitate access to and exploitation of data

In the case of Copernicus, the nature of the process of exploitation of EO data and its transformation to actionable information requires access to data-platforms allowing discovery, visualisation, manipulation, processing of the data, combined with the marketplace offering specific resources and expertise services. Platforms are increasingly adding new data analytics features to support the various needs of users with actionable pre-defined analysis algorithms allowing either advanced visualisation or building modular processing chain. Such platforms are provided by the programme (e.g. CDSE, WEkEO), Member States or industry. They may be specialised to address a specific domain or domain agnostics.

[81] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl6-2024-governance-01-5

[82] Dynamic Purchasing System (DPS) for Copernicus Missions (CCM) - Category 2.

4.3.6 Support to users and awareness

4.3.6.1 Awareness actions

The first step of all initiatives promoting uptake is **raising awareness among different stakeholder groups**. It is important to convey information that resonates with the specific stakeholder needs, considering their geospatial literacy and working language. Such efforts include (i) **active one to one targeted engagements** (e.g. EUSPA establishing key accounts among industry actors, EC internal coordination, (ii) **active one to many outreach activities** [83], and (iii) **one to many communications** (e.g. websites, publications, [84]

4.3.6.2 Demonstration of the added value of Copernicus and Galileo/EGNOS

Uptake of Copernicus and Galileo/EGNOS solutions is supported by a wide range of demonstration activities. They help bring together users and providers to test different solutions, often in an iterative process, with the aim to convert initial users into operational users. This is supported by R&D projects focussing on developing the downstream market.

As examples, for Copernicus, a large portfolio of Horizon 2020 and Horizon Europe projects has the focus on extending the use of Copernicus services and downstream solutions to non-space communities. Examples include the CMEMS Use Case Demonstrations, the C3S Demonstrator projects and the CAMS Use Cases. The Framework Partnership Agreement for Copernicus User Uptake provides a pool of impactful examples of Copernicus initiatives that have demonstrated their added-value.[85] For Galileo and EGNOS, EUSPA organises demonstration activities, mainly within Horizon and Fundamental Elements[86] projects, along with dedicated initiatives focused on the implementation of innovative use cases (e.g. EGNSS4CAP, a phone app that digitalises procedures to facilitate compliance with reporting requirements in the agriculture sector). EUSPA facilitates demonstration of new use cases of Copernicus via dedicated contracts with industry (e.g. Copernicus demonstrators[87]) or pilot projects with users to explore innovative use in operational scenarios (e.g. Copernicus for drone safety assessment by FlyingBasket)

4.3.6.3 Standardisation at user level

The EU Space Programme, via EUSPA, actively drive standardisation initiatives at the user level by participating in activities led by organisations such as Eurocae and IEC. Recognising the pivotal role of industry and user associations, the collaboration with these entities is core element of

[83] Copernicus Thematic Workshops. One example could be the Thematic Workshop on Energy.
[84] Some examples of this may be Copernicus - Europe's Eyes on Earth, the DG DEFIS factsheets on EU Space or EUSPA's newsroom and media library.
[85] https://www.copernicus-user-uptake.eu/user-uptake/applications
[86] Fundamental elements is an R&D funding mechanism that supports the development of EGNSS enabled chipset receivers and antennas. This project is part of the GNSS market uptake strategy led by EUSPA.
[87] Copernicus demonstrators.

the work done by EUSPA. The collaborative approach ensures that the standards promoted not only meet technical excellence but also align closely with the practical needs and perspectives of end-users. Through this strategic collaboration, the impact of standardisation efforts is strengthened, facilitating the effective implementation and widespread uptake of space-based solutions across sectors and user communities.

4.3.6.4 Skills Development

Lack of adequate skills for the utilisation of EO or GNSS based solutions may significantly hinder user uptake. Therefore, efforts have been made to support skills development. One of the main Commission actions under the European Skills Agenda was the development of a Pact for Skills, which aims at supporting public and private organisations through the fair green and digital transitions. The Large-Scale Partnerships set up a model for collective action among industrial players, public authorities, SMEs,[88]. Similar initiatives include the Copernicus Academy and projects such as EO4GEO and now SPACE4GEO, which cover EO and navigation. The recently launched SpaceSUITE project is an ERASMUS+ Blueprint project for the development of innovative resources for education and training to bridge the gap between the supply and demand of skills in the ever-growing downstream space sector. The Copernicus Academy counts nearly 200 members (January 2023) and organised almost 500 courses and events that reached an estimated audience of 334,000 [89]. On the navigation side, similar efforts have included EU-funded projects such as E-KNOT and GENIUS.

EUSPA launched a series of initiatives focused on skill development, suchsuch as the EU Space Academy (with a growing offer of seven courses on Space- and non-space matters), competitions, hackathons and workshops for agencies and governmental organisations.

4.3.6.5 Studies on the value generated by Copernicus or EGNSS

Extensive work has been conducted by the implementing actors to measure the market for Satellite Navigation and EO (e.g. EUSPA market reports) and highlight relevant success stories (e.g. NEREUS 99 stories). These efforts underpin the promotion of user uptake as they help convince users of the value Copernicus, Galileo and EGNOS generate.

5 Promoting user uptake at national level

The efforts conducted at EU level for the promotion of user uptake of Galileo, EGNOS and Copernicus are informed – and to a good extent driven – by the needs of the different Member

[88] Pact for Skills.
[89] The Copernicus Academy: Spreading awereness and knowledge, as of January 2023.

States. Thus, uptake efforts at EU level, are complemented by Member States activities to promote use of Galileo, EGNOS and Copernicus in direct connection with national policy priorities and the specificities of their respective space ecosystem. The Competitiveness Council of December 2022[90] strongly underlined this message, which was further iterated in the responses provided by Member States to a dedicated inquiry inside the Space Committee of September 2023. Member States welcomed the progress made at the national level to optimise the use of space data, considered potential obstacles limiting the adoption of EU space services at the EU and national levels and identified solutions to overcome these challenges. In line with the measures identified to boost user uptake presented in the previous section, Member States stressed that more work is needed in the following areas:

- **User centred development**: fostering the collaboration between space and non-space actors and promoting a better sharing of best practices among the different user groups, the services and applications developed will meet the end-user needs;
- **Legislation**: developing sectorial policies and legislation to promote the use of space data and eliminating regulatory or administrative elements that can hinder uptake;
- **Support to industry**: facilitating access to financial support for innovative solutions;
- **Support to users and awareness**: working towards the development of the necessary specific skills by the users, particularly those within the public administrations.

5.1 Overview of Member States national space uptake strategies

An **examination of the national uptake space strategies** in 24 Member States and Norway reveals diverse approaches tailored to the national priorities and objectives.

Each national strategy motivates engaging in the EU Space Programme and leveraging on EU initiatives with the **intent to align with EU space policy**: all countries want to develop their national uptake strategy in alignment with EU space policy and initiatives. If not explicitly mentioned, this expectation can be derived from the analysis of the objectives and scope of the national strategies, that are in line with the EU space policy for each of the analysed legislation. The alignment between the national strategies and the framework at the EU level emerges from key measures and initiatives converging to foster collaboration and synergies between the Member States and EU institutions in the space domain. This alignment is extremely relevant as it bolsters the resilience, competitiveness, and sustainability of EU space initiatives while delivering tangible benefits to a diverse array of sectors and stakeholders.

Another common element that emerged from the analysis of the national strategies is the **clear perception that space applications and services are drivers of new economic development opportunities**: the new space economy, services, and applications of Galileo, EGNOS and Copernicus are specifically evaluated in the national strategies as elements to be leveraged to create new business opportunities for national economic operators and to diversify economic

[90] Competitiveness Council - December 2022 (1 December - 2 December 2022).

activities. The national strategies put a clear emphasis on the importance of the Galileo/EGNOS downstream services market, sharing the prioritisation of specific services and sectors because of either the economic structure of the national economy or the level of maturity of the market segment.

Not all national strategies seem to cover all EU Space Programme components to the same extent. According to the analysis, EO is more often covered by national strategies than other components[91]. Many national strategies are focused on the development of scientific research and R&I in relation to Galileo, EGNOS and Copernicus applications in various sectors. With few exceptions (e.g. Bulgaria, Czech Republic, Luxembourg), all national strategies consider that:

- Galileo, EGNOS and Copernicus applications and services are already widely used for the effective and efficient delivery of public services in traditional sectors such as environmental, climate and natural disaster monitoring, agriculture, urban planning, maritime, road and railway management and navigation, health and emergency.
- Galileo, EGNOS and Copernicus applications and services can be drivers for the digitisation of processes, organisations and functioning of the activities in public administrations, public agencies, and public entities.

The assessment revealed that Copernicus and EO data and services **play a central role in the national strategies**: the applications that are most commonly referred to include relevant and often well-established sectors such as meteorology (e.g. in Austria, Czech Republic), environmental monitoring (e.g. in Denmark, Italy), climate change, deforestation, floods, prevention and management of crisis like storms and natural disasters (e.g. Finland), agriculture (e.g. Cyprus, Estonia, Finland).

The national strategies confirm that applications and downstream market of Galileo and EGNOS services in the transportation are widely developed. This is probably due to the fact that, on the one hand, the benefits derived from the use of space data in transport are well known and impactful. On the other hand, most of these markets are more mature and can be often influenced by public institutions (e.g. public transport, aviation, maritime). These **services are considered key factors for current delivery and future development** of many services in the Member States. In some cases, Galileo and EGNOS services are recognised for the importance that they already have in rescue activities and for public emergency and rescue authorities. In other cases, the use of Galileo and EGNOS services and location information is mentioned in the national strategy as relevant in support to agriculture and forestry, urban planning, land use, and the construction industry (Finland) and in other cases the relevance of Galileo and EGNOS services is underlined in the context of high level EU objectives, such as fight against climate change, natural resource and environmental protection (Germany).

[91] This information is obtained through a dedicated survey conducted in 2023. For more information, please see Annex E.

National strategies seem to focus on certain sectors more than others[92]. Referring to the taxonomy of GNSS and EO market segments used in the GNSS and EO Market Report, such sectors as environmental monitoring, space, forestry, infrastructure and urban planning, agriculture and climate services are the most targeted, while insurance and finance, and consumer solutions are least targeted. The least selected market segments represent a market that is very mature in terms of adoption of Galileo and EGNOS technology and that brings benefits mainly to individuals (consumer solutions) or a market that is quite new, still exploring the possible benefits of Galileo and EGNOS and without clear benefits to the society, which would justify a stronger attention from national Space Agencies and Ministries.

The analysis of national uptake strategies demonstrates that **each strategy seeks to respond to national needs and specificities while reflecting the level of development of the country** and its involvement in the EU space policy, without neglecting common trends and interests in the exploitation of new economic opportunities for public economic services and for private national economic operators. The strategies stress the importance of research and innovation in relation to applications and services provided by Galileo, EGNOS or Copernicus.

The following table provides an overview of national uptake strategies implemented in several Member States and Norway and summarises the alignment between the identified national uptake strategies and the EU Space Policy.

Table 3. Consolidation of Member States national space uptake strategies

Country	Existing Strategy	Owner	EGNSS in scope (Y/N)	Copernicus in scope (Y/N)
1. Austria	Austrian Space Strategy 2030+[93]	Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology	Yes	Yes
2. Belgium	Belgian space defence strategy	Federal Public Services, Foreign Affairs, Foreign Trade and Development Cooperation and BELSPO	Yes	Yes
3. Bulgaria	N/A	CASTRA[94]	N/A	N/A

[92] See note 78, page 43.
[93] People Climate and Economy: Space is for Everyone.
[94] CASTRA: Bulgaria's Space Policy.

Country	Existing Strategy	Owner	EGNSS in scope (Y/N)	Copernicus in scope (Y/N)
4. Cyprus	Cyprus Space Strategy 2022-2027[95] and the ERATOSTHENES Centre of Excellence	Deputy Ministry of research, Innovation and Digital Policy and its Department of Electronic Communications	Yes	Yes
5. Czech Republic	National Space Plan 2020-2025[96]	Ministry of Transport	Yes	Yes
6. Denmark	National Space strategy[97]	Ministry of higher education and science	Yes	Yes
7. Estonia	Estonian Space policy and program 2020-2027[98]	Ministry of economy and communications	Yes	Yes
8. Finland	Finland 2025[99]	Ministry of Economic Affairs and Employment and Ministry of Transport and Communications	Yes	Yes
9. France	Plan d'application satellitaires 2023-2027[100]	Ministry of the Ecologic transition and of territorial cohesion	Yes	Yes
10. Germany	Copernicus Strategy of the German Federal Government[101] and the nee national Space strategy	Federal Ministry of Transport and Digital Infrastructure	Yes	Yes
11. Greece	N/A	Hellenic Space Center[102]	N/A	N/A
12. Hungary	Hungary space strategy[103]	Ministry of foreign affairs and trade of Hungary, Department for space policy and space activities	Yes	Yes
13. Ireland	National Space Strategy for Enterprise 2019-2025[104] and the Copernicus Relay Ireland	Department of Business, Enterprise and Innovation	Yes	Yes

[95] Cyprus Space Strategy 2022-2027.
[96] Czech Republic's National Space Plan 2020-2025.
[97] Denmark's National Space Strategy: Update of strategic objectives.
[98] Eesti kosmosepoliitika ja -programm (2020–2027).
[99] Finland 2025: The world's most attractive and agile space business environment which benefits all companies operating here.
[100] Le plan d'applications satellitaires.
[101] The Copernicus Strategy of the German Federal Government.
[102] Hellenic Space Center.
[103] Hungary's Space Strategy.
[104] Ireland's National Space Strategy for Enterprise (2019-2025).

Country	Existing Strategy	Owner	EGNSS in scope (Y/N)	Copernicus in scope (Y/N)
14. Italy	The Italian Space Economy strategic plan and National Copernicus User Forum (UFN) is the core of the User Uptake Strategies[105]	Italian National Institute for Environmental Protection and Research	Yes	Yes
15. Latvia	The Space Strategy of Latvia 2021-2027[106]	Ministry of Education and Science and Ministry of Economics	Yes	Yes
16. Lithuania	Space sector development plan 2022[107]	Ministry of Economy and Innovation		
17. Luxembourg	Stategie Spatiale 2023-2027[108]	Luxembourg Space Agency	No	Yes
18. Malta	Malta National Space Strategy[109]	Minister for Equality, Research and Innovation	Yes	Yes
19. Netherlands	Dutch space policy and space memorandum of the Ministry of Economic Affairs and Climate Policy[110]	Ministry of Economic Affairs and Climate Policy	Yes	Yes
20. Norway	The Government's strategy for Norwegian space activities[111] and national agencies sectorial plans and other initiatives	Norwegian space agencies and Ministries and agencies	Yes	Yes
21. Poland	Polish Space Strategy 2017–2030[112]	Polish Space Agency (POLSA)	Yes	Yes
22. Portugal	Portugal Space Strategy 2020-2030[113]	Portugal Space Agency and Minister for Science, Technology and Higher Education	Yes	Yes

[105] Italian National Copernicus User Forum (Coalition) Secretariat: ISPRA - Italian National Institute for Environmental Protection and Research.
[106] The Space Strategy of Latvia 2021-2027.
[107] LIETUVOS RESPUBLIKOS EKONOMIKOS IR INOVACIJŲ MINISTRAS ĮSAKYMAS DĖL LIETUVOS KOSMOSO SEKTORIAUS PLĖTROS KONCEPCIJOS PATVIRTINIMO.
[108] Luxembourg Space Agency: Strategie Spatiale (2023-2027).
[109] Malta National Space Strategy: Consultation Document January 2022.
[110] Tweede Kamer der Staten-Generaal 2018-2019.
[111] Norsk Romsenter: Norwegian Space Agency.
[112] Polish Space Sector Entity Directory 2022.
[113] "Portugal Space Strategy 2020-2030": Current Implementation Status and a Guide for the Future.

Country	Existing Strategy	Owner	EGNSS in scope (Y/N)	Copernicus in scope (Y/N)
23. Romania	The National Strategy for Research, Innovation and Specialisation Smart 2022-2027[114]	Romanian space agency	Yes	Yes
24. Slovakia	A conceptual framework of space activities in the Slovak Republic	Ministry of Education, Science, Research and Sport of the Slovak Republic	Yes	Yes
25. Slovenia	Slovenia space strategy 20230 (Draft)[115]	Ministry of economy, tourism and sport	Yes	Yes
26. Spain	NO STRATEGY	Agencia Espacial Española (AEE)[116]	N/A	N/A
27. Sweden	Swedish strategy for space activities[117]	Ministry for educations and defence	Yes	Yes

Annex 4 contains a more detailed overview of existing national space uptake strategies, including their focus on EO or Galileo/EGNOS as well as their priority areas and objectives, their uptake approaches, and their identification of user needs. It indicates in what way national strategies are aligned with the EU space strategy and highlights the main measures, contents and initiatives set out as part or in consequence to the national uptake strategies.

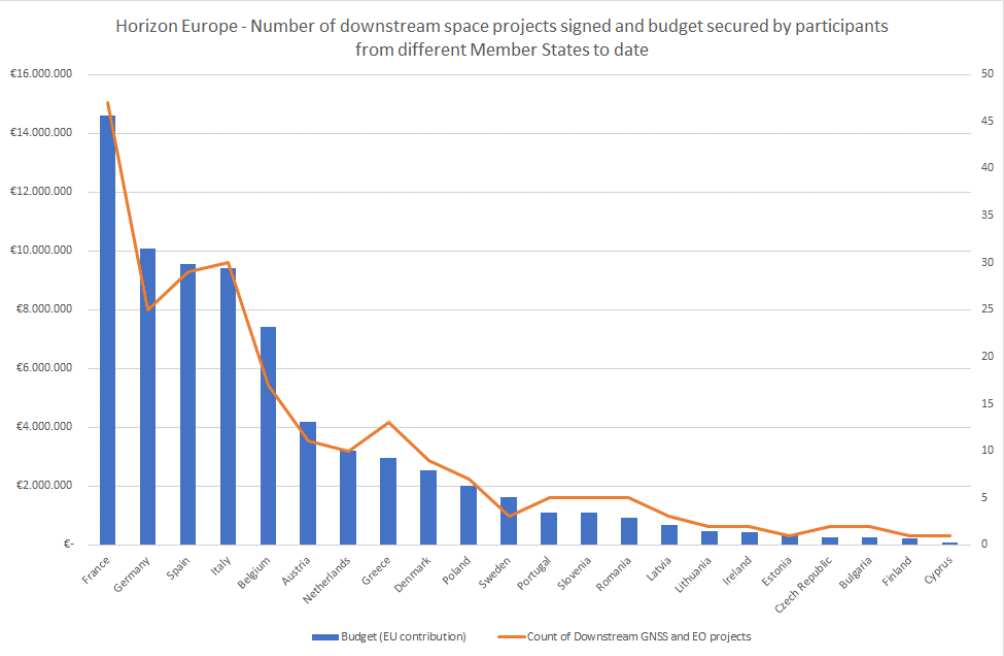
5.2 Member States' Use of EU Funding for Innovation and User Uptake

As mentioned in Section 2.4, the funding for the EU's flagship Programme components is obtained through various instruments. For some of the funding instruments, notably **Horizon Europe Cluster 4 "Digital, Industry and Space" and the Framework Partnership Agreement on Copernicus User Uptake (FPCUP)**, participants from EU Member States can obtain budget based on the competitiveness of the proposals including (also) national participants.

The figure below shows a clear polarisation in terms of capability to secure projects and funding under Horizon Europe in the countries with a space-faring tradition, e.g. due to the establishment of a national space agency, industrial presence, etc. The top four Member States (France, Germany, Spain and Italy) secured almost 60% of the total budget in the downstream topics of the first space calls of Horizon Europe.

[114] GUVERNUL ROMÂNIEI HOTĂRÂRE: privind aprobarea Strategiei Naționale de Cercetare, Inovare și Specializare Inteligentă (2022-2027).
[115] Slovenska vesoljska strategija (2023-2030).
[116] Agencia Espacial Española.
[117] A Strategy for Swedish Space activities.

Figure 7 Legal entities participating in a downstream space Horizon Europe



Source: analysis of Cordis data on the projects funded under the downstream topics of the Horizon Europe calls HORIZON-CL4-2021-SPACE-01, HORIZON-CL4-2022-SPACE-01 and HORIZON-EUSPA-2021-SPACE.

Downstream projects are relevant for both space and non-space innovators. Data from available statistics show that there is room for action to incentivise participation in those countries with a less established space track record and presence.

The Caroline Herschel Financial Partnership Agreement (FPCUP) initiative started in 2018. Its primary goal is to enhance the uptake of EU space EO services at the Member State level through a user-oriented approach, as outlined in section 2.4. The initiative involved public entities from Member States, encompassing 250 partners across 23 countries. The partners proposed projects to the Commission under the FPCUP framework, with a total of 220 actions ultimately funded. Selected projects were awarded grants to support their implementation linked to Copernicus uptake. Notably, for the Work Programme 2018-2021, the total budget allocated amounted to EUR 22.6 million. However, as stressed by ECA, the implementation of the FPCUP was fragmented. The expected impact of the action remains to be fully assessed, partially due to delays caused by administrative aspects and the impact of COVID-19[118].

[118] EU space programmes Galileo and Copernicus: services launched, but the uptake needs a further boost.

5.3 Support to users and awareness

The Copernicus Relay and Copernicus Academy, essential components in advancing the widespread adoption and effective utilisation of Copernicus data and services, are part of a larger network of space supporters. The networks boast a total of 339 members, with the Copernicus Academy spanning 53 countries across four continents and the Copernicus Relay extending to 37 countries on five continents.

The Copernicus Relay, serving as regional hubs, facilitate communication and collaboration among diverse stakeholders, including local authorities, industry, and academia. This network of 115 members plays a crucial role in raising awareness, promoting education, and supporting capacity-building initiatives. The network's global presence is evident, with 88.7% of Copernicus Relay members located in Europe, both EU and non-EU countries.

The Copernicus Academy focuses on education and training, providing a platform for knowledge exchange and skill development related to Copernicus data and EO technologies. The Academy has 224 members from 53 countries across four continents. 81.7% of Academy members are from Europe, with a significant representation from EU countries.

Both the Copernicus Relay and Academy contribute to uptake of Copernicus data by engaging with a broad spectrum of users globally. The network members are highly active in promoting the mission of Copernicus Academy and Relay. Since 2017, the Academy developed 489 courses and training modules, organised 481 events and reached approximately 334 000 people through promotional activities. In 2022 alone, an estimated 107,000 people have been reached. Since 2017, the Copernicus Relay stablished 79 hotlines and contact points, organised 574 events reaching approximately 432 000 people through promotional activities. The outreach efforts in 2022 were substantial reaching estimated 126 000 people.

5.4 National Legislative and regulatory frameworks

In addition to the policies and legislation at the EU level, Member States (MS) legislations at national regional and local level play a crucial role in shaping and in influencing the use and exploitation of the huge potential of satellite services among MS, EU citizens, end users, companies, public entities, and administrations. Considering the various and innovative nature of satellites enabled services and applications, legislations may enhance the useful integration of such services in everyday life.

Legislative and regulatory initiatives at various levels help promote the use of satellite data:

- **Promoting technology standards**: legislation can mandate the use of specific technology standards or interoperability requirements. In the context of satellite services, this can promote the development and adoption of standardised Earth Observation (EO) data and solutions, facilitating seamless integration of EO data into public administration operations as well as into everyday users' life. When it comes to the downstream market segment of Galileo and EGNOS services, standards posed by

legislation at various level are a powerful tool to support safety-related applications and to ensure the interoperability of Galileo services. Introducing or updating standards related to Galileo and EGNOS downstream applications is recognised as a priority at EU level, to be addressed with specific regulatory tools and legislative acts;

- **Supporting data privacy and security**: legislation can establish guidelines and regulations for data privacy and security, which are essential for the safe exploitation of satellite-based services that often involve the collection and dissemination of sensitive data. A clear and harmonised legal framework can promote confidence in the secure use of satellite data, services and applications minimising the risks of violations and data breaches;
- **Funding and investment incentives**: national/local governments can, through specific policy and legislative acts, allocate funds or provide tax incentives for public administrations or private users to incentivise the use of satellite services. Such incentives can promote the use of these technologies in various applications, from disaster management to environmental monitoring and may help to raise confidence in space-enabled technologies and applications among EU Member States.

There is a number of positive examples of **national legislations** promoting the use of Galileo, EGNOS and Copernicus services:

1) Spanish legislation for control and enforcement of fisheries activities

The Sub-directorate General for Control and Inspection (abbreviated as SGCI), operating within the Directorate General for Fisheries Management of the SGP, serves as the designated authority responsible for overseeing inspections of maritime fisheries in external waters. Specifically, SGCI is tasked with the continuous surveillance and validation of fishing operations via satellite-based tracking devices installed on Spanish fishing vessels, such as the Vessel Monitoring Service (VMS) and the Electronic Recording and Reporting System (ERRS). This enforcement role is further defined by the implementation of Royal Decree 176/2003, which designates fisheries inspectors as authority officials. When an anomaly or violation during fisheries activities is identified through satellite monitoring systems based on EGNSS positioning and timing data, these officials compile a comprehensive inspection report. This report includes a technical account of the suspected activity and provides a certified record of the vessel's geographical location at the time of the incident, all data provided thanks to satellite navigation monitoring and locating applications and services. As a result, satellite positioning and monitoring applications are instrumental in upholding legal compliance and facilitating effective oversight of domestic fisheries operations.

2) German legislation on the use of Galileo and EGNOS in transport and logistics

Germany has incorporated Galileo and EGNOS services into its road transport and logistics sector. Oversight and regulation of the German road toll system, known as LKW Maut, are under

the authority of the German Federal Office for Goods Transport, commonly referred to as BAG. LKW Maut is applicable to all trucks and commercial vehicles with a weight of 7.5 tons or more. The operation of the toll system was initially managed by Toll Collect GmbH, a joint venture primarily led by Deutsche Telekom AG, Daimler AG and Cofiroute until 2018, when the German government assumed control of the companies. This toll system is underpinned by satellite technology, eliminating the need for physical toll booths on the road. Consequently, LKW Maut stands out as one of the most advanced toll systems globally, employing a combination of technologies, including GNSS vehicle tracking systems, and on-board electronic units (OBUs) to monitor and levy tolls. OBUs are affixed to vehicles and establish communication with Toll Collect's central servers, facilitating a swift and convenient toll payment process. The relevant legislation governing this system is the German Federal Trunk Road Toll Act (BFStrMG), which officially came into effect in July 2011, and it therefore encourages the use of satellite navigation to improve logistics and transport management, contributing to a more efficient freight transport system.

3) Italian legislation on ERTMS and rail transport

Over the years, Italy has developed several initiatives through the public company entrusted of the management of the Italian railway network, Rete Ferroviaria Italiana (RFI), for the development plan for the European Railway Traffic Management System (ERTMS) and its main components, the European Train Control System (ETCS) and the Global System for Mobile communications - Railways (GSM-R), on the Italian railway network. This, in execution of the EU legislative obligations under the EU guidelines for the development of a Trans-European transport network – as indicated by Regulations (EU) No.1315, No. 1316/2013, No. 6/2017, No. 919/2016, No. 776/2019 – as well as those arising from the National Plan ERTMS Implementation. Through the works of RFI, Italy has effectively implemented the ERSAT EAV (ERTMS+SATELLITE Enabling Application Validation) project. The project used satellite technology to serve the ERTMS/ETCS system, with ground-to-board radio communication by means of public networks and exploiting the concept of Virtual Balise (which implies less investment in installation and maintenance as the current buoys used along the railway line are replaced with "virtual" balise operated by the satellite receiver). Therefore, the related EU and Italian legislation entrusting RFI to manage the Italian network in an efficient, secure and safe manner, led to the development of new and innovative monitoring and locating systems for all Italian railway transport operations, with positive outcomes and consequences both from an efficiency and an economic point of view.

4) Swedish use of Copernicus data for environmental protection

Sweden has been at the forefront of environmental protection and sustainability. It was the first country to adopt an Environmental Protection Act in 1967. Since then, Sweden continued implementing legislation for the reduction of carbon emissions, pollution, and environmental sustainability, which in recent years, brought an increase of use of Earth observations data for such purposes. The majority of EO data used by the Swedish government are focused on forest

mapping, ice breaker services, meteorology, and disaster mitigation. Considering the importance of Copernicus program applications and data, the Swedish National Space Agency started working with an Open Data Cube[119] to promote EO data for governmental usage and development in Sweden. The data cube is a component of the Swedish National Space Data Lab, an effort to encourage the application of artificial intelligence (AI) techniques in conjunction with EO data. This development will be published open-source and contribute to the global expansion of massive EO data analysis expertise and capability.

The integration of satellite-based services and data into national regulations enhances efficiency, safety, and sustainability in diverse fields, ranging from agriculture to transportation, to environmental monitoring and protection. These examples illustrate how EU Member States recognised the potential of Galileo, EGNOS and Copernicus data and services to benefit various sectors and aligned their national legislation to facilitate their effective use.

6 Lessons learned in promoting user uptake

Since their beginnings Galileo, EGNOS and Copernicus have gone a long way into delivering world-class data and services in support of policy making and operational processes across many sectors. However, as pointed out in the 2021 ECA Report[120], user uptake needs a further boost to realise the benefits for the various users and to ensure return on public investment.

It's crucial to acknowledge the significant role played by actors at both EU and national levels in promoting user uptake of EU space data and services. Through the deployment of a diverse set of measures and actions, these stakeholders have actively facilitated the integration of space-based solutions into various sectors. Along this journey, valuable insights have been gained regarding the barriers impeding user uptake as well as the key factors that drive successful user uptake. Lessons learned from previous collaborations, including with ESA and Member States activities, underscore the importance of synergy between these entities to optimise resources and achieve common goals. By coordinating efforts, it is possible to minimise duplication of workstreams, leverage complementary strengths, and capitalise on shared expertise.

A strategy that supports uptake of space data and services should address the former and replicate the latter. It is important to identify and understand these factors and the circumstances under which they apply. To that end, a host of activities undertaken by the various actors has sought to engage users, understand their needs and the difficulties they face when trying to adopt Copernicus or Galileo/EGNOS solutions. At the same time, service providers were closely engaged to document their own needs and issues in exploiting EU space assets and developing solutions that match user needs.

[119] An Open-Source Geospatial Data Management & Analysis Platform.
[120] See note 11, page 12

6.1 Cross-cutting aspects

6.1.1 Fragmentation

One important factor consistently reported as barrier to user uptake of Galileo, EGNOS and Copernicus is the inefficient allocation of resources characterising the downstream sectors of GNSS and EO. The most important one is the fragmentation of the demand and the supply side with different dimensions.

Fragmentation on the demand side refers to variations in applicable regulations or regulatory frameworks. This leads to a scenario where authorities with similar mandates and capacities either use or abstain from using solutions based on Copernicus, Galileo, or EGNOS. Depending on the national regulatory framework, there may be provisions allowing the use of space-based solutions, such as using them for monitoring purposes. Conversely, there are other instances where national regulations do not permit the use of space data and services, or authorities may opt not to use them.

The fragmented and immature demand, often within the same application area, requires tailor-made solution per customer, which do not allow for economy of scale and slows down the market growth. Actions that pool the demand and allow standardisation/alignment of solutions would support scaling up of the space data use. For example, environmental footprint reduction implies the monitoring of ESGs. EO data can provide a powerful independent assessment tool, however the demand is immature and fragmented. Pooling the demand via a common way of monitoring the ESG based on space data will allow not only a more trustworthy assessment, but also give the solution providers the opportunity to scale-up to the growing EU-wide market. Such inefficiencies are observed across several segments. Moreover, the different levels of digital maturity and capacity across not only sectors and countries but also individual organisations within the same sector and country, impede the ability and likelihood of users to test, accept and eventually adopt technology-based solutions, such as those enabled by Copernicus, Galileo and EGNOS. Finally, when it comes to the use of Copernicus data embedded in EO enabled services, the operational needs of individual organisations can lead to the demand for partially different solutions. In some segments, such as energy, with fragmentation among energy providers, the lack of uniform adoption across all stakeholders poses a challenge. Different levels of awareness, resources, and technological capabilities contribute to this fragmentation.

This also impacts the fragmentation on the supply side, with many providers offering similar services that may in turn lead to confusion amongst prospective users. Service providers are also affected by barriers in the Internal market, such as the different framework conditions for doing business across the different EU Member States (including aspects such a public procurement, taxation, accounting, etc.), which make it harder for companies to offer their EU space-based solutions on a wider market. The lack of large(r) players in the Copernicus downstream solutions sector is the consequence of the fragmentation on the demand side and creates a barrier to develop EU-wide solutions that are required by some of the newly adopted regulatory

frameworks, such as the deforestation free value chain. EU-wide solutions would offer reliability and comparability of results required by the legal framework. Development of such a solution goes beyond the capacity of a start-up or a SME. Such companies are predominant in the space downstream sector that accounts today for around 600 companies active in the EO value chain. The immature demand and difficult access to fundings, i.e. limited availability of equity and debt funding for later fundraising stages, hinders their scaling-up efforts.

6.1.2 Regulatory Framework

Legislation should therefore strike a balance between promoting the benefits of satellite services for public entities and administrations, companies, citizens and users, while ensuring their responsible and secure use. Collaboration between governmental bodies, industry stakeholders and experts is vital for developing legislation that optimises the use of Galileo, EGNOS and Copernicus services, data and applications considering the broader regulatory framework, both in the public and in private sector.

A **conducive regulatory framework can act as a major catalyst** for the adoption of Copernicus, Galileo or EGNOS in the various application areas. Thus, the incorporation of EO and GNSS, and even more so the explicit reference to Copernicus, Galileo and EGNOS, in different legislative acts and regulations, has proven to be a very effective tool to accelerated adoption of space-based solutions, *inter alia* eCall, smart tachograph, the Common Agricultural Policy, the PBN regulation and several environmental policies (please see further examples in Chapter 4). Both public administrations and corporates will adopt Copernicus, Galileo and EGNOS for policy implementation, reporting or compliance assurance, if this is explicitly mandated (i.e. appropriate procurement mechanisms are in place as described in Section 4.2) or at least mention as an acceptable option to conduct such tasks.

The global coverage of Galileo and Copernicus offers a prime opportunity for EU companies to pursue internationalisation of their offering, entering international markets and promoting the adoption of EU Space in other countries. There have been many **institutionally driven space diplomacy efforts** to promote **Copernicus,** e.g. establishing cooperation agreements with multiple countries, launching regional collaboration initiatives such as GMES & Africa or more recently the CopPhil initiative under Global Gateway. However, the achieved results are undermined by lack of continuity of such activities with efforts fading out after a programme or project ends. Moreover, such activities are also affected by fragmentation and lack of coordination between different actors running many programmes in isolation, leading among others to confusion of prospective users in targeted geographies.

On the side of **Galileo and EGNOS**, in regulated sectors such as maritime, aviation and road transport, their international adoption resides in the development and update of international

regulatory and standardisation measures[121], that enable their adoption by allowing the use of specific technologies and ensuring the interoperability of the systems (please see more in chapter 4.2).

On the contrary, even in cases where the value proposition of solutions enabled by Copernicus, Galileo and EGNOS is well known and proven, **if the applicable regulation** (whether at EU or national level) **does not foresee or even hinders their use, their adoption will be slower**[122]. Moreover, the broader regulatory framework often sets the conditions for the use of space-enabled applications. For example, the application of **data protection and privacy** rules might limit the applicability of satellite navigation, for example for tracking purposes. When safety, security and regulatory compliance are at stake, it is necessary to find the right balance between the different interests: on the one hand, the protection of personal and commercial data, and on the other hand, the public good pursued by the related regulation.

6.1.3 Awareness

The first step across initiatives promoting user uptake is **to raise awareness among the different stakeholder groups**. The key here is to convey information (and collect needs) that resonate with the stakeholder needs, considering their geospatial literacy and working language. The promotion of user uptake of Copernicus, Galileo and EGNOS requires a consistent effort **to go out of the "EU space bubble" silo** into the various user communities across market segments. This barrier was addressed through different actions, as mentioned in Section 4.2.4, with varying degrees of success. For example, in segments like road and automotive, rail, tourism, health, and consumer solutions, there is a low level of awareness about the potential applications of Copernicus data. Limited education and outreach initiatives hinder the understanding of how these technologies can benefit these industries.

One of the most important lessons learnt in this process is that access to **success stories** can significantly support adoption. Thus, as mentioned in Section 4.2.4.4, market studies (e.g. the GNSS and EO Market Report)[123], business cases[124] (including cost-benefit analyses), or case studies presenting how an organisation dealing with how a specific operational need[125] has been effectively fulfilled by using Galileo/EGNOS or Copernicus based solutions, can have a substantial impact in overcoming the barrier of initial awareness and functioning as a call to action for further exploration and testing.

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[121] E.g. by IMO in maritime, ICAO in aviation and UNECE in road and automotive.

[122] An example is legislation at the national or international level preventing the use of space images and data as proof in Court proceedings or for policy implementation monitoring. A further example is the case of Water Quality Monitoring, where different national regulations result in different levels of adoption of Copernicus-based solutions.

[123] https://www.euspa.europa.eu/european-space/euspace-market/gnss-market/eo-gnss-market-report

[124] EGNOS - Precision Agriculture: EGNOS helping farmers to reduce costs and environmental impact.

[125] For instance, sea-ice navigation.

Another very common success factor in achieving initial awareness and supporting the subsequent steps of acceptance and adoption is the **presence and activity of an individual within the prospective user organisation championing** the use of a new solution powered by Galileo/EGNOS or Copernicus. This can be driven by their own initiative (e.g. an individual within a Water Management Authority raising awareness among colleagues that Copernicus-based INSAR monitoring can support Aquifer Management processes[126]) or through interaction with either the implementing actors (EUSPA engaging corporate users in different market verticals) or companies (EO solution providers serving a given application area).

All these aspects point to the fact that **raising awareness requires dedicated effort on the supply side, whether this refers to actors entrusted with the promotion of the EU Space Programmes or the industry and academia delivering solutions**.

6.1.4 User needs and requirements

The most important factor for a successful transition to full operational utilisation is that the capacity of the solution in question to **really meet the user needs**, regarding the format and the agreed conditions (in terms of budget, timeliness, security). **Initial users** who have experienced how a given solution supports their activities, are in a better place to convince their management to dedicate funds, establish the needed procedures and assign adequately skilled staff for the exploitation of EGNSS or Copernicus enabled solutions. As lessons learned, this means that (i) understanding the operational reality and requirements of users is central to such efforts, (ii) the developed solutions need to address the identified requirements, (iii) the resulting value proposition needs to be well communicated. These considerations feed back into the need for less technology push activities **focussing instead on demand pull**, including seeking to integrate Copernicus, Galileo and EGNOS as parts of larger solutions that serve the needs of the targeted stakeholders.

6.1.5 Other end users[127]

International organisations and NGOs benefit from solutions using Galileo, EGNOS, and Copernicus, but often face capacity challenges due to entrenched procedures, lack of skills, and budget constraints. Initiatives such as EUSPA EUSpace4Ukraine aim to overcome these barriers by fostering strong relationships, matchmaking demand and supply and ensuring interoperability between the different systems and applications (e.g. EASA or CEN-CENELEC).

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[126] Sentinels Benefits Study (SeBS) A Case Study Aquifer Management in Spain.

[127] Building on the definition of "Other Copernicus users" provided in the Space Regulation (2021/696) this should cover research and education organisations, commercial and private bodies, charities, nongovernmental organisations and international organisations that benefit from the outputs of Copernicus, Galileo and EGNOS.

The public directly benefits from Galileo services, especially through mass-market devices like smartphones. While mass-market applications for Copernicus are emerging, increased media use of Copernicus data is raising awareness. EU agencies are also relevant space users, and EUSPA collaborates with them to fulfil specific needs and enhance resilience in security and governmental missions. The successful adoption of Galileo, EGNOS, and Copernicus by these user groups requires seamless integration into their solutions and services. Efforts to promote EU Space Programs should align with this crucial integration need.

6.1.6 Data Access and Processing

Effective data access and processing are crucial considerations, particularly in the context of Copernicus. The value of Copernicus, centred around Earth Observation data, lies in its ability to generate valuable information and insights. **Unlocking this value involves several steps, from data acquisition to access, and from specialised data processing using platforms and tools to the creation of advanced information products and services**. This process integrates satellite data, in-situ measurements, and socio-economic data, ultimately presenting information through dedicated dashboards for end-users.

Historically, **challenges related to data access and exploitation** posed significant barriers to user uptake. However, targeted investments and trial-and-error attempts over the years have largely addressed these issues. The **lack of interoperability between platforms** has been a hindrance to the user journey, but recent initiatives, such as the launch of larger platforms with extended contractual perspectives (up to 10 years) and a broader range of data services like the Copernicus Data Space Ecosystem (CDSE), aim to build trust among Copernicus users.

Currently, **various technological and market trends**, such as the emergence of digital twins and advancements in supercomputing, **present both opportunities and challenges**. It is essential to ensure that promotion efforts prioritise user needs and realities rather than being solely driven by technological advancements. More specifically, several additional barriers have been identified that are present in various market segments:

- **Cost and Accessibility**: Barriers exist in road and automotive sectors due to the perceived expense and technical challenges of integrating Copernicus data, hindering adoption, especially among smaller industry players.
- **Technology Complexity:** The complexity of integrating Copernicus data into existing systems poses challenges across industries, requiring specialised knowledge and technical expertise. This complexity, especially in extracting value from Earth Observation data and integrating it with AI-systems, hampers widespread adoption.
- **Regulatory gaps**: Absence of clear mentions to use of space data and services in regulatory frameworks, crucial for reliability and traceability, present challenges for uptake in sectors

like insurance and finance[128]. Adapting existing practices to incorporate Copernicus data may require changes in regulations and standards, slowing down uptake.

- **Integration Challenges**: Sectors like energy and raw materials face difficulties in the straightforward integration of Copernicus data. Initial awareness and understanding of the added value among stakeholders may impede the uptake process.
- **Data Utilisation Complexity**: In forestry, despite advanced applications like wildfire detection, the complexity of utilising Copernicus data for purposes like disease monitoring limits broader adoption.
- **Risk Aversion**: Urban development and cultural heritage sectors may exhibit risk aversion in adopting new technologies. Municipalities and heritage preservation organisations may be hesitant to shift from traditional methods to satellite-based monitoring.

6.1.7 Skills, processes, and tools

Another important aspect enabling or impeding adoption by public administrations, corporate actors (large or small) or international organisations, NGOs and social partners is related to the presence of the necessary **skills**. Thus, the presence of adequately skilled staff and tailored tools both on supply and demand side is a central prerequisite for the development of fit-for-purpose solutions exploiting Copernicus, Galileo and EGNOS, as well as and for the integration of these solutions in operational workflows of users. The shortage of skilled staff within public organisations and corporate actors[129] is recognised since long time and significant actions were taken to address it through dedicated programmes and initiatives (see 4.2.4.2).

Public administrations (and non-space industrial actors) are often **entrenched in their operational processes** established over many years and do not have procedures in place to explore, test and appreciate the relevance and benefits of new technologies. Many potential users (public or corporate) **do not have a dedicated geospatial department** or budget that would allow them to include new solutions in an organic way. In several cases, even when the value proposition of a given solution to support a given policy area is known and even if the regulation is in place, the ability of the public authorities to procure these solutions may lag.

[128] Insurance companies and financial institutions often rely on historical data and modeling to assess the potential impact of natural disasters on their portfolios. However, Earth observation data, including satellite imagery and remote sensing, can provide real-time or near-real-time information about the extent and severity of these disasters. By integrating Earth observation data into their risk assessment models, insurance companies and financial institutions can improve the accuracy of their risk assessments and make more informed decisions about pricing, underwriting, and risk management. This could ultimately lead to more resilient financial systems and better protection for policyholders and investors alike.

[129] See relevant findings here.

6.1.8 Internationalisation

The lessons learned from the internationalisation activities stress the importance of international collaboration for the continued success of Galileo, Copernicus, and the EU Space ecosystem. The proactive approach taken by the European Commission and its partners strengthened global space relations and opened new avenues for innovation and market expansion. When reflecting on user uptake of Galileo, EGNOS and Copernicus, it is evident that their global reach positioned them as valuable assets for companies venturing beyond European borders. Over the years, numerous initiatives have been undertaken to facilitate businesses in accessing and establishing themselves in international markets.

The European Commission plays a pivotal role in international space relations, actively engaging with non-EU states and other global players. The expansion of specific services and components to non-EU countries, such as Copernicus Data Hubs, the Public Regulated Service or the EU Space Program IRIS2 stress the importance of international cooperation.

7 Conclusion

The uptake of EU space data and services stands at a juncture, marked by achievements and challenges highlighted in the 2021 ECA Special Report. Stakeholders recognise progress but concerted efforts are needed to address shortcomings and foster collaboration for optimal space data utilisation.

ECA recommendations provide a roadmap for improvement, emphasising transparency, cooperation, and strategic planning. Addressing concerns and adopting a proactive approach can position the EU as a global leader in space data, contributing to scientific, technological, and socio-economic advancements.

Efficient use of Copernicus, Galileo, and EGNOS data is essential for socio-economic benefits. Despite progress, user uptake still varies across the different segments. Supporting measures are needed, especially in markets with lower innovation rates.

EGNSS user uptake has made significant strides, with Galileo featured in 65% of global receiver models in 2022. The number of Galileo-enabled smartphones and tablets reached over 900 models, and approximately 500 European airports and helipads utilise EGNOS for landing procedures. Despite progress, operational usage of Galileo and EGNOS varies across segments, regions, and user communities, necessitating support for market adoption and attention to Galileo differentiators.

Copernicus provides precise Earth observation data, exceeding expectations in reliability and volume. This data supports various applications, including environmental monitoring and disaster management. It excels in areas like emergency management, sustainable agriculture, and security-related domains. Copernicus-derived products are well-established in emergency management, demonstrating progress aligned with policy objectives in various sectors. While

Copernicus performance is above expectations, Copernicus commercial uptake lags behind EGNOS and Galileo. However, Copernicus potential for commercial uptake has potential for substantial growth and advancement.

EUSPA employs a user-centric approach with pillars focusing on market knowledge, demand support, and offer creation. To fully benefit from EU Space Components, continued support for Horizon Europe, Fundamental Elements, and Cassini is imperative, requiring better coordination.

The imperative for adoption is underscored by the need to continually update services. Encouraging private sector involvement, enhancing partnerships, consulting social partners and ensuring better access to finance are essential. Robust monitoring mechanisms, clear communication, and ongoing assessments address concerns raised by the European Court of Auditors.

To benefit from EU Space components, continued support for Horizon Europe, Fundamental Elements, and Cassini is imperative. Coordination and alignment ensure a stronger EU Space landscape. Partnerships with public and private entities enhance impact.

To foster user uptake, it is essential to keep encouraging private sector involvement, enhancing partnerships, and ensuring better access to finance. Also, robust monitoring mechanisms, clear communication, and ongoing assessments address concerns raised by the European Court of Auditors

A comprehensive space data strategy aligning with EU priorities is crucial for economic growth within planetary boundaries. Collaboration, innovation, and adaptability are key to overcoming challenges and ensuring adoption across sectors. Regulations can accelerate adoption if well-chosen and coordinated. Clearer guidance for funding opportunities and collaborative efforts between EUSPA and Member States are essential.

A comprehensive space data strategy would strengthen the EU's global position, contributing to the well-being of citizens and society at large, and it is crucial to align space data and services with EU priorities to stimulate economic growth. Recognising interdependence, the strategy should prioritise advancements, environmental monitoring, disaster response, societal resilience and sustainable development.

In conclusion, significant progress has been made in EU Space data and services uptake. To address challenges and foster economic growth, a forward-looking strategy that emphasises collaboration, innovation, and adaptability is needed.

A. Annex A: Illustrative taxonomy of space-enabled applications of interest for satellite navigation and Earth Observation

The table below shows an exemplification of taxonomy of applications and their relevance for GNSS and Earth Observation from EUSPA's GNSS and EO Market Report, issue 2. The description of the applications is featured in Annex 3. By covering only GNSS and EO, the taxonomy is not exhaustive for all the components of the EU Space Programme.

Segments	Subsegments	Applications	GNSS	EO	Synergy
Agriculture	Environmental monitoring	Carbon capture & content assessment		x	
		Environmental impact monitoring		x	
	Natural resources monitoring	Biomass monitoring			x
		Crop yield forecasting			x
		Soil condition monitoring			x
		Vegetation monitoring		x	
	Operations management	Asset monitoring	x		
		Automatic steering	x		
		CAP monitoring			x
		Farm machinery guidance	x		
		Farm management systems			x
		Field definition			x
		Livestock wearables	x		
		Pastureland management		x	
		Precision irrigation			x
		Variable rate application			x
	Weather services for agriculture	Climate services for agriculture		x	
		Weather forecasting for agriculture		x	
Aviation and drones	Communication	ATM System Timing	x		
	Environmental Monitoring	Aircraft Emission Measurement and Monitoring			x
		Particulate Matter Monitoring		x	
	Navigation	Drone navigation	x		
		Performance Based Navigation (PBN)	x		
		Performance Based Navigation (PBN) for drones	x		
		VFR complement	x		
	Operations Management	Aircraft Maintenance and Operation Optimisation		x	
		Airport Capacity and Safety		x	

Segments	Subsegments	Applications	GNSS	EO	Synergy
		Drone Operations Planning	x		
		Monitoring Terrains Obstacles		x	
		U-space services	x		
	Surveillance	Electronic Conspicuity (uncertified)	x		
		Electronic Conspicuity (certified)			
		GADSS	x		
		Infrastructure Timing	x		
	Weather Services	Hazardous Weather Identification		x	
Climate, Ecosystems and Biodiversity	Biodiversity, Ecosystems and Natural Capital	Animal tracking for biodiversity purposes	x		
		Ecosystems monitoring		x	
	Climate services	Climate change mitigation and adaptation		x	
		Climate monitoring and forecasting		x	
		EO-based climate modelling		x	
		GNSS-based climate modelling	x		
	Environmental monitoring	Environmental auditing		x	
		Environmental impact assessment and ESG		x	
		Environmental resources management		x	
Consumer solutions, tourism and health	Corporate	Location-based billing	x		
		Geo-advertising			x
		Mapping & GIS			x
		Workforce management	x		
	Health & Lifestyle	Air quality monitoring		x	
		Games			x
		Geo-tagging			x
		mHealth	x		
		Safety and emergency	x		
		Social networks	x		
		Sport, fitness and wellness incl. specialist support tracking			x
		UV monitoring		x	
		Tourism Fruition	x		
	Navigation & Tracking	Navigation	x		
		Personal & asset tracking	x		
		Visually impaired support	x		
	Robotics	Consumer robotic	x		
		Enhanced human	x		

Segments	Subsegments	Applications	GNSS	EO	Synergy
Emergency management and humanitarian aid	Prevention & Mitigation	Impact exposure analysis and proactive mitigation measures		x	
	Preparedness	Early warning emergency applications			x
		Hazards monitoring			x
	Response	Crisis area assessment			x
		Operational wildfires modelling		x	
	Post-event recovery	Post-crisis damage assessment and building inspection			x
		Restoration of supply chain and infrastructure services			x
	Humanitarian aid	Health and medicine response and coordination (incl. anticipatory humanitarian action)			x
		Management of refugee camps		x	
		Population displacement monitoring		x	
		NGO's asset management	x		
		Welcome applications to people in need of humanitarian aid	x		
	Search and Rescue	SAR operations: at sea	x		
		SAR operations: aviation	x		
		SAR operations: land	x		
		Situational awareness supporting SAR		x	
Energy and raw materials	Energy Network Fidelity	Energy Network conditions monitoring		x	
		Phasor Measurement Units (PMU)	x		
	Environmental Impact Monitoring	Environmental impact assessment for energy and raw materials		x	
	Market Intelligence	Supply chain insights		x	
	Raw Materials	Illegal mining monitoring		x	
		Mining vehicle management and control	x		
		Mineral exploration, site selection planning/monitoring			x
	Renewable Energy	Renewable energy assessment potential and forecast		x	
		Renewable energy plant design optimisation		x	
		Risk assessment for renewable energy assets		x	
		Renewable energy site selection, planning and monitoring			x
Fisheries and aquaculture	Aquaculture	Aquaculture operations optimisation			x
		Aquaculture site selection		x	
	Fisheries	Illegal, unreported and unregulated fishing (IUU) control			x
		Catch optimisation		x	
		Fish stock detection and modelling		x	
		Fishing aggregating devices	x		

Segments	Subsegments	Applications	GNSS	EO	Synergy
		Fishing vessels navigation	x		
Forestry	Environmental monitoring	Biomass monitoring			x
		Deforestation/degradation monitoring		x	
	Natural resources monitoring	Forest Inventory monitoring			x
		Forest vegetation health monitoring		x	
		Illegal logging monitoring		x	
	Operations management	Automatic steering	x		
		Forest asset management	x		
		Forest certification		x	
		Forest machinery guidance	x		
Infrastructure	Environmental Impact Monitoring	Environmental impact assessment of infrastructure		x	
	Infrastructure Construction and Monitoring	Construction Monitoring			x
		Monitoring of impact of human activities on infrastructure		x	
		Oracle Database Appliance (ODA) Support Monitoring		x	
		Pipeline Monitoring			x
		Post-Construction Monitoring			x
	Infrastructure Planning	Infrastructure Site Selection and Planning			x
		Permitting		x	
		Vulnerability Analysis		x	
	Timing & Synchronisation of Telecommunication Networks	Data Centre	x		
		Digital Cellular Network (DCN)	x		
		Professional Mobile Radio (PMR)	x		
		Public Switched Telephone Network (PSTN)	x		
		Satellite Communication (SATCOM)	x		
		Small Cells	x		
Insurance and finance	Finance	Commodities trading		x	
		ESG Reporting		x	
		Risk assessment		x	
		Timing and synchronisation for finance	x		
	Insurance for natural disasters	Event footprint		x	
		Index production		x	
		Risk modelling		x	
Maritime and inland waterways	Inland waterways	Autonomous Surface Vessels			x
		Collision Avoidance (AIS, VDES)	x		
		GNSS vessel engine management system	x		

Segments	Subsegments	Applications	GNSS	EO	Synergy
		Inland waterways navigation			x
	Maritime engineering	Marine surveying and mapping			x
		Dredging			x
	Merchant vessels	Collision avoidance (AIS, VDES)	x		
		GNSS vessel engine management systems	x		
		Maritime Autonomous Surface Ships			x
		Merchant navigation	x		
		Navigation through sea ice			x
		Ship route navigation			x
	Ocean and Environmental monitoring	Maritime pollution monitoring		x	
	Port	Automated port operations	x		
		Piloting assist at ports			x
		Port safety			x
		Port security		x	
		Port Operations	x		
	Recreational craft	Recreational navigation	x		
	Vessel tracking	Dark vessel monitoring			x
Rail	Attractiveness enhancement	Passenger information systems	x		
		Public Transport – Tram and Light Rail	x		
	Maintenance improvement	Condition-based maintenance	x		
		Infrastructure monitoring		x	
		Predictive maintenance	x		
	Safety related	Enhanced Command & Control Systems	x		
		Trackside personnel protection systems	x		
	Train driving optimisation	Driver Advisory Systems (DAS)	x		
		Fleet management	x		
Road and automotive	Asset management	Bike sharing	x		
		Public transport - buses	x		
		Road fleet management	x		
	Liability and enforcement	Insurance telematics	x		
		Road User Charging (RUC)	x		
		Smart tachographs	x		
	Safety related	Connected and Automated Driving (CAD)	x		
		Emergency assistance	x		

Segments	Subsegments	Applications	GNSS	EO	Synergy
	Smart mobility	Congestion control			x
		Infotainment services			x
		Navigation – In-Vehicle Systems (IVS) & Personal Navigation Devices (PND)	x		
Urban development and cultural heritage	Environmental Monitoring	Air quality monitoring in urban environments		x	
		Light pollution		x	
		Thermal auditing		x	
		Urban greening			x
		Urban heat islands		x	
	Smart Cities Operations	Smart streetlights	x		
		Smart waste management	x		
	Urban planning and monitoring	Informal dwellings		x	
		Real estate		x	
		Surveying and mapping of urban areas			x
		Urban modelling, 3D modelling, Digital Twins			x
		Urban planning		x	
Space	Supporting or Acting as Mission Payloads	Technology Demonstration (TechD)	x		
		Scientific & Operational Missions (SOM)	x		
	Lunar Applications	Lunar Orbit (LO)	x		
		Moon Surface Positioning (MS)	x		
		Translunar Orbit (TLO)	x		
	Guidance, Navigation and Control (GNC) Subsystem	Attitude Determination (AD)	x		
		Precise Orbit Determination (POD)	x		
		Real Time Navigation (RTN)	x		
		Space Timing and Synchronisation (S-T&S)	x		

It is important to highlight that, beyond EUSPA's taxonomy, other taxonomies do exist and are equally suitable to support the assessment of benefits from space programme, if they are comprehensive and mutually exclusive from the standpoint of covering the application. Examples of other taxonomies include EARSC EO taxonomy[130].

[130] EO Taxonomy.

B. Annex B: Summary Tables of EO/GNSS adoption per EUSPA market segment

GLOSSARY

LEVEL	DEFINITION
Minor	Either N/A or merely some pilots are in place/use
Medium	Some operationalisation in specific processes is in place
Major	Significant number of stakeholders operationally utilise Copernicus/EGNSS

Agriculture

Segment	**Agriculture**		
Copernicus uptake	Minor	Medium	**Major**
EGNSS uptake	Minor	Medium	**Major**
Stakeholders and Applications			
Earth Observation			
There are a wide range of EO based applications targeting different types of stakeholders. At a policy level, EO is widely used in gathering statistics on overall agricultural production in a region, especially in the context of food security. Within the EU there is also an increasing use of such data for monitoring CAP compliance. Such information is also used by commercial actors, for example to support trading of agricultural commodities. EO is also being used in agricultural insurance. There are an increasing number of service providers wo have EO based applications available or under development which target individual farmers (or farm owners), for example to monitor crop conditions, optimise fertilisation strategies, identify harvesting time, or to support claims for insurance pay-outs or CAP subsidies.			
Global Navigation Satellite Systems			
Similar to EO, the main user communities of GNSS applications in the field of Agriculture are first and foremost the farmers, their associations and their cooperatives. Alongside them, there are governments and agricultural agencies as well as environmental agencies at different levels (i.e., regional, national and international). A final group of stakeholders can be found in the different insurance companies and crop traders, whilst these primarily rely on EO applications for their daily activities (see above). For GNSS, the applications can be grouped in two subsegments, namely natural resource monitoring applications (which often rely on synergies between EO and GNSS) and operations management applications that are primarily GNSS-only applications such as asset monitoring, automatic steering, etc. The GNSS applications are mainly used to improve the efficiency and effectiveness of the daily activities carried out by farmers, whilst the positioning information provided through GNSS also contributes to the improved monitoring of various activities. GNSS is also contributes to CAP related activities such as geo-tagged photo application in mobile phones to support and complement EO data.			
Level of Awareness / Adoption			
Copernicus			
There is a very high level of awareness of the potential of Earth Observation at all levels of stakeholder/user, with a network of service providers acting as intermediaries to individual farmers or farm owners. However, this is not true for small and medium size farmers where there is still lack of awareness. Therefore, the level of adoption is high for some uses (such as food security monitoring, precision framing amongst big farmers, CAP monitoring by MS) and low uptake in others (such as amongst small to medium			

size farmers, or within new concepts such as regenerative agriculture or CAP-compliance tools at farmer level).

EGNSS

The modern farmer is relying on satellite-based technologies, alongside other innovative technologies, to optimise the efficiency and effectiveness of the various daily activities they perform on their fields. Adoption of EGNSS across agricultural applications is assumed to reach 100% across all GNSS-enabled applications by 2026, whilst the adoption of EGNOS in receivers is believed to already have reached 100% as of 2020. The main drivers for such high uptake of EGNSS can be explained by looking at various market and technological trends such as the need for increased profitability, the need to introduce solutions applicable to small and medium-sized farms, the need to comply with different policies related to the disbursement of subsidies, significant improvements in high-accuracy solutions, and the combination of GNSS with various range of complementary technologies including EO.

Major R&D Initiatives

Copernicus

There are many different R&D initiatives looking at EO for agriculture, funded by the EC (Horizon Europe), EUSPA, ESA and national agencies. These range from improving the overall estimation of agriculture statistics to developing new user focussed applications.

EGNSS

Some notable R&D initiatives that are ongoing in the agricultural segment include projects on the use of RPAS (to provide an alternative to remote sensing data, such as EO, or to complement existing machineries such as crop-sprayers), and robotics (for precision farming use cases especially in the field of high profit-margin agriculture such as wine, grapes, some specific fruits and vegetables, etc.). Whilst the introduction of the Internet of Things for agriculture will contribute to the generation of valuable data streams, it is already anticipated that the 'connected farm' might require advanced ICT infrastructure such as high-performance computing.

Policy, Legislation and Regulation

Copernicus

The Farm to Fork strategy aims to support the objectives of the European Green Deal by making food systems sustainable and environmentally friendly. Among other things it includes a set of policies for reducing the environmental and carbon footprint of European food systems while also ensuring Europe's food security in the face of a changing climate. Other key policies, in particular the revised Common Agricultural Policy, have been aligned with the objectives of the Farm to Fork strategy, and there are close links between the farm to fork and biodiversity strategies. There is also a clear connection between agriculture on the one hand and the LULUCF regulation and the EU soil Strategy on the other.

EGNSS

The EU Common Agricultural Policy (CAP) is by far the biggest policy instrument that the EU has put in place to address various challenges that are being faced in terms of economic, environmental and territorial aspects. The key objectives flowing from the CAP aim to provide a viable food production, sustainable management of natural resources and climate action, and a balanced territorial development. The European Green Deal is another major policy framework that is setting new initiatives to achieve carbon neutrality by 2050, including initiatives such as the Farm to Fork strategy, the EU Biodiversity strategy and the EU Soil Strategy. Apart from these, a series of directives relevant for the uptake of (E)GNSS across agricultural activities include the fertilising products regulation (EU) 2019/1009, the directive 2009/128/EC on sustainable use of pesticides, and many others (an overview can be found in the Report on User Needs and Requirements (by EUSPA)). Across all these, EGNSS is a key provider for precise and reliable positioning information that is combined with EO/Copernicus information for the correct monitoring of various policies.

Barriers & Future Directions

Copernicus
The key barrier to improving EO based services is the lack of availability of in-situ data for application calibration and validation. A variety of initiatives are attempting to address this issue, including the EU's aim to build a common data space for agriculture.
EGNSS
No major barrier. The agricultural segment, like many other segments, is facing challenges linked with climate change and the need to prioritise sustainability and EGNSS can help. Downstream space-based technologies such as GNSS can and will play a vital role in tackling these challenges whilst still ensuring profitability for the farmers. Further digitalisation of the segment is expected, and the introduction of innovative solutions will need to be managed accordingly. Blockchain, Internet of Things for agriculture and High-Performance Computing are only a couple of innovations that are bound to make their introduction in this segment.

Aviation and Drones

Segment	**Aviation and Drones**		
Copernicus uptake	**Minor**	Initial	Major
EGNSS uptake	Minor	Initial	**Major**

Stakeholders and Applications
Earth Observation
Important stakeholders in this segment include Airlines, Airports, Air Navigation Service Providers (ANSP), Air Traffic Management (ATM) entities, Civil Aviation Agencies, and drone operators. A promising application for EO in this segment is flight planning, as EO data can identify hazardous weather conditions in their early stages, allowing airliners to adapt and optimise their flights. The identification of obstacles for drone flight paths as well as identification of population density can furthermore be done with satellite imagery. Additionally, EO can support the identification of high-probability contrail zones (which accounts for 60% of aviation's impact on climate), so airlines can adjust flight paths to avoid them.
Global Navigation Satellite Systems
The use of GNSS is integral to the day-to-day activities for stakeholders across both manned aviation (e.g. airlines, pilots, helicopter operators, airports, ATMs and ANSPs) and unmanned aviation (e.g. drone operators, drone infrastructure providers, etc.). GNSS is an integral and key technology behind various applications for which PNT information is crucial such as ATM system timing, Performance Based Navigation (PBN), Visual Flight Rules (VFR) complement, Electronic Conspicuity and surveillance, Global Aeronautical Distress & Safety System (GADSS) and infrastructure Timing. For drones, GNSS supports navigation as well as also electronic conspicuity to ensure awareness of other airspace users. . EGNOS supports helicopter operations, including medical and emergency ones. EUSPA supports operational implementation of such missions with dedicated practical tools and co-funding.
Level of Awareness / Adoption
Copernicus
Copernicus sees emerging uptake by aviation and drone stakeholders. Some airports use it to support their compliance with ICAO Standards and Recommended Practices for aeronautical information and aerodrome mapping. ANSPs use Copernicus Sentinels, together with CAMS and C3S services, to support atmosphere composition monitoring and detect hazardous weather conditions such as hurricanes, and ash, dust and smoke deriving from natural disasters (e.g., volcano eruptions, wildfires), which enables intelligent re-routing and enhances the optimisation of fuel consumption and aircraft maintenance.

Drone operators and Air Navigation service providers are starting to integrate Copernicus Global Human Settlement Layer (GHSL) in flight mission planning and management, as well as to mitigate the ground-based risks posed by some drone operations.
EGNSS
Across the GNSS applications, Galileo sees the highest penetration in annual shipments supporting all operations. Galileo included in most receiver models both for navigation and position reporting. Emerging requirements for demanding applications in the fastest growing markets in specific and certified category drive evolution of the navigation function. Galileo OS-NMA sees potential in supporting robust navigation and surveillance applications. EGNOS adoption for manned aviation is supported by the PBN regulation that mandates LPV implementation to all instrument runway ends by 2024, and exclusive use of PBN from 2030, positioning EGNOS as the main enabler for CAT I. Further evolution to a DFMC environment, with EGNOS V3 and ARAIM leveraging Galileo will support further the use of EGNSS. Galileo, via its contribution to Cospas Sarsat, supports Global Aeronautical Distress and Safety System (GADSS). The first search and rescue beacons implementing Galileo SAR and Return Link Service (both ELT Distress Tracking and ELT Survival) are already commercially available.
Major R&D Initiatives
Copernicus
Predictive maintenance is an important topic for which Copernicus can provided added value in the aviation industry, specifically by forecasting and/or detecting atmospheric particles present in flight paths (e.g., resulting in clogging of turbine engines and cooling vents) which enables airlines to optimise their maintenance schedule around expected damage. CAMS specifically is useful to assess atmospheric conditions resulting in abrasion, clogging and corrosion of flight assets.
EGNSS
In light of the Single European Sky, various projects and initiatives are ongoing related to the safety and security of the European airspace (i.e., the SESAR projectEUSPA is supporting development of innovative applications leveraging differentiators via Horizon Europe and Fundamental elements programmes (eg, CERTIFLIGHT, GEODESY, DEGREE), as well as introduction of space in the relevant standards
Policy, Legislation and Regulation
Copernicus
The aviation sector is responsible for approximately 4% of CO2 emissions in Europe. At the end of 2022, the European Parliament and the Council reached a deal to help make the aviation sector ‘Fit for 55', setting in law its contribution to the EU target of reducing net greenhouse gas emissions by at least 55% by 2030. Copernicus can help support the mitigation and monitoring of such emissions and such legislation is foreseen to improve overall uptake of Copernicus in this segment.
EGNSS
For (E)GNSS, a wide range of organisations are active in the field of regulations and standardisation: International Civil Aviation Organisation (ICAO), International Telecommunication Union (ITU), International Air Transport Association (IATA), regional airlines associations, Civil Air Navigation Services Organisation (CANSO) groups at the international level; the European Commission, EUROCONTROL, European Civil Aviation Conference (ECAC), and airlines and airspace user associations at the European level. When it comes to standards, the European Organisation for Civil Aviation Equipment (EUROCAE) and the Radio Technical Commission for Aeronautics (RTCA) are crucial. In 2018, the European Commission adopted the PBN Regulation, mandating the implementation of EGNOS approach procedures by all airports by 2024 and exclusive use of PBN by 2030. For drones, EU Regulations 2019/947 and 2019/945 set out a framework for the safe operations of civil drones in the European skies, whilst the U-Space regulatory package – 2021/664, 2021/665 and 2021/666 establishes and harmonises the necessary requirements for manned and unmanned aircraft

to operate safely in the U-space airspace. The European Commission's Drone Strategy 2.0 makes several references to the use of the EU Space services An extensive overview of all policies, regulations, legislations and standards related to (E)GNSS can be found in the Aviation and Drones Report on User Needs and Requirements.
Barriers & Future Directions
Copernicus
Copernicus is expected to primarily continue adding value the flight planning in manned aviation, as it can bring accurate information about atmospheric conditions that may affect traffic. Airport planning, or operational surveillance of airports, may also be a promising future application, although the barrier of the Sentinels' coarse resolution may hamper uptake. In drones, Copernicus provides value to identify populated areas with potential to support harmonised safety assessment in EU and its support to SORA 2.0 is under analysis.
EGNSS
Various GNSS barriers are limiting drone operations such as signal availability in challenging environments, multipath, as well as jamming and spoofing of the signals. Whilst ongoing work on OSNMA and CAS will play a role in tackling spoofing attempts, the work by ICAO on the future dual-frequency multi-constellation (DFMC) GBAS concepts aims to enhance the robustness of GBAS receivers and approach services which will improve the performance of basic GPS-only receivers. EGNSS has potential to support medium risk operations that are defined by the EASA Special Condition for Light Unmanned Aircraft Systems applicable to medium risk operations, where means of compliance are under definition. EGNSS can also support Innovative Air Mobility operations, that EASA proposes to define under a new annex in the Regulation 965/2012 Air-Operations, Annex IX Part-IAM (Innovative Air Mobility).

Climate, Environment and Biodiversity

Segment	**Climate, Environment and Biodiversity**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	**Minor**	Initial	Major
Stakeholders and Applications			
Earth Observation			
While the global climate and biodiversity crisis has spurred the need for data and services to address pressing challenges, numerous EO applications are being developed to fulfil the need for data. Copernicus data is a vital tool for monitoring various environments, including water, oceans, coasts, atmosphere, and land. It provides essential data to monitor our impact on the environment and take informed decisions to mitigate the influence of climate - and other environmental changes - on human activities as well as monitoring the impact of human activities on our Earth system Important users of EO in the Climate, Environment, and Biodiversity segment include governments and other public authorities for which EO data is important for various aims such as sustainable decision-making and environmental law enforcement; NGOs, regional centres and environmental institutes for which EO data is used, for example, to monitor and restore various ecosystems; and the industry and financial institutions for which EO data is useful the implementation of ESG and sustainability practices, for climate/environmental risks monitoring and climate adaptation. In the environmental monitoring segment, EO data is used for impact assessments, risk assessments, legal audits, and environmental resources management. EO data also plays a crucial role in deforestation and carbon removal markets in the identification of areas for afforestation/reforestation/restoration sites, in monitoring seasonal productivity and ongoing carbon sequestration actions and in helping to estimate ground biomass and support the evaluation of sequestrated carbon volume. EO also plays a central role in climate services to improve and validate climate models while climate resilience efforts rely on such data to monitor ecosystems, provide timely			

warnings for extreme weather events, and manage water – and other - resources affected by climate change. In the biodiversity, ecosystems and natural capital segment, EO data contributes to the ecosystem's monitoring, restoration and conservation, including coral reefs, wetlands, grasslands, snow and ice.

Global Navigation Satellite Systems

The use of GNSS across the different subsegments of this cluster is rather limited to two distinct applications. On the one hand there are the animal trackers used for biodiversity purposes, whilst on the other hand GNSS plays a role in climate modelling. The stakeholders are therefore not different to the ones listed under the EO section.

Level of Awareness / Adoption

Copernicus

The level of awareness and adoption of Copernicus data in the Climate, Environment, and Biodiversity segment varies according to stakeholders needs and the different applications. It is in climate services where the uptake is the most important as satellite data provides significant contributions climate modelling and forecasting for example to understand the resilience of various sectors to climate change such as infrastructures, insurance and energy. In climate and environmental monitoring, EO use is currently influenced by standardisation bodies like the Task Force on Climate-related Financial Disclosures (TCFD) and Task Force on Nature-related Financial Disclosures (TNFD) which are gaining international recognition from various institutions and businesses, facilitating the integration of EO data into financial and business frameworks. Many large companies are also starting to rely on EO data to disclose various types of information for sustainability reporting driven by several reporting directives and standards such as CSRD, CSDD, EUDR, ESRS, including land cover and land cover changes showing the absence of deforestation and reforestation efforts, water withdrawal from areas of water scarcity, emissions data, atmospheric gas monitoring, and detection of pollution, such as oil spills in water bodies. In the biodiversity, ecosystems and natural capital segment, different actors, such as NGOs, are starting to recognise the advantages of integrating EO into their fundamental operations.

EGNSS

Whilst there is a very limited use of GNSS in this segment, GNSS reflectometry and radio occultation are used for the support of climate modelling. Both of these techniques would benefit from the use of Galileo as part of a multi-constellation solution, as Galileo would add improved accuracy and more frequent updates of positioning information compared to GPS-only solutions. However, very little is known of the actual adoption or awareness of EGNSS added value within this niche field.

Major R&D Initiatives

Copernicus

With regards to climate services, climate modelling is in a state of continuous evolution and advancement as researchers refine existing models and create new ones, incorporating the latest scientific discoveries, EO data, and computing capabilities. EU Destination Earth is an important initiative which combines climate modelling and EO technology to develop a comprehensive digital model of the planet, enabling a deeper understanding of climate change impacts, simulating possible scenarios and informing effective mitigation strategies. In addition, reanalysis is an important process that will improve climate modelling and forecasting tools. It compiles comprehensive historical weather and climate data by blending past observations with previous short-term weather forecasts to rerun modern forecasting models. In the environmental monitoring segment, the demand for data and advancements in EO technology have led to the emergence of integrated value chains, with start-ups developing new products based on EO data for impact assessments, risk assessments, compliance assurance, legal audits, and environmental resources management. In the biodiversity, ecosystems and natural capital segment, the evolution of technology and integration of various data sources with EO allows new ecosystem monitoring applications to be developed.

EGNSS
No major R&D initiatives exist for EGNSS in this segment.
Policy, Legislation and Regulation
Copernicus
The main EU recent evolution is the European Green Deal, launched in 2019. Under this regulation, there are several new and upcoming regulations linked to Climate, Environment, and Biodiversity. Firstly, the new rule on Corporate Sustainability Reporting Directive (CSRD) requires a large set of companies to disclose information on the risks and opportunities arising from environmental issues and on report on the impact of their activities on the environment beyond just carbon, including pollution, water, waste, and biodiversity. Secondly the new Regulation on Deforestation-free products , obliges companies to ensure products sold in the EU have not led to deforestation and forest degradation. Finally, the new legislation for Carbon Removal Certification which the EC is currently working. This aims to develop the necessary rules to monitor, report and verify the authenticity of these removals. Also embedded within the green deal, the EU's climate strategy encompasses policies and measures to significantly reduce greenhouse gas emissions, accelerate the fair transition to renewable energy sources, and foster green innovation across various sectors. In tandem, the EU Climate Adaptation Strategy, updated in 2021, is designed to enhance the EU's resilience to the inevitable impacts of climate change, ensuring that communities, infrastructure, and ecosystems are better prepared to withstand and recover from climate-related challenges such as extreme weather events and rising sea levels. In addition, the recent EU 2030 Biodiversity Strategy and nature Restauration Law, lays out comprehensive goals to halt biodiversity loss, limit global warming and restore Europe's natural environments by the end of the decade.
EGNSS
No major policy, legislations or regulations exist relevant to EGNSS in this segment.
Barriers & Future Directions
Copernicus
With regards to **climate services**, EO technologies and services are already well developed and are continuously evolving according to the latest key R&D trends mentioned above. In addition to these trends, climate resilience is becoming an increasing important topic in which EO can play a key role, particularly in assessing risks associated with water scarcity, sea-level rise, flooding, irregular water streams, deforestation, and extreme heat, offering a comprehensive understanding of changing climate conditions. For **environmental monitoring**, although increasingly more companies are using EO data for ESG/ sustainability reporting and climate/biodiversity risks, such data is limited for a larger scale (i.e., country level, sector level, etc.) which limits the comparison between companies or industries. Markets related to the **biodiversity, ecosystems and natural capital** segment, will experiment significant growth, involving a growing demand for data, including EO data. However, the exact role of EO data in this expanding market is difficult to predict as it depends on the evolution of various factors. A key factor is the evolution of in-situ technologies which are increasingly being fused with EO technologies to enhance ecosystem monitoring across various applications. Furthermore, the consolidation of diverse data sources into single platforms, as demonstrated by initiatives like the WWF's 'Geospatial ESG Consortium' promises to significantly elevate data quality but such developments are still at initial states. Lastly, as technology improves, with the **evolution of Sentinel missions (CO2M) and the anticipated launch of private satellite constellations,** EO data quality and availability will rise, especially in hyperspectral imaging and thermal data, as well resolution which are critical elements in the success of ecosystems monitoring and climate resilience.
EGNSS
No clear barriers nor future directions were identified related to EGNSS in this segment.

Consumer Solutions, Tourism, and Health

Segment	**Consumer Solutions, Tourism, and Health**		
Copernicus uptake	Minor	**Initial**	Major
EGNSS uptake	Minor	Initial	**Major**

Stakeholders and Applications

Earth Observation

This segment comprises several diverse stakeholder communities with differing needs and a diverse set of applications. Earth Observation has a major (indirect) contribution to all communities through its applications in weather forecasting and mapping. EO data can be used both for personal health needs (i.e., providing local forecasts of UV, pollen levels) and for public health issues (e.g., identifying conditions for the spread of diseases). It can also be used for monitoring air pollution, urban heat islands and water quality, which impacts both personal and public health. Such information is relevant for individuals, for public health authorities, and for related businesses such as insurance.

Global Navigation Satellite Systems

This segment is characterised by its mass-market applications and users, as well as some professional users relying on mass-market location-based services. Across all three subsegments, the smartphone or wearable user is the main stakeholder (e.g. smartphone, tablet and wearable applications), and for each subsegment some specific stakeholders can be identified on top of the consumer: for the Consumer Solution subsegment there are some corporate applications (e.g. billing, workforce management) used by companies; the tourism subsegment sees relevant authorities, institutions and companies; whilst the health subsegment has their own specific relevant authorities and institutions. Within the User Needs and Requirements report for Consumer Solutions, figure 1 provides a very clear overview of the overlap of applications across the different subsegments and its respective users.

Level of Awareness / Adoption

Copernicus

At present there is a relatively small, but growing, awareness of the potential of EO data, with a small number of applications under development which have the potential to be pathfinders for wider adoption.

EGNSS

As the use of multiple constellations for consumer solution applications has an impact on the battery consumption (see section on 'Barriers & Future Directions'), device manufacturers would often limit the active use of GNSS to maximum two constellations. Galileo managed to become rapidly the constellation alongside GPS actively used onboard these handheld devices. It is estimated that the penetration of Galileo amongst new application shipments is already above 90% and expected to reach 100% by 2026. At the end of 2022, over 4 billion Galileo-enabled smartphones were sold, with over 270 smartphones models being Galileo-enabled. Due to the issue of battery drain, the use of EGNOS is either limited or not used at all (despite most latest models being EGNOS-enabled).

Major R&D Initiatives

Copernicus

There are no major R&D initiatives in this area for Copernicus.

EGNSS

Apart from solving the challenge of battery consumption, no major R&D initiatives exist for EGNSS in this segment.

Policy, Legislation and Regulation

Copernicus

The European Health Union is a set of regulations aiming at reinforcing cooperation between member states, and enhancing the roles of EU Agencies, to address potential cross border health threats.
EGNSS
The E112 Regulation makes the use of Galileo mandatory to establish location for emergency calls to the 112-emergency number. The Regulation applies in all EU Member States from 17 March 2022. Several standardisation activities are ongoing related to signalling, performance requirements and testing & certification procedures.
Barriers & Future Directions
Copernicus
There are no specific barriers identified to further adoption of EO based services, mainly this just requires an increased effort to promote the uptake of such solutions.
EGNSS
Several barriers and limitations inherent to the (E)GNSS signal are important to be listed. The challenge that the industry needs to tackle first and foremost would be that of power consumption. The use of GNSS information in smartphones and wearables consumes the battery and could lead to batter lifetime issues. Different techniques can be utilised to optimise power consumption. Other limitations are associated with the availability of the signal both indoors and in challenging environments, as well as the susceptibility to multipath. Finally, there is the issue of signal jamming and spoofing.

Emergency Management and Humanitarian Aid

Segment	**Emergency Management and Humanitarian Aid**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
EO plays a pivotal role in responding to emergency situations, such as droughts, earthquakes, floods, and other natural disasters. Downstream applications of EO extends across all phases of emergency management, from preparedness and early warning to rapid mapping and post-event analysis. The use of EO in disaster risk reduction efforts at national and local levels is seen across private and public sectors and supports monitoring and early warning systems. The Copernicus Emergency Management Service (CEMS) provides information for prevention, preparedness, response and recovery activities for different natural and man-made disasters and other humanitarian crises.			
Global Navigation Satellite Systems			
The use of GNSS, and especially the positioning information, is vital for most of the applications within this segment. On the one hand there are the various search and rescue beacons relying on GNSS to transmit the location of the person in distress, on the other hand the positioning information is also used for the fleet management of vehicles and equipment used by humanitarian aid workers. When it comes to the different search and rescue beacons, three classifications are made: (i) Aviation (i.e. emergency locator transmitter (ELT), and personal locator beacon (PLB)), (ii) Land (PLB), and (iii) Maritime (emergency position indicating radio beacon (EPIRB), PLB, automatic identification system search and rescue transponder (AIS-SART) and man overboard beacon (AIS-MOB)).			
Level of Awareness / Adoption			
Copernicus			
CEMS' on-demand mapping component and Early Warning component, compiled from the Forest Fire Information System (EFFIS), the Flood Awareness System (EFAS) and the Drought Observatory (EDO),			

sees significant uptake in Europe. CEMS sees specific uptake in areas where nations may not have extensive 'in-house' capabilities. Nations that do have specific expertise, for example in flood mapping, often continue to rely on their own systems rather than use Copernicus EFAS. Adoption by NGO organisations for humanitarian aid applications is generally at minor/initial stage.

EGNSS

Galileo is an essential contributor to the COSPAS-SARSAT programme. The programme is a satellite-based search and rescue distress alert detection and information distribution system, which informs Rescue Coordination Centres (RCCs), coast guards and other emergency response teams in case a distress signal is received. Besides being an integral part to COSPAS-SARSAT, the Galileo differentiators such as the search and rescue service, and the Return Link Service (RLS), as well as the upcoming Remote Beacon Activation (RBA) service provide essential contributions to the global network of emergency response. From a device point-of-view, the estimated penetration of Galileo amongst new shipments in 2023 would be 60% for EPIRBs and 90% for AIS-SARTs and MOBs. These uptake rates are foreseen to hit 100% by 2026.

Major R&D Initiatives

Copernicus

Advances in deep learning and AI also support the emergency management segment, for example in fire hazard forecasting: hybrid modelling, coupling physical models with data-driven machine learning, is used to create robust fire hazard forecasts at large scales and enhance our understanding of fire dynamics in complex ecosystems. Furthermore, systems are being put in place that combine meteorological, geospatial and open data to improve emergency situational awareness and preparedness, which allows responders to better react to extreme weather events driven by climate change. Finally, the NewSpace offer also diversifies data streams and deliver alternative solutions to the ones established by Copernicus EMS.

EGNSS

Advances in deep learning and AI also support the emergency management segment, for example in fire hazard forecasting: hybrid modelling, coupling physical models with data-driven machine learning, is used to create robust fire hazard forecasts at large scales and enhance our understanding of fire dynamics in complex ecosystems. Furthermore, systems are being put in place that combine meteorological, geospatial and open data to improve emergency situational awareness and preparedness, which allows responders to better react to extreme weather events driven by climate change.

Policy, Legislation and Regulation

Copernicus

In 2021, the EU's Civil Protection and Humanitarian Aid Operations department published a new Disaster Preparedness Guidance Note that explains its approach to disaster preparedness, which plays an important role in building the resilience of communities, and risk-informed humanitarian response. Copernicus can support such efforts through its risk & recovery mapping and early warning and monitoring system.

EGNSS

The following regulations are applicable to Humanitarian Aid subsegment:

- Convention (IV) relative to the Protection of Civilian Persons in Time of War (Geneva, 12 August 1949).
- International Humanitarian Law.
- Council Regulation (EC) N° 1257/96 on humanitarian aid.
- Decision (EU) 2019/420 of the European Parliament and of the Council on a Union Civil Protection Mechanism.

When it comes to search and rescue, the sector is more heavily regulated when it comes to the use of GNSS, especially in the field of Aviation (ICAO GADSS 6.0) and Maritime (IMO Global Maritime Distress and Safety System (GMDSS).
Barriers & Future Directions
Copernicus
Due to the nature of emergency management and humanitarian aid, data and insights need to be rapidly translated into useable information. This immediate need constitutes a specific barrier for the uptake of Copernicus as not all services provide the information at the required speed. Furthermore, due to the technical complexity of EO data and products, future initiatives in this segment should focus on making sure the information cannot only be delivered rapidly and frequently, but in a format directly useable by the stakeholders. Finally, NewSpace end-to-end capabilities need to be properly assessed and possibly incorporated in the future.
EGNSS
Similar to the barriers within the Consumer Solution, Tourism and Health segment, GNSS power consumption is an issue for search and rescue beacons. Limitations also arise in challenging environments for real-time status and position reporting, the time-to-first fix in remote areas and the rising threat of jamming and spoofing of the GNSS signal.

Energy and Raw Materials

Segment	**Energy and Raw Materials**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
EO will play an increasingly large role in the Energy segment as the world accelerates the fair green energy transition. Important stakeholders in the Energy segment include energy project developers, utility companies, energy asset manufacturers, financiers, as well as government institutions, energy traders and supply chain managers. EO satellite data enable these actors to plan and monitor assets, audit (environmental) policies and regulation, and gain an overall information edge. A key application in this segment is site selection, planning and monitoring. To select and plan new sites, EO data helps forecast renewable energy potential (e.g., for solar/wind parks). It also helps increase energy grid stability, or anticipate near-term energy prices, by nowcasting renewable energy production. In the Raw Materials segment, stakeholders include mining companies and associations, financiers, government institutions, commodity traders, and supply chain managers. EO data enables them to identify areas with the most mineral resources potential in mineral exploration phase, monitor environmental impact of mines and increase operational efficiency and improve safety, for example by continuously monitoring mine pits and tailings slope stability. Finally, Earth Observation also contributes to track the implementation and effectiveness of environmental due diligence activities of suppliers in Minerals Supply Chains.			
Global Navigation Satellite Systems			
GNSS is key in the synchronisation of energy networks and smart grids using Phasor Measurement Units (PMUs) which contributes to the safe and efficient functioning of the energy grid. Looking at raw materials and renewables, GNSS positioning is used for the site selection, planning and operational activities, whilst it also plays a major role in all activities relating to mining. Whether this is for the site selection, surveying or merely managing the fleet of different heavy utility trucks or machinery. The list			

of stakeholders is similar, and often the same, as the ones presented above namely energy project developers, utility companies, energy grid managers, etc.
Level of Awareness / Adoption
Copernicus
The level of awareness and overall uptake of Copernicus by the energy industry varies between the sub-segments: practically all solar energy stakeholders use Copernicus in their day-to-day operations (specifically CAMS/C3S), whereas only a handful of the wind practitioners are convinced of the added value (and most continue to rely on in-situ measurements). Various initiatives and tools have been developed (e.g., using SAR data) to analyse important characteristics, such as windfarm wakes. Uptake has clear potential, but it is not yet widespread for the wind segment. The uptake of Copernicus in the Raw Materials can be considered from the early mineral exploration phase to map the current land use and environmental conditions and to identify proxy to economic mineral deposits; at this stage, the level of awareness among actors is high on the benefits brought by Copernicus. During the mine life, geotechnical applications for slope stability and ground deformation become a key challenge for mine sites, some mines utilize Copernicus (Specifically Sentinel-1) to increase safety (e.g., by monitoring slope stability). A rather limited number of actors are now using Copernicus data for environmental monitoring of mining activities and an even smaller number to gain knowledge on the minerals and metals supply-chains. This is where the biggest potential for uptake lies.
EGNSS
PMUs are considered a vital application to ensure grid reliability, efficiency and stability, only around 50,000 units are currently deployed in energy grids across the world. Looking at mining activities, awareness and adoption has reached such high levels that not using GNSS has become unthinkable across the world. The use of GNSS across the world in open pit mines is likely the largest driver for GNSS and thus EGNSS adoption in the energy and raw materials segment as open pit mines rely on GNSS for various applications (see above). Due to the improved accuracy and availability when adopting EGNSS-enabled receivers, the adoption of EGNSS across the world in open pit mine applications is expected to grow from 25% in 2023 to 35% over the next decade (slow replacement rate and long lifetime of devices hinders a quicker uptake). For PMUs, it is assumed that this penetration rate has already reached 100%.
Major R&D Initiatives
Copernicus
Renewable energy generation is heavily dependent on the climate system that underpins it, and macro-level climate change is impacting the potential of renewable energy sources. Over the next few decades, substantial shifts in weather characteristics are anticipated due to the ongoing rise in average global temperatures. Major investments are being made to better understand the impact of these changes on the renewable energy sector, by creating new models to comprehensively understand how climatic changes will impact weather patterns and, consequently, solar and wind farm yields. Other R&D initiatives focus on the integration of Renewable Energy Systems in the existing power grids, which poses a major challenge due to the intermittent nature of these energy sources. In the Raw Materials segment, combining various data sources (including Copernicus, commercial satellites, upcoming missions, airborne and low altitude, and in situ data) into one coherent system to help mineral exploration and mining site monitoring has seen significant investments, as well.
EGNSS
Apart from ongoing studies related to Galileo OSNMA and CAS, as well as authentication in general, there are no major R&D initiatives exist for EGNSS in this segment.
Policy, Legislation and Regulation
Copernicus

Boosting the share of renewables has been at the heart of the EU's strategic objectives as represented in the EU Green Deal and the REPowerEU plan, the latter setting the target for renewables to 45% and lays out concrete measures to make Europe independent from Russian fossil fuels well before 2030. All of this is foreseen to further boost Copernicus uptake within the segment, specifically aiding topics such as the definition of "go-to areas", obligated to the Member States under the REPowerEU plan, where EO data can play an important role. On the other hand, a key focal point of the 2023 Critical Raw Materials Act foresees ambitious domestic targets of at least 10% of the EU's annual consumption of strategic raw materials to be extracted locally (against close to 2% today). The Act also includes investing in research, innovation, and skills: to strengthen the uptake and deployment of breakthrough technologies in critical raw materials. Earth observation data is one of these key technologies and can help accelerate the objectives set out by the EU, which will further boost uptake of Copernicus. Another legislative driver is the Battery Regulation setting important requirement in the traceability of battery components through the battery product passport.

EGNSS

In 2008, the European Commission issued the 2008/114/EC Directive on the Identification and designation of European critical infrastructures and the assessment of the need to improve their protection. The energy domain is mentioned and recognised as a key critical infrastructure. In 2023, the Directive on the Resilience of Critical Entities entered into force repealing the 2008/114/EC Directive. Key stakeholders in the field of policies, legislation and regulation alongside the European Commission would be the ENTSO-E and each national TSO, as well as the European Agency for the Cooperation of Energy Regulators (ACER). However, no major policy, legislations or regulations exist relevant to EGNSS in this segment.

Barriers & Future Directions

Copernicus

Copernicus provides a strong value proposition to the segment: it is readily available for free, and often provides sufficient spatial resolution for various applications at hand. However, the temporal resolution is often a limiting factor. This is felt specifically in the Raw Materials segment after the failure of Sentinel-1B, as the temporal resolution of the SAR data is now just once 12 days (and Sentinel-1C is delayed due to issues with the Vega launcher). For the wind segment, inaccuracies due to required extrapolation of the data (wind speed is measured at the sea surface, whereas the turbines operate at 150m+ in the air) force the users to continue relying on in-situ measurements for bankable proposals. Uptake of Copernicus is however still foreseen for specific 'new' applications, such as mapping wind farm wakes using SAR data. Furthermore, for preliminary exploration in areas where obtaining local data is difficult and costly (which is valid for both renewable energy applications and mineral exploration), Copernicus provides significant value.

EGNSS

With the latest developments on Galileo HAS, OSNMA and CAS, further adoption of the EGNSS differentiators is expected across the different applications used in both the Energy and the Raw Materials segments. One existing barrier that is likely to be faced across most, if not all, segments are threats associated with jamming and spoofing. Whilst this is unlikely to occur at mining sites or during site selection activities (as these are often in remote areas), the potential consequences of a jamming or spoofing attack on an energy grid could be high (i.e., black-out of a city). More awareness could be raised on these elements as the failure of the energy grid would have an immediate impact on other critical infrastructures as well as most day-to-day activities. The industry's growing interest in adopting Galileo OSNMA and/or CAS is therefore a step in the right direction. Other limitations can be associated with the operating environment for specific surveying operations (i.e., in dense urban areas or where natural obstructions can occur (i.e., tree canopy, deep open pit mines) as well as lack of vertical positioning. Deployment of complementary technologies alongside GNSS (i.e., RTK, use of RPAS, dedicated software) could overcome these barriers.

Fisheries and Aquaculture

Segment	**Fisheries and Aquaculture**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	Initial	**Major**

Stakeholders and Applications

Earth Observation

Several applications of Copernicus data support the fisheries and aquaculture segment. In the domain of **fisheries**, EO is used to assess the location of fish stocks and to potentially optimise fishing efforts by providing information on factors like ocean temperature and chlorophyll levels, critical for determining fish distribution and abundance. Optical and radar data is also used to trace and 'see' fishing vessels and assess the legality of their actions, thus also helping to prevent and combat illegal, unreported and unregulated (IUU) fishing. In the field of **aquaculture**, EO-based applications mostly support site selection for future fish farms thanks to the input of environmental conditions, forecasts and predictions, often in the form of maritime spatial planning products. EO applications also contribute to the optimisation and planning of aquaculture operations, both at sea and inland, by providing a host of information to aquafarmers. Users of EO for fisheries and aquaculture span fisheries management authorities, aquaculture operators, environmental organisations, researchers, commercial fishing firms, and international bodies like the Food and Agriculture Organization of the United Nations (FAO), collectively ensuring the health and sustainability of these industries.

Global Navigation Satellite Systems

The positioning and navigation information from GNSS plays an important role in the safe navigation of fishing vessels from the moment the vessels leave their birthplace in its harbour until it returns after a time at sea. GNSS also contributes to IUU detection through its role in the Automatic Identification System (AIS) as well as the Vessel Monitoring System (VMS) that uses GNSS as a source for the position information of the vessel. The primary function of the AIS is of course to provide the vessel and its crew with an additional layer of safety as it is used for collision avoidance. To be able to locate fishing gear (e.g., nets, buoys, etc.) as well as fishing grounds, the use of low-cost GNSS receivers is sharply on the rise. Besides the fishing vessels and their crews, GNSS is used by fishing monitoring agencies, surveillance authorities, as well as data analytics companies.

Level of Awareness / Adoption

Copernicus

The use of EO data is becoming more important in catch optimisation, fish stock detection and aquaculture operations optimisation as the fishing and aquaculture industries are under efficiency and sustainability pressure. Authorities understand that EO is key in sustainable fish stock management while the role of EO is becoming more important in the aquaculture segment where farms are moving more and more offshore (due to sustainability and competitivity concerns).

EGNSS

Galileo is widely adopted in AIS receivers, whilst it sees a much lower adoption in the VMS (2023 figures are estimated at +60% vs. +15%). For most of the low-cost applications, standalone GPS receivers dominate the market as users do not see the need for additional constellations such as Galileo. Galileo

is also present in the emergency beacons that are mandatory in these vessels (i.e. EPIRBs and PLBs, see emergency management section).

Major R&D Initiatives

Copernicus

While blue carbon economy is booming, R&D efforts focus on various indices derived from EO data that can be used to map and monitor the growth of seaweed in conjunction with other monitoring activities that involve field sampling and surveys. Still in the field of aquaculture, several R&D projects aim at improving the European Maritime Spatial Planning (MSP) Platform - which is used for the optimisation if site selection - including the development of new tools based and the identification of technological gaps in MSP applications.

EGNSS

Ongoing work regarding the evolution of VMS and AIS to Very High Frequency Data Exchange (VDES) is including research on the use and adoption of Galileo OSNMA to provide a layer of authentication that can improve the monitoring of vishing vessels by the respective authorities. Also, to support the emergency situation of an overdue vessel, a new concept for the remote activation of emergency beacons (e.g. EPIRBs) has emerged with the development of new SAR beacons for maritime.

Policy, Legislation and Regulation

Copernicus

The Common Fisheries Policy (CFP) is a fundamental policy framework that governs fisheries management across EU member states. It includes regulations related to fishing quotas, technical measures, conservation, and sustainability. However, more effort is needed to fully implement the CFP. This is why the **Fisheries policy package** was adopted in 2023 as it contributes to a healthier marine environment and maintains the profitability of the sector in the coming decades. The EU Aquaculture policy provides the legal framework for the development of aquaculture. It includes rules on environmental impact assessments, site selection, and the approval of aquaculture businesses.

EGNSS

A detailed overview of relevant policies, legislations and regulations for this segment can be found in the User Needs and Requirements Report on Maritime, Inland Waterways, Fisheries and Aquaculture. The four most important ones are:

- FAO Code of Conduct for Responsible Fisheries (1995) which serves as an international reference framework for various national and regional instruments. Whilst the Code is not a legally binding instrument, it has been widely adopted and some parts are based on international law and legally binding flag states responsibilities. In 2016, the FAO Agreement on Port State Measures entered into force which is the first international and legally binding instrument that targets IUU fishing;
- The EU's Common Fisheries Policy (CFP), which originated as a part of the Common Agricultural Policy (CAP), as a first comprehensive legal framework with environmental, economic and social sustainability at its core;
- The European Green Deal, the Farm to Fork and Biodiversity strategies.
- Commission Regulation on satellite-based Vessel Monitoring Systems.

Specifically, for (E)GNSS, the International Maritime Organisation (IMO) Resolutions A.915 (22) and A.1046 (27) form the main structure for the Maritime Radio Navigation Systems requirements. With

A.915 (22) serving as the “navigation and positioning” document covering the GNSS requirements for various navigation and positioning applications and operations.
Barriers & Future Directions
Copernicus
With regards to aquaculture, the market of EO for site selection is going to grow in the coming years as a result of the ever-increasing importance of aquaculture in recent key policies and the overall projected expansion in global food demand. With regards to fisheries, EO contribution to controlling and monitoring IUU fishing can and goes beyond meeting the needs of fishing authorities and has a clear room for increasing in the future. Generally, the users’ needs for future developments have to do with higher resolution revisit rates or more frequently than is the case today although users can already derive insights and better plan operations thanks to space-derived insights.
EGNSS
No GNSS is capable of providing all operational requirements, especially integrity, without the use of an augmentation system such as an SBAS and RAIM. For several years now, there is ongoing work related to the evolution of EGNOS v3 and the possibility to provide a dedicated Maritime Safety Service relying on integrity, which can then also be used by fishing vessels. As mentioned above (see ‘Major R&D initiatives’), The finalisation and adoption of VDES as well as the potential inclusion of Galileo OSNMA in VMS are the major directions foreseen for GNSS in the fisheries segment.

Forestry

Segment	**Forestry**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	**Initial**	Major
Stakeholders and Applications			
Earth Observation			
EO/Copernicus data are used to support a wide range of forest applications. It enables timely mapping of forests and identification of changes in forest cover and canopy condition. This includes mapping changes due to the environment (e.g., due to droughts or wildfires), to disease or to storm damage. EO can also be used to monitor logging, including in particular detection of illegal logging in areas that would otherwise be difficult to reach. Such applications are used by forest managers, but are increasingly being used by others, for example by companies offering certification of deforestation-free products. At a policy level, EO is used to support EUDR implementation, Proposal for a Regulation on a Forest Monitoring Framework and to produce statistics on forest cover in support of afforestation/reforestation initiatives and LULUCF monitoring.			
Global Navigation Satellite Systems			
The use of GNSS within the Forestry segment is primarily linked with applications used by forest managers to efficiently execute their forestry operations and entail applications such as automatic steering and machinery guidance as well as forest asset management, inventory and EUDR compliance. Apart from the forest managers, this segment also includes governmental bodies that oversee and monitor for example the environmental impact related to forestry activities as well as the monitoring of different forestry policies that have been adopted at national, European or global level.			
Level of Awareness / Adoption			
Copernicus			

There is generally a reasonably high level of awareness of EO based solutions, with initial adoption of such solutions by several early adopters leading to more widespread adoption by stakeholders in the industry. Wildfire detection as well illegal logging monitoring are particularly well advanced, while other applications (e.g., disease monitoring) are less so. Other promising area to increase the uptake, is the carbon removal certification through nature-based solutions such as forest restauration or C3S data to understand and mitigate climate change on forests. The use of Copernicus layers for forest management, especially amongst private forest owners, is less advanced, see note on barriers below.

EGNSS

Across the world only around 50,000 GNSS applications are in use within the forestry industry, with the vast majority (99%) of them being machinery guidance applications. In 2020, the uptake of Galileo in new shipments reached 80%, and this penetration is expected to reach 100% by 2026. The main added value of Galileo would be the improved accuracy and availability of the signal compared to GPS-only solutions.

Major R&D Initiatives

Copernicus

There are ongoing initiatives by EEA (as CLMS entrusted entity) and within Horizon Europe to improve the Copernicus layers for forestry to better meet the needs of users. There is also interest in research into using EO to detect forest health as well as just canopy cover, and to estimate biomass to support LULUCF reporting. Other R&D initiatives are expected for EUDR compliance. There is currently high interest in the use of new types of measurement (hyperspectral images, p-band SAR) for forestry applications.

EGNSS

No major R&D initiatives exist for EGNSS in this segment.

Policy, Legislation and Regulation

Copernicus

The European Green Deal commits the EU to improving its forested area, both in quality and quantity, and to fighting global deforestation linked to the EU's footprint. These aims are further reflected in the new Forest Strategy 2030 and the EUDR. This sets the ground for a series of actions including the development of the EU Observatory on Deforestation and Forest Degradation which will build Earth-Observation-based monitoring tools for forests that may be operationalised by Copernicus and taken up by FISE as part of the integrated forest monitoring system. With regards to the EU Deforestation Regulation (EUDR), its aim is to ensure that the goods consumed by EU citizens do not contribute to deforestation or forest degradation globally. Specifically, it strives to guarantee that the supply chains of the following commodities are free from deforestation: cattle, cocoa, coffee, oil palm, soya, wood, rubber and their derived products.

The Forestry Strategy underlines the strong link with biodiversity, explaining that Forest management Plans should include forest-related risk assessment and management, as well as better integrate biodiversity-related data. This is further covered in the new EU Biodiversity Strategy for 2030, which requires the EU to increase its forests in quantity and improve their health and resilience. Several other EU policies or communications pinpoint specific forest-related topics, including the Common Agricultural Policy, the Habitats and Birds Directives, the European Union Forest Law Enforcement, Governance and Trade Action Plan (FLEGT), the EUDR regulation, Forest Monitoring Framework regulation proposal and more.

EGNSS

In the Regulation (EU) 2023/1115 on deforestation-free products to tackle deforestation and forest degradation, the possible role for EGNSS includes the contributions that GNSS can give to collecting geo-coordinates of plot of lands, position/timing and geo-tagged photos for traceability purposes or the creation of a reliable forest inventory management system as well as future utilisation of OSNMA to increase trustworthiness of collected geospatial data.

Barriers & Future Directions
Copernicus
As mentioned above, issues around timeliness and frequency of CLMS layers prevent them being as widely used as they might be. Research into more advanced topics (plant health, biomass) are often limited by the availability of in-situ data. There is strong interest in using new types of measurement (hyperspectral images, p-band SAR) to develop new applications.
EGNSS
No immediate barriers or future directions for EGNSS have been identified. However, it is believed that the introduction of Galileo HAS and OSNMA will be welcomed by the industry.

Infrastructure

Segment	**Infrastructure**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
Today, the **Interferometric Synthetic-Aperture Radar (InSAR)** technology - relying, amongst others, on Sentinel 1 since 2014 - has proven to offer reliable and useful information in a wide range of applications, including monitoring the movement of tunnels, roads, bridges and pipelines, or the displacement of dams to a precision of millimetres (with a possibility to obtain historical data). Such large-scale, historical and precise information cannot be obtained by in-situ techniques which makes it a key tool for infrastructure designers and engineers as well as public authorities. This data helps in making informed decisions about maintenance, repair, and construction activities, ultimately ensuring the safety and reliability of critical infrastructures. **Optical imagery** - provided, amongst others, by Sentinel 2 since 2015 – has also proven to be efficient in supporting change detection in land cover and vegetation. It supports applications related to monitoring the environmental impact of infrastructure and to monitoring vegetation impeding on infrastructure. The main users of EO for infrastructure monitoring are government agencies and private sector entities, including engineering firms and utility companies.			
Global Navigation Satellite Systems			
Regarding GNSS use within the infrastructure segment, a differentiation needs to be made between the Construction part (primarily surveying activities) and the Telecommunications part (primarily timing and synchronisation). GNSS is used by construction companies, as well as relevant authorities and infrastructure managers, during and after the construction of a certain infrastructure. Key applications relying on GNSS are construction operations, post-construction monitoring, as well as site selection & planning. Looking at the Telecommunications segment, the operators of a telecommunication network are using GNSS for the timing and synchronisation of various networks in many applications (e.g., data centres, small cells, digital cellular network, professional mobile radios, satellite communication and public switched telephone network).			
Level of Awareness / Adoption			
Copernicus			
The use of EO data is progressively penetrating all infrastructure management activities at all stages of the infrastructure life cycle. From the initial site selection and planning to the assessment of infrastructure environmental impact and the regular monitoring of construction operations, the increasing exploitation of EO-based information brings solutions to an ever-growing user base in the infrastructure management area. More concretely, a number of public authorities and constructions companies have already adopted InSAR solutions powered by Copernicus Sentinel-1. This uptake is also			

reflected both at EU level, with the recently launched European Ground Motion Service of Copernicus, and at Member State level (in Germany, Italy, Spain and France), with the roll out of regional or nationwide InSAR services. Although the level of uptake of EO-based solutions is growing, it is still at an early stage and there is a clear demand from and towards the infrastructure sector for more and better satellite-based solutions that help to reduce uncertainties and risks, achieve environmental and climate goals, and increase operational efficiency.

EGNSS

There is a widespread adoption of Galileo across both subsegments within this segment. All applications related to the construction and monitoring of infrastructures are assumed to be 100% enabled by Galileo. The same can be concluded about the majority of telecom applications that rely on GNSS for their timing and synchronisation.

Major R&D Initiatives

Copernicus

R&D is focussing on many new applications that can be further developed and marketed. A first example **is water leaks,** which are an important problem found in nearly every pipeline system in the world. The use of near infrared satellite imagery can highlight areas of high moisture vegetation near water pipelines and hence helps in detecting leaks. Moreover, InSAR has the ability to monitor **subtle movements of dams**. Automated warning system could help in preventing disasters by detecting ground subsidence at an early stage. In parallel, various AI/data driven models are being further developed. This includes advances in digital elevation models, geophysical and soil characteristics for civil engineering related to networks deployment, real-time monitoring and long-time records of known sites affected by ground motion or natural risks, as well as climate records describing frequency and intensity of seasonal weather events for climate vulnerability and risk assessments.

EGNSS

In the field of timing and synchronisation there are various projects ongoing related to EGNSS standards for timing receivers as well as initiatives to improve the robustness of said receivers as well as the telecom network by leveraging Galileo OSNMA.

Policy, Legislation and Regulation

Copernicus

Achieving the goal of neutrality by 2050 defined by the European Green Deal will require a wide range of actions that reduce the environmental footprint of infrastructure and strengthen its climate resilience. In addition, the EU's environmental impact assessment directive requires that the impact of infrastructure projects on the environment be thoroughly assessed and monitored. The directive 2004/54/EC on minimum safety requirements for tunnels ensures that all tunnels longer than 500 metres, whether in operation, under construction or at the design stage, and forming part of the trans-European road network, comply with the new harmonised safety requirements.

EGNSS

There is no regulatory authority dedicated to infrastructures in general, but the European Commission is focused on the protection of critical infrastructures. The main EC directive in place was the 2008/114/EC on the Identification and designation of European critical infrastructures and the assessment of the need to improve their protection, although this Directive did not explicitly mention telecommunications as a critical infrastructure (something the US does include in its list of critical infrastructures). The 2008 Directive was amended in 2023 by the Directive on the Resilience of Critical Entities which includes the digital infrastructure sector. Apart from this Directive, several telecommunications related entities are in charge of most standards and regulations: the Body of European Regulators of Electronic Communications (BEREC), the National Regulatory Authorities in charge of regulating telecommunications, and several spectrum regulation agencies including the International Telecommunications Union (ITU).

Barriers & Future Directions
Copernicus
In the next years, several EO applications are expected to become generally available and widely used, driven by the overall market trends, the specific needs of actors in the sector, and the advances in technological capabilities. It includes l**arge-scale ground movement mapping** with large archives of data (with the needed storage capacity) and the use of EO in support of **permits delivering and assessing environmental impact** of infrastructure construction activities. The potential to better monitor critical infrastructure such as **bridges and tunnels** appears to be strong; but will require the integration of sentinel data with commercial data since the spatial resolution of Sentinel-1 is insufficient to locate the sources of movement. Next to further technological developments, there is a significant need for market development support, engagement of actors that can become champions for the adoption of EO, and replication of best practices.
EGNSS
Focusing on the use of the (E)GNSS for construction and monitoring related activities, the main barriers are associated with the limitations created by the operating environment (e.g., dense urban areas, natural or artificial (e.g. buildings) obstructions or the need for highly accurate vertical determination which cannot easily be provided through the use of GNSS. The upcoming Galileo HAS is foreseen to have a big impact on the GIS market and RTK users in Europe have already widely started adopting Galileo. EGNOS on the other hand has already been contributing to minor additional support for mapping and surveying activities as shared by stakeholders in light of public consultations for various projects including the User Consultation Platform. Looking at timing and synchronisation, as with other critical infrastructures the potential threat of jamming and spoofing attacks is a source of concern for telecom network operators. Adoption of Galileo OSNMA is foreseen to add an additional layer of robustness to handle spoofing attacks.

Insurance and Finance

Segment	**Insurance and Finances**		
Copernicus uptake	Minor	**Initial**	Major
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
Important stakeholders in this segment include insurers (and re-insurers) and international and local financial institutions (e.g., private and commercial banks, stock exchanges or traders). EO is used to compute indices for parametric products particularly for crops and livestock insurance (i.e., index production), calibration of risk models (i.e., risk modelling) and assessing damage and thereby claim management (i.e., event footprint), benefitting both the insurance and finance stakeholders. In addition, EO data supports screening processes (i.e., risk assessments) undertaken by financial institutions for their investments and contributes to the development of logistics strategies of organisations exploiting natural resources (i.e., indices for commodities trading).			
Global Navigation Satellite Systems			
As described above, there is a wide range of stakeholders active in the Insurance and Finance segment. When it comes to the use of GNSS however, that list can be reduced to banks and stock exchanges as well as the relevant monitoring authorities. Within these financial institutions, GNSS receivers are deployed for the timing and synchronisation of the financial network and more specifically to provide accurate timestamping to each and every transaction.			
Level of Awareness / Adoption			

Copernicus
Copernicus data and services see initial uptake in this segment. For example, some service providers in this segment use C3S, more specifically the Climate Data Store (CDS), to assess climate change impacts on biodiversity, risk management for commodity trading, and sustainable water management. CAMS is also used by the insurance sector for support by providing up-to-date catalogue of windstorms and their associated impacts on the ground, and other historical events that help prediction calculations.
EGNSS
Driven by the MiFID II directive (see the section on Policy, Legislation and Regulation below), the adoption of EGNSS across European shipments of GNSS receivers has gone up steadily over the past years. It is estimated that roughly 60% of the receiver sales are already Galileo-enabled and that this penetration rate will near 100% by 2033. Another driver of the interest in EGNSS amongst the clients for timing receivers are found in the Galileo differentiators such as OSNMA as it would provide a first mitigation layer against potential spoofing threats. An issue that is seeing increased attention amongst various stakeholders including the ones within critical infrastructures such as financial institutions.
Major R&D Initiatives
Copernicus
Agricultural insurance products supported by EO have seen notable R&D investments in recent years, eliminating the need for physical loss assessments and ensuring quick claim settlements. Copernicus data is used to monitor critical weather parameters like rainfall, wind speed, and temperature to design transparent insurance policies, bypassing the need for time-consuming and resource-heavy physical loss assessments.
EGNSS
Apart from ongoing studies related to Galileo OSNMA and CAS, as well as authentication in general, there are no major R&D initiatives exist for EGNSS in this segment.
Policy, Legislation and Regulation
Copernicus
The rise of contemporary regulatory frameworks, such as the Task Force on Climate-related Financial Disclosures (TCFD), Sustainable Finance Disclosure Regulation (SFDR), Financing Sustainable Growth, EU Taxonomy, EU Green Bond Standard, and the EU Action Plan on Sustainable Finance, is compelling financial institutions and insurance providers to precisely monitor and document ESG metrics. The use of Copernicus for collecting sustainable finance data and to close the data gap will be crucial for the implementation of data-driven, evidence-based policymaking in areas like micro-prudential supervision, financial stability, macroeconomic analysis, and risk and reserve management.
EGNSS
Alongside the European Commission, the main regulatory and policy stakeholders in Europe are the European Banking Authority (EBA) as well as the European Securities and Markets Authority (ESMA). For the financial sector, the main EC directives in place are the 2008/114/EC on the Identification and designation of European critical infrastructures and the assessment of the need to improve their protection, despite the fact that this Directive does not explicitly mentions the Finance domain as a critical infrastructure (something the US does include in its list of critical infrastructures). In 2023, the Directive on the Resilience of Critical Entities entered into force which sees an expanded scope of eleven sectors including the Banking and Financial Market Infrastructure. For Finance, the MiFID II Directive and its RTS25 annex is crucial as it includes user requirements that need to be met for the timestamping of transactions and requires the demonstration of the fact that their system can comply with the timing and synchronisation requirements. This can be done using GNSS timing receivers.
Barriers & Future Directions
Copernicus

Some key elements which may hinder the uptake of Copernicus include the conservative nature of the finance and insurance segment, where stakeholders are more likely to stick with existing systems and techniques. Another barrier is the integration of Copernicus data and services in existing products, requiring significant development costs. A lack of relevant EO skills in the segment is another factor, as well as concerns about continuity and reliability of the data and services. Areas where Copernicus is foreseen to play an important role in the future market evolution is transparency in carbon markets and ESG risk mapping and modelling.
EGNSS
In light of the MiFID II requirements, concerns have been raised by finance stakeholders as it is still unclear to them how they can prove how the timestamp has been created. Across Europe GNSS receivers have been adopted to comply with these requirements, but requests have been raised to have certified UTC sources from network connectivity as well. For now, financial operators are implementing different architecture solutions using multiple timing sources (including GNSS and local oscillators) to ensure that they meet the requirements. As highlight in other segments, the threat of jamming and spoofing is seeing wider attention and critical infrastructure operators such as financial stakeholders will look to improve their timing and synchronisation infrastructures, opening the room for adoption of Galileo OSNMA and/or Galileo CAS.

Maritime and Inland Waterways

Segment	**Maritime and Inland Waterways**		
Copernicus uptake	Minor	Initial	**Major**
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
EO plays an important role in advancing the blue and green economy, reducing emissions, ensuring port security, and enhancing maritime safety. Vessel-operators, port authorities, environmental agencies and recreational boaters are just a few stakeholders whose daily activities are positively impacted by EO.			
Global Navigation Satellite Systems			
GNSS is a key component of the Automatic Identification System (AIS) which supports collision avoidance. Mariners across the world rely on GNSS for safe and efficient navigation across seas, oceans and inland waterways. In addition to navigation, the positioning information is contributing to applications such as port operations, river information services, dark vessel monitoring, marine mapping and surveying etc. Besides the mariners and inland waterway skippers, other stakeholders such as authorities and data-analytics companies rely on GNSS information for their activities. Whilst no longer covered in the Maritime and Inland Waterways segment, search and rescue beacons for maritime users (see Emergency Management and Humanitarian Aid segment) rely on GNSS as well.			
Level of Awareness / Adoption			
Copernicus			
Copernicus sees significant uptake in specific application such as ship routing, inland waterway navigation, detection of offshore ‘dark vessels’, and oil spill detection (and tracing it back to the polluter by cross-matching tracking data using AIS, VMS and EO imagery).			
EGNSS			
Since May 2016, Galileo has been recognised by the International Maritime Organisation (IMO) as a part of the World-Wide Radio Navigation System (WWRNS), earning Galileo the necessary IMO wheel mark as a GNSS that can be used for maritime navigation. Since then, the adoption of Galileo has steadily increased. It is currently estimated that 30% of all maritime GNSS receivers in use are Galileo-enabled,			

whilst this uptake is near 90% for EGNOS-enabled receivers. Amongst new application shipments, those designed for inland waterway vessels currently see the lowest uptake of Galileo (around 40% in 2023), whilst all other applications see an uptake between 50% and 100% for new shipments. Galileo is also present in the emergency beacons that are mandatory in these vessels (EPIRBs and PLBs, see emergency management section).

Major R&D Initiatives

Copernicus

The development of semi-autonomous or fully unmanned ships is an important trend in the maritime industry, propelled by innovations in digital technologies such as artificial intelligence, smart robotics, and advanced navigation systems. Copernicus can play a specific role here through the precise mapping of inland waterways which contributes to the geospatial understanding necessary for effective route planning.

EGNSS

As in many transport segments, the major R&D initiative in both Maritime and Inland Waterways is the development and testing of autonomous vessels in anticipation of the launch of such vessels. GNSS and Galileo's differentiators will play an important role in these Maritime Autonomous Surface Ships (MASS). Other areas of R&D are the evolution of EGNOS towards EGNOS v3 and a dedicated Maritime Safety Service which will provide improved integrity features on the one hand, and ongoing developments regarding Galileo OSNMA adoption for various maritime applications (e.g. dark vessel monitoring, general navigation to make them more robust against potential spoofing attempts. Also, to support the emergency situation of an overdue vessel, a new concept for the remote activation of emergency beacons (e.g. EPIRBs) has emerged with the development of new SAR beacons for maritime.

Policy, Legislation and Regulation

Copernicus

Regulatory initiatives are paving the way for maritime autonomous surface ships (MASS), where International Maritime Organisation (IMO) has been addressing the regulatory challenges of autonomous vessels at the international level. This new code could be published as soon as 2025. Space-based solutions, including Copernicus for mapping, may play an important role in the safety regime for MASS.

EGNSS

The Maritime domain is highly regulated. The International Maritime Organisation (IMO) is the most important regulatory authority for the safety, security, and environmental performance of international shipping. Other important organisations are the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the International Telecommunications Union (ITU), the International Electro-technical Commission (IEC) and the Radio technical Commission for Maritime Services (RTCM). In Maritime, the International Convention for the Safety of Life at Sea (SOLAS) is the pivotal treaty that ensures that ships flagged by signatory States comply with minimum safety standards in the construction (of the vessel), equipment, and operation. Specifically, for (E)GNSS, the International Maritime Organisation (IMO) Resolutions A.915 (22) and A.1046 (27) form the main structure for the Maritime Radio Navigation Systems requirements. With A.915 (22) serving as the "navigation and positioning" document covering the GNSS requirements for various navigation and positioning applications and operations. Looking at the subsegment of Inland Waterways, the European Commission has a leading role and sets the framework directives and guidelines providing the minimum requirements for the River Information Service (RIS). A detailed overview of relevant policies, legislations and regulations for this segment can be found in the User Needs and Requirements Report on Maritime, Inland Waterways, Fisheries and Aquaculture.

Barriers & Future Directions

Copernicus

Copernicus is expected to play an increasingly important role in the future for maritime spatial planning and to detect and link pollution to ships at sea. However, some barriers to uptake exist and include technical limitations, such as spatial resolution and signal latency, which may not always be adequate to e.g., detect an oil spill or ice cap. The evolution of technologies such as Maritime Autonomous Surface Ships and related applications will furthermore be key to drive innovation in the blue economy, and Copernicus is similarly foreseen to play an important role here, .g. supporting the optimisation of shipping routes.
EGNSS
As anticipated in the Fisheries and Aquaculture segment, no GNSS is capable of providing all operational requirements, especially integrity, without the use of an augmentation system such as an SBAS. For several years now, there is ongoing work related to the evolution of EGNOS to provide a dedicated Maritime Safety Service relying on integrity. Alongside SBAS improvements, GNSS receivers will include and integrity functionality based on SBAS and Receiver Autonomous Integrity Monitoring (RAIM). Presented under the 'Major R&D initiatives' section, the future direction of this segment will focus more and more on autonomous operations, not only for vessels, but also for port operations. Galileo's differentiators such as OSNMA and HAS will be a crucial contributor towards this autonomous future, providing with the first an additional security layer in position reporting and with the second increased accuracy to support marine operations (e.g. pilotage, bathymetry).

Rail

Segment	**Rail**		
Copernicus uptake	Minor	**Initial**	Major
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
The primary role of EO is to monitor track conditions, looking either for subsidence or for vegetation incursions and monitoring of soil moisture under the railway track could be added as another significant application. The key stakeholders in this case are rail infrastructure managers and maintenance engineers. Other applications include using EO for monitoring signal visibility at level crossings.			
Global Navigation Satellite Systems			
Looking at the rail segment from the GNSS point-of-view, one can categorise the different applications in two groups. On the one hand, there are the safety critical applications such as enhanced command & control systems (CCS), trackside personnel protection systems. On the other hand, there are non-safety critical applications, such as rail fleet management, passenger information systems. The main groups of stakeholders that are relying on said applications range from passengers relying on train transport to get from point A to point B, to the: Infrastructure Managers (e.g. DB NETZ, SNCF Reseau; ADIF); Railway Undertakings (the operators – e.g. DB, SNCF, RENFE) and Railway Industry (ALSTOM; SIEMENS) that rely on GNSS for the safe operations across the entire railroad network, the monitoring of their assets as well as to improve the train scheduling and maintenance practices. Apart from these two major groups, there are also the rail undertaking/infrastructure managers and a large group of different component and product manufacturers.			
Level of Awareness / Adoption			
Copernicus			
There is a reasonable degree of initial awareness of EO among the rail stakeholders, in particular for infrastructure monitoring purposes, with outreach to key stakeholders by ESA, EUSPA and others. The level of uptake is initial, with some service providers already including Copernicus in the mix of			

monitoring services in the area of railway infrastructure management and maintenance, such as in case of vegetation or ground movement monitoring
EGNSS
GNSS and EGNSS adoption in safety-related applications still depends on incorporation in the legislation (see below). Based on the latest material used by EUSPA for their EO and GNSS Market Report, the penetration of Galileo amongst rail application shipments is expected to reach 100% by 2025 for all non-safety critical applications such as passenger information systems and asset management, as well as for the safety critical applications such as driver advisory systems (DAS) and trackside personnel protection systems. EGNOS is also widely supported across safety critical applications with the aim to launch large scale demonstrators in 2025 to facilitate its future possible inclusion in ERTMS – the European Rail Traffic Management System in order to allow safe use of GNSS for train localisation in signalling
Major R&D Initiatives
Copernicus
No major R&D initiatives exist for Copernicus in this segment.
EGNSS
Harmonisation and standardisation of all rail-related practices remains top priority in Europe. This goal brings together various entities such as the Europe's Raill Joint Undertaking (EU Rail), the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (CENELEC). Back in 2021, they signed a Memorandum of Understanding to accelerate the European rail standardisation work. In line with this objective, a large number of EU-wide projects are supported through Horizon Europe: in 2022, a total of six Flagship projects were launched with a combined project value of 583.4 million EUR, focusing on topics such as sustainable and green railways, digitalisation and automatisation of rail systems as well as multimodal transport.
Policy, Legislation and Regulation
Copernicus
Rail is covered by the EC's overall mobility strategy, which calls for increased development of rail transport for passengers and goods, a doubling of high-speed rail by 2030, and increased resilience of the European rail network. This is backed by funding under the Connecting Europe Facility.
EGNSS
To keep Europe's railways amongst the safest in the world, the EU is maintaining high standards in rail safety. This ambition has resulted in a plethora of legislative actions by the EU in cooperation with various stakeholders. Across Europe, a wide range of stakeholders is active in the field of policy and regulatory initiatives alongside the European Commission such as the European Railway Agency (ERA), the Community of European Railway and Infrastructure Companies (CER), European Rail Infrastructure Managers (EIM), the ERTMS User Group, the European Rail Industry Association (UNIFE) and the Union Industry of Signalling (UNISIG). In Europe, the railway systems are subject to a normative framework that requires the demonstration of the system's safety. This framework is composed of specific European standards derived from the IEC standard 61508:2011 and includes the EN 50126 standard on systematic RAMS management process, the EN 50128 standard on requirements and techniques applicable to software development for control-command and protection applications, as well as the EN 50129 standard addressing safety-related electronic systems.
Barriers & Future Directions
Copernicus
No specific barriers have been identified so far, but there is a need for increased case studies to promote adoption of EO in general and Copernicus in particular across this segment.
EGNSS

Since rail is a very safety-sensitive environment, there are several limitations to the use of GNSS across the different applications. With a big share of rail traffic taking place in environments including tunnels, urban areas, hills/mountains, etc. there is often the obscuration of the GNSS signals. Integrity is also a major requirement for most rail applications Ongoing work on EGNOS for Rail or Receiver Autonomous Integrity Monitoring (RAIM) should pave the path of greater adoption of integrity mechanisms within rail applications. Similar to other transport segments and critical infrastructures, the rail segment is also aware of GNSS disruptions caused by jamming and spoofing events. The use of GNSS within the Command & Control Systems will need to be able to detect jamming and/or spoofing and be able to react accordingly.

Road and Automotive

Segment	**Road and Automotive**		
Copernicus uptake	**Minor**	Initial	Major
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
As 80% of the world's road network is unpaved, road networks tend to be particularly vulnerable to environmental, weather and vehicle-related damage with direct impact on its users. Copernicus data can to some extent support drivers in remote areas and on roads affected by meteorological events.			
Global Navigation Satellite Systems			
The positioning and navigation information provided through GNSS applications is vital for the reliable functioning of several different applications in the Road and Automotive market segment. GNSS plays a key role in safety-related applications, such as connected and automated driving as well as emergency assistance (e.g. eCall). It provides information for fleet management systems (e.g. cars, commercial vehicles, buses, bikes, scooters) and for smart mobility applications. Finally, it is a crucial layer for liability-related applications such as insurance telematics, smart tachographs as well as road user charging. Stakeholders relying on GNSS range from the drivers, their passengers, road transport operators as well OEMs and their suppliers, road traffic managers and road network operators.			
Level of Awareness / Adoption			
Copernicus			
Copernicus sees a limited role and uptake in this segment. The most relevant use case is the use of Copernicus for the infrastructure management, where early adopters among road network operators and construction companies use, often through the solution by service providers, mainly the CLMS EGMS component and Sentinel-1 data through InSAR techniques to support ground motion monitoring. Sentinel 2 data is potentially relevant for vegetation monitoring, but the use is limited by the spatial resolution. Further, C3S weather forecasts are used by infotainment service providers.			
EGNSS			
the adoption of EGNSS by European car manufacturers is introducing EGNSS worldwide as most, if not all, car manufacturers using GNSS applications rely on a multi-constellation (perhaps already multi-frequency) chipset. Galileo is part of almost every new vehicle model being put on the market (adoption of Galileo across the EU27 is assumed to be 100%, based on expert validation interviews, for applications such as the in-vehicle systems (IVS), on-board units (OBU), smart tachograph, eCall, etc.). When it comes to EGNOS, the use case is limited, an example would be the tracking of dangerous goods, which is a niche-aspect of freight transport (adoption of EGNOS across the EU27 is assumed to be 100% for applications such as OBUs, smart tachograph, as well as amongst dangerous goods vehicles). Since the Road and Automotive market is a mass market segment, the majority of the users perceives GNSS as a commodity			

. However, for certain applications the use of EGNSS is mandatory (see section on Policy, Legislation and Regulation).
Major R&D Initiatives
Copernicus
No major R&D initiatives exist for Copernicus in this segment.
EGNSS
Two major R&I platforms are active across Europe to foster development of GNSS applications in this segment i.e., the European Road Transport Research Advisory Council (ERTRAC), supported by the European Commission, as well as the CCAM Partnership. Both platforms are active in supporting the implementation of various Horizon Europe projects. Various initiatives are ongoing across a range of automotive topics such as *integrating vehicle in the transport system (i.e., AUGMENTED CCAM, CONDUCTOR, etc.), key enabling technologies (i.e., AI4CCAM, CONNECT, etc.), large-scale demonstrators (i.e., MODI, ULTIMO),* and more*.*
Policy, Legislation and Regulation
Copernicus
The ITS directive (Directive (EU) 2023/2661) requests that, where appropriate, the ITS applications and services relying on earth observation data should use Copernicus data, information and services. Other data and services may additionally be used in addition to Copernicus data.
EGNSS
The 2023 ITS Directive refers explicitly to the importance of ensuring compatibility with the authentication mechanisms provided by Galileo in order to mitigate GNSS signal spoofing attacks. In its ANNEX II, the Directive refers to the use of Galileo, the upcoming OSNMA as well as the High Accuracy Service and EGNOS. Across the European Union, several initiatives and legislations are in place that foster the uptake of (E)GNSS across various applications, by either making it mandatory to rely on Galileo/EGNOS, or to strongly advise its use. In 2020, the European Commission adopted the Sustainable and Smart Mobility Strategy with the aim to make reach different milestones regarding safety and sustainability by 2030, 2035 and 2050. Prior to this strategy, several legislative initiatives were already taken to improve the safety on the roads through the adoption of the eCall in-vehicle system (mandating the use of Galileo and EGNOS for the positioning service), use of smart tachographs in commercial vehicles, and various other regulations ((e.g. Recast Directive (EU) 2019/520 and Commission Implementing Regulation (2019/9080 and Delegated Regulation (2019/8369) repealing the Directive 2004/52/EC and Decision 2009/750/EC on the interoperability of road toll system in the community, etc.). Other major initiatives are the ISA Delegated Act, the UN Type Approval Regulation (notably 144 and 155). A non-exhaustive list of relevant legislations and regulations can be found in for example the Report on User Needs and Requirements for Road (by EUSPA).
Barriers & Future Directions
Copernicus
A primary barrier for Copernicus uptake in this segment is technological: the spatial resolution provided by Sentinel satellites is often too coarse to provide significant insights into road conditions.
EGNSS
Lack of indoor positioning would hinder the use of GNSS in tunnels and car parks (potentially relevant for fleet management. Associated with all type of applications (i.e., fleet management, smart mobility, safety and liability critical applications) is the threat of jamming and spoofing. Especially in light of the upcoming Cooperative, Connected and Automated Mobility (CCAM), these challenges will need to be addressed before a widespread deployment of autonomous vehicles on European roads. As mentioned across several other segments, the adoption of OSNMA, and potentially CAS could be a step in the right direction.

Urban Development and Cultural Heritage

Segment	**Urban Development and Cultural Heritage**		
Copernicus uptake	Minor	**Initial**	Major
EGNSS uptake	Minor	Initial	**Major**

Stakeholders and Applications

Earth Observation

City authorities, urban planners, real estate agencies, cultural heritage managers and surveyors all use solutions powered by EO to perform a wide range of applications. EO provides valuable information in support of urban planning, monitoring of informal dwellings, and informing the progress of urban greening. Moreover, EO-based services provide essential information on air quality in urban environments, measuring particles that might affect the heath of citizens and monitoring greenhouse gas emissions. This is also critical when monitoring cultural heritage sites, whereby the impact of air quality and potential ground subsidence may endanger these sites.

Global Navigation Satellite Systems

Focusing specifically on GNSS, the surveyors and city planners are the main stakeholders when it comes down to the use of positioning information. GNSS is especially relevant for the surveying and mapping of urban areas or for the provision of accurate positioning data when it comes to the creation of Digital Twins, 3D and Urban models. In light of smart city applications, GNSS positioning is also used for applications such as smart waste management and smart streetlights to provide accurate information to the relevant managers of said smart infrastructures across an urban area for the collection of waste or the maintenance of streetlights.

Level of Awareness / Adoption

Copernicus

This segment sees initial uptake of Copernicus data and services. Specifically, the Copernicus programme supports urban planning and monitoring through its satellite and in situ data as well as through its services such as the Copernicus Land Monitoring Service (e.g, with its Urban Atlas, Land cover/Land Change maps and EGMS). Various European municipalities are monitoring the air quality in cities through products powered by CAMS, specifically useful for cities where limited data is available to monitor pollutants, as well as Copernicus data to map heatwaves and water quality in coastal cities.

EGNSS

Due to the need for high accuracy positioning information across all surveying activities, EGNSS is estimated to have reached 100% penetration across annual shipments for any surveying-related application. However, as GNSS-only solutions do not offer the required performances, surveyors will use other technologies such as PPP and RTK in parallel with their GNSS equipment. Also, EGNSS applications also include smart streetlights and smart waste management

Major R&D Initiatives

Copernicus

Many research initiatives tackling urban challenges include EO data in their approach. Urban resilience is in focus with solutions developed for managing climate related issues, such as flood risks or heat islands. Further research addresses data fusion, enabling integration of data from multiple sources to, for example, map cities or allow comprehensive monitoring.

EGNSS

Except ongoing studies and launch of Galileo HAS, no major R&D initiatives exist for EGNSS in this segment.

Policy, Legislation and Regulation
Copernicus
Policies and initiatives that drive information needs in this segment include SDG3: Good Health and Well-being: living conditions in urban areas, including e.g. air quality or availability of green spaces, have a significant impact on citizens' health and well-being and SDG11: Sustainable cities and communities: access to public transport, open spaces, and quality of air are crucial factors for quality of life and environmental sustainability in urban areas. OECD Principles on Urban Policy, the Regional Development and Cohesion Policy 2021-2027, and the Urban agenda for the EU drive information needs on topics such as air quality, circular economy, climate adaptation, culture and heritage.
EGNSS
The most relevant instrument in the field of urban development and more specifically related to all survey-related activities is the Directive 2007/2/EC on establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) which aims to harmonise and standardise European spatial data, allows for the sharing of environmental spatial information to better facilitate the public access to spatial information.
Barriers & Future Directions
Copernicus
There are currently no turnkey solutions that work for all municipalities without customisation and integration efforts. While some free data exists, it will still require dedicated processing and analysis. For some applications, resolution and / or revisit times of satellites providing free data may not be sufficient, requiring acquisition of costly commercial data. This constitutes an additional barrier to the uptake of EO among urban planners. But given the increasing urgency of challenges to be tackled, EO solutions may become more cost-effective per se with their constantly evolving capabilities (larger constellations, higher revisit times, higher resolution, wider types of sensors and data) adding to their attractiveness and usefulness in urban contexts.
EGNSS
The majority of the GNSS limitations are overcome by employing complementary technologies such as PPP and RTK. However, several GNSS inherent barriers remain such as obstructions caused by the operating environment (i.e., dense urban environments), lack of accurate vertical accuracy, radio interferences (i.e., jammers), etc.

Space

Segment	**Space**		
Copernicus uptake	**N/A**	Initial	Major
EGNSS uptake	Minor	Initial	**Major**
Stakeholders and Applications			
Earth Observation			
N/A			
Global Navigation Satellite Systems			
Beyond the terrestrial use of GNSS, it has been proven that GNSS also serves as a valuable tool in space itself. Real-time navigation for spacecraft, based on space borne GNSS receivers, is becoming a common technique for Low Earth Orbits (LEO) as well as Geostationary Orbits (GEO). The EO and GNSS Market Report by EUSPA classifies the different applications in three categories: (i) Acting/supporting mission payloads, (ii) Deep space applications, and (iii) Navigation and control subsystem. All of these applications rely on GNSS receivers. The main stakeholders in this segment are the spacecraft manufacturers,			

spacecraft operators as well as the space-based service providers. The final users of these applications would be all downstream space segments' users as presented in the subsections of this chapter above, including the general public.
Level of Awareness / Adoption
Copernicus
N/A
EGNSS
Whilst EGNSS and specifically Galileo is expected to see an increased uptake amongst GNSS receivers (i.e., from 60% for low navigation requirements and 85% for high navigation requirements and scientific payloads in 2023 to 100% by 2033 across all type of applications), its real differentiator compared to other GNSS is the upcoming Galileo Space Service Volume (SSV).
Major R&D Initiatives
Copernicus
N/A
EGNSS
A plethora of R&D initiatives are ongoing when it comes to space applications. Specifically relevant for GNSS (and potentially EGNSS) are in-orbit servicing and the interoperable SSV. In-orbit servicing refers to the refuelling or repairing of satellites and aircraft whilst in orbit. Besides the provision of absolute and relative positioning through GNSS, it is also believed that this could extend the lifetime of satellites by delivering and re-equipping in-orbit satellites with new pieces of hardware including GNSS receivers. Regarding the interoperable SSV, the current understanding is that the SSV is limited to Earth's orbit, which hinders further exploration relying on the SSV including lunar explorations. The international space community is investigating the extension of GNSS PNT applications across the SSV to include the Moon. This would potentially require dedicated lunar orbiting satellites (with their own GNSS receivers) to pave the way to a full autonomous lunar navigation system.
Policy, Legislation and Regulation
Copernicus
N/A
EGNSS
The most notable elements to mention in light of the policy and regulatory framework for the Space segment would be the 1967 Outer Space Treaty (so-called Space Law), the Galileo 2nd Generation Implementing Act, the 2016 EU Space Strategy and the 10th EU/ESA Space Council taking place in 2020. Looking at the EU Space Programme, four distinct components can be identified namely: Galileo and EGNOS, Copernicus, GOVSATCOM and IRIS², and Space Situational Awareness (SSA). All of these components are also being managed, keeping in mind the potential synergies that can be created by using all components together in specific use cases.
Barriers & Future Directions
Copernicus
N/A
EGNSS
Whilst space borne GNSS receivers are not that much different from terrestrial GNSS receivers, they are deployed in a very different environment with its own challenges (i.e., radiation, much higher velocities, etc.). To cope with these challenges as well as the fact that the GNSS signal used in space by satellites and other spacecraft often comes from the other side of the globe (i.e. much larger distance than terrestrial applications relying on satellites orbiting in direct line of sight), the United Nations

International Committee on GNSS (ICG) documented the interoperable multi-GNSS SSV (covering all global and regional navigation systems).

C. Annex C: Member States' interventions in the Competitiveness Council (research and space configuration) 2nd December 2022

The below table is drafted based on the debrief and summary of the video recording of the Competitiveness Council (Research and space) that took place of 2 December 2022[131].

Ministers discussed how to increase the use of space data and applications within the EU across different market segments, focusing on what has already been implemented and developed at national level to make better use of space data exploitation. They also reflected on possible barriers hindering the uptake of EU space services at European and national levels.

The barriers identified by the Member States closely align with those identified throughput this Staff Working Document and can be grouped according to the categories previously established:

- Lack of awareness about the existing space-based services and applications
- Lack of skills: necessary knowledge and understanding about the utilisation of space-based data, services and applications is missing amongst those who should be utilising them.
- Existence of entrenched operational procedures: burdensome existing regulatory and administrative procedures diminish the interest in adopting these technologies
- Lack of funding: lack of the necessary capital to develop new applications and apply the existing ones.

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Austria		European Space Policy Institute			

[131] See note 77, page 43.

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Belgium				Member States and institutions must coordinate to provide better access to space databases for the private sector Take into consideration relevant security aspects	
Bulgaria					Support the processes related to the expansion of the range of activities and policies at European level relying on information obtained through space infrastructure Ensure an equal playing field for all participants including SMEs
Croatia		Significant efforts to embed the use of space-based services both in law and in practice		There is a permanent gap between the availability of data and its wider use	More investment in the development of capacities and skills needed for the uptake and exploitation of data
Cyprus			Cyprus is not a member of EUMETSAT		Specify which type of space-based data, of all those the Union has available, is needed by each user through AI or Machine Learning to be able to provide them with it Support actions that aim to bring together entrepreneurs and experts from different sectors by reinforcing existing tools
Denmark			For public administration: Need for further education and staff with the right knowledge and understanding of the use of satellite data		Better overview or perhaps a directory of available space data Common approach to eliminate or overcome unnecessary regulatory or administrative barriers to the uptake at both national and EU level
Estonia			The biggest barrier hindering the uptake of EU space services today is the lack of education and knowledge of our space		Create regional centres to bring easier and fastest access to global remote sensing data to businesses Open the door to innovative European new space companies to develop a modern and cost-effective satellite network

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Finland					
France				Preserve control over space data	Provide open services for the Galileo positioning system Develop investment plans for the downstream sector
Germany	Yes (2023)			Member States' perspectives need to be given enough room	Simple access to data Training for users Bottom-up approaches for promotion EO should be added as a possible instrument to be used in the application of all regulations where it can have a potential impact
Greece					Create more synergies with major European players such as the EU Space Agency, the European Defence Agency and ESA while engaging with the new space community and the relevant stakeholders following not only a top down, but also a bottom-up approach
Hungary	National Law for an Earth Observation information system				
Ireland	No space strategy per se but a National Space strategy for enterprise		Challenges prevail in the context of improving the overall level of awareness of the existence and potential benefits of the use of data among public sector authorities and the commercial sector Administrative element when applying or funding is burdensome, especially for SMEs and micro enterprises		Reduce the multiplicity and duplication of data silos, containing both national data and the EU Earth observation data Facilitate public private partnership collaborations between companies, academia, and public bodies in order to encourage the development of demonstrators using space data that could help address specific policy goals
Italy					Ensure appropriate investments

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Latvia		Developed a roadmap for wider use of open access satellite data services and applications. The roadmap provides activities in four main areas: training, the development of earth observation services, regulations and planning documents Plan to integrate Open Access satellite data into activities of sectoral ministries, and planning documents	Currently high added value Copernicus information is used only in those sectoral policies and sectors where specific intellectual capacity and skills have been developed		Deliver well developed sectoral policies in a way that promotes the use of space data.
Lithuania				Data security and defence considerations shall be taken fully into account	Develop implementation guidelines which should help to generate a competitive space industry by creating high added value technologies, products and services Awareness raising and sharing of best practices Ensure cost effective access to space
Luxembourg					Promote long term cooperation between sectors
Malta	Yes (2022)			EU actions should be tailored to the needs of the Member States	Enhance availability and accessibility of space data Targeted support to space education and research Provide with near real-time and high-resolution satellite images Strengthen the link between space and non-space sectors

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Netherlands		Satellite data portal. An initiative of the Netherlands Space Office that provides satellite data free of charge to Dutch users. This promotes the use of space data by public organisations, scientific institutions and enterprises.			More public investment is needed for further scaling up of existing information services
Poland		Sat-4-envi. Project for users in the public administration Trainings for public administration employees.	No national space market. No natural links between smaller and bigger companies. Limited national market in the upstream and down-stream sectors. Not enough internal investment and a lot of competition in the global market. Inflation.		Promotion of satellite data through training sessions and joint projects.
Portugal	Yes				Promote the interaction between space and non-space actors Create legislation to promote the use of space data
Romania				Uptake activities should take into account the Member States' specificities	
Slovakia			Regulatory or administrative barriers		Strengthen a closer cooperation among EU institutions and Member States through supporting of disruptive and cutting-edge technologies.

MEMBER STATE	NATIONAL STRATEGY	EXAMPLES OF ACTIONS TAKEN	IDENTIFIED BARRIERS	COMMENTS	PROPOSALS
Slovenia			Lack of general awareness about space activities and usability of space data Difficulties when it comes to access capital, especially for small and medium enterprises Lack of commercial awareness of space companies which are often a spin-off of research institutions		
Spain		Spanish Space Agency will focus on the development of products and services based on satellite data			Promoting the use of space data in European policies Make the use of space services compulsory in those sectors where user safety should not be compromised (aviation, rail, maritime)
Sweden					

D. Annex D: Summary of National Space Strategies

This Annex section provides an overview of existing national space uptake strategies per nation, including any specific focus on EGNSS and/or Copernicus, without neglecting their priority areas and objectives, their uptake approaches, and their identification of users' needs.

Austria: The Austrian Space Strategy 2030+ appears to be in harmony with the EU space strategy, sharing similar objectives priorities and actions. The Austrian strategy considers space-based Earth Observations data and services, such as the carbon monitoring services, indispensable for sustainable deployment of natural resources and for the reduction of energy consumption. In particular, Earth Observation is core part of Target 4 of the Strategy, Space for All Areas of Life: under this target, the Strategy considers data and signals generated by weather services, Earth Observation services, along with those generated by telecommunication services and navigation satellites services, as an essential part of daily life for Austrian citizens since services based on such data and signals have a high level of quality and reliability and are easy to obtain and use.

In the Strategy, space-based services in meteorology, Earth Observation, telecommunications and the EGNSS related services are also deemed relevant for their support to public services.

To exploit and develop better users' experiences related to space services measures proposed by the Strategy are:

- the development of the use of space data and signals in meteorology, Earth Observation, telecommunications and EGNSS services to evolve into products and services for commercial use, that will be promoted through the Austria's signing of optional ESA programmes;
- the development and implementation of a roadmap for greater use of space-based data and services in meteorology, Earth Observation, telecommunications and satellite navigation;
- the implementation of measures to expand high-performance data centres, including data access for Earth Observation.

Belgium: The Belgian space policy is aligned with space strategy at EU level, as it focuses on the following objectives:

- enhancing new opportunities and skills to be developed in Belgian scientific and research domains, in order to favour synergies and cooperation between universities, research centres and industry, to ensure long-term space innovation to be transferred to Belgium key industry sectors;
- mobilising the scientific and industrial capacities in the Country in relations to space and satellites services;
- fusing on space applications for public authorities, citizens and end users;
- taking into account major developments in the space domain and adapting to them.

These measures include, for example, adapting the national space strategy to the development occurred in the fields of launchers and Earth Observation, by stimulating co-financed projects close to commercial markets. The Belgian space policy is complemented by the national defence strategy, which highlights that a safe, secure and sustainable space environment allows Belgian defence but also economic, industrial, academic and public stakeholders and citizens to fully exploit the benefits of space-based services and capabilities, thanks to four main pillars: robust and secure access to space capabilities, contributions to the ion of national and allied assets and stakeholders, contributions to a safe, secure and sustainable outer space for all space users, cooperation with international stakeholders to apprehend and mitigate risks and threats.

Bulgaria: While Bulgaria has not established yet a dedicated national space strategy, the country benefits from the initiatives undertaken by the Cluster of Aerospace Technologies, Research, and Applications (CASTRA). CASTRA is driven by a mission to advance space sector research, foster innovation, develop technology and business applications, stimulate interest and engagement from the national public, academic institutions and small to medium-sized enterprises. It also provides support to organisations and contributes to the growth of Bulgaria's space ecosystem. As the primary non-governmental entity in Bulgaria dedicated to advancing the domestic space sector, CASTRA actively participates in shaping national policies and strategies in this field. CASTRA's experts are engaged in various public and private expert groups at both national and EU levels pertaining to space. As a robust and independent professional organisation, and in line with EU space policy objectives, CASTRA actively assists the Bulgarian government in creating a sustainable environment for space-related industrial, research and development, educational, and public outreach activities. Bulgaria's successful integration into the EU will also involve an active participation in shaping EU space policies and collaborating with EU executive bodies responsible for space exploration and related matters.

Cyprus: The Cyprus Space Strategy 2022-2027 appears aligned with space strategy at EU level since Cyprus' priorities in space are focused on satellite communications and navigation, Earth Observation applications in various domains, climate and atmosphere research, and in the development of relations with EU and international organisations.

The strategy is structured around 8 pillars, each of them later developed around a series of key actions;

- Education, Skills and Awareness
- Entering in the space supply chain and international impact
- Research and product commercialisation
- Governmental services for National and Socioeconomic sustainabilityμ
- ESA Associate Member
- Satellite Communications
- Astronomy
- Earth Observation

The Earth Observation sector is considered a priority since Cyprus has ideal climate conditions for Earth Observation thus having the possibility of securing funds and attract investments to

set up pilots for use-cases and to develop end users' applications. Moreover, in Cyprus water domain EO applications are of high interest. Delivering water of good quality is a crucial societal function object to the Cyprian space strategy.

Cyprus' national Space Strategy is complemented by the work of the ERATOSTHENES Centre of Excellence of the Cyprus University of Technology (CUT) established through the EXCELSIOR H2020 Widespread Teaming Phase 2 project. The Centre conducts both basic and applied research towards improved understanding, management, and monitoring of natural resources and infrastructures and to offer users services and products in line with the latest development of remote sensing and related geospatial technologies or other high-tech tools.

Czech Republic: the National Space Plan 2020-2025 has set several priority areas for intervention and one of such areas is represented by Satellite Downstream Applications, based on satellite telecommunications, satellite navigation and Earth observation. Downstream applications are considered more accessible innovations form a market stand point: "This area gives immense opportunities to come with new ideas with relatively short way to market when encouraged and supported well". The strategy identifies 4 key tools that can contribute to the successful implementation of the Space National Plan:

- Awareness raising, education and training;
- Participation to innovations competitions, such as Galileo and Copernicus Masters (today CASSINI Hackathons);
- Incubation and technology transfer, in particular via ESA BICs and other initiatives;
- Project support tools that guarantee a multi-year budget approach sustained by national and European funding and support programmes.

Denmark: the Danish National Space strategy was updated in 2021 to set up 5 strategic objectives in line with space strategies and policies at the EU level. A substantial part of the country's digital infrastructure is provided by systems such as Galileo and Copernicus. Thus, the space strategy looks towards promoting the use of Copernicus and Galileo to develop and exploit new and innovative applications for end users. Through this, one of the main goals is to establish space-enabled infrastructures that can be transformed into sustainable climate, environment, nature and biodiversity solutions.

Among the five objectives posed by the Strategy, it is worth highlighting the aim at promoting the use of EO satellite data and EGNSS services and information to contribute to the digitisation of public services.

Estonia: The Estonian Space policy and program 2020-2027 acknowledges the many opportunities for the Estonian space sector arising from the application of services and data provided by satellites in the development of new services. Chapter 4 of the program is focused on the development of the public sector through the activities of the Estonian Space Service Centre, which enables Estonian users to share satellite services and data. The Centre will combine the existing ESTHub (the national satellite data centre) and the soon to be created SatComHub. ESTHub is designed to simplify the work of users, companies, government agencies,

universities and research institutes who wish to develop services based on data remote sensing from satellite navigation or observation systems (Copernicus, EGNSS). The goal is to ensure access to space data and services by establishing a corresponding infrastructure in Estonia and developing cooperation with other countries and organisations. The Space Service Centre provides Estonian national institutions and companies with rapid access to space services and data, facilitating the introduction of innovative public services and giving Estonian companies a competitive advantage.

Finland: The Finnish 2025 strategy emphasises the importance of the new space economy and of the related opportunities for Finnish users and economic operators. The strategy acknowledges that location-based navigation services, based on EGNSS, are widely used in traffic and transportation systems while weather forecasts use data generated by Copernicus and led to solutions based on space applications to tackle challenges and changes in the operating environment. The strategy highlights the need to use data extracted from Earth Observation activities to tackle climate change, deforestation, floods, storms and other natural changes and disasters that could be addressed with satellite-generated data and images. Moreover, the strategies acknowledge that public and security and rescue authorities use EGNSS services and location information in their operations as well as for optimisation in agriculture and forestry, urban planning, land use, and the construction industry. Therefore, in line with overall EU space policies and objectives, the Finnish plan highlights the importance of the introduction and development of innovative applications and solutions to enhance a wider applications of satellites data and information for everyday life in favour of end users and citizens.

France: The French Satellite Applications Plan 2027, in line with EU space strategies and, is led by the Commissariat général au développement durable, which in 2019 created the Applisat, a platform for public users of satellite data and their partners, under the management of the Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema). This platform informs the community about satellite Earth Observation programs and news and disseminates feedback from institutions that have mobilised satellite data.

To develop the new plan, the Commissariat conducted a review with the pilots of the thematic actions of the French 2018 plan. Discussions with the various departments in the ministerial cluster helped identify obstacles to the use of satellite applications. The main obstacles cited by the departments related to lack of knowledge of available resources, expertise and assets. The actions of the 2023-2027 Satellite Applications Plan focus on providing tools to overcome the identified obstacles. In order to do so, the plan is organised into 5 areas of actions: education and training of institutions, identification of technical support resources and funding mechanisms, pooling and transferring solutions, promoting the space an satellites ecosystem and uniting it around Applisat platform in order to enhance the spreading of new satellites and space-enabled technologies and applications, in order to contribute to the digitisation of end users applications and of public services activities at national, regional and local levels.

Germany: Germany’s new space strategy, adopted in October 2023, focuses on fostering European and international cooperation, helping the aerospace industry as a growing market,

investing in climate change, in resources for environmental protection, promoting digitalisation, data and downstream applications and promoting sustainable use of space and international space exploration. The German strategy recognises that almost every company and citizen in the country today uses technologies and services based on space applications and that Earth Observation programs open new dimensions in climate research, in urban and regional planning and in the prevention and management of crisis and disaster situations.

Among the areas of action, the new strategy focuses on the development of EU and international cooperation, the development of innovative and reliable EGNSS applications, fighting against climate change and on the valorisation of resources and environmental protection. The strategy emphasises on how the long-term capabilities of EU Earth Observation programs and Copernicus are essential for the German federal government. This new national strategy is partly based on the Federal Government's Copernicus Strategy (2017), which sets out objectives and fields of action for the successful implementation of the EU Earth Observation program and activities. The Copernicus Strategy has as its main objectives

- promoting Copernicus services reliability to provide up-to-date information for the performance of administrative tasks at federal government, federal state and local authority level, as well as for corresponding downstream services;
- promote the use by German companies of innovative value-added services and business models based on Copernicus data and services and market them internationally;
- encourage authorities, companies, research institutes and users to make direct use of Copernicus data and services;
- use Copernicus services to favour international political actions, committing the country to actively include these services in relevant international programmes and initiatives;
- ensure the sustainability and evolution of Copernicus services and applications in the Germany.

Greece: According to the Hellenic Space Centre website, one of the purposes of the HSC is to formulate the elements of the national strategy and the definition of an action plan in the domain of space, however the national strategy is not publicly available.

Hungary: The Hungarian Space Strategy, published in 2021, sets out the country's objectives in line with the EU policies and space strategy, focusing on some strategic goals:

- utilising the potential in space sector to stimulate innovation and sustainable growth in the national economy;
- strengthening Hungary's international role, creating organisational frames of coordination;
- developing the knowledge-based social and economic conditions and infrastructural background that is essential for prosperity of the space sector in favour of the Hungarian citizens.

Under the short-term measures to enhance the implementation of the strategic goals, the Strategy sets out, the development of user capabilities related to space technology and the increase in domestic demand for space-based services across the relevant pillars of the EU Space Programme (Earth Observation, EGNSS and telecommunication). The overall aim of the Strategy is to establish concrete actions to promote digitalisation in the field of economy, education, research and development and innovation and, to ensure the development of public administrations that make a significant contribution to improve competitiveness of the country and to the well-being of its citizens.

Ireland: The Irish National Space Strategy for Enterprise 2019-2025, in line with EU strategic policy objectives, sets out as its main goals;

- doubling the space related revenue and employment in space-active Irish companies;
- increasing industry, public and international awareness of the space domain and Ireland's activities in space;
- developing sustainable Earth Observation services sector based on advanced data analytics capability;
- enhancing new EGNSS downstream services and market applications.

To achieve this, the Irish government is promoting new forms of investment such as the Climate Action Fund and the Disruptive Technology Fund, which aim at leveraging investment by public and private bodies in climate action measures, offering opportunities to utilise Ireland's space resources such as near real-time Earth Observation data provided through the EU's Copernicus programme. Another key opportunity mentioned in the Strategy derives from the 2017 agreement between Enterprise Ireland and ESA, allowing public entities and private actors to access an unprecedented volume of near real-time data about captured by the EU's Copernicus programme. The strategy also highlights that the Irish Government has been identified as a primary consumer of Earth Observation data, recognising as well that consumer-based applications are moving from an institutional level to a commercial one by developing an increasingly higher volume of commercial space and satellite applications. Hence, the development of data related applications and sustainable services offer a growing opportunity to Irish industry and users. Additionally, enterprises can make use of Ireland's Copernicus Relay to further engage with opportunities offered by Copernicus program.

Italy: The Italian Space Economy strategic plan was created to define national policy in the space sector. The services and data highlighted in the Plan are telecommunications, EGNSS and positioning, Earth Observation data and environmental monitoring. In line with EU strategic goals, the plan is also proposed as the first instrument adopted by the country to implement the National Strategy for Intelligent Specialisation. The plan specifically promotes a user uptake strategy for Copernicus through the work of the National Copernicus User Forum, serving as a platform for dialogue and collaboration among various stakeholders interested in the

Copernicus program. The primary functions and objectives of the Italian National Copernicus User Forum are:

- information exchange: the Forum serves as a hub for sharing information and knowledge about the Copernicus program and its services. It disseminates information about the availability of Copernicus data, tools, and applications to users in Italy;
- users' feedback: the Forum gathers feedback and requirements from Italian users of Copernicus data and services. This feedback is essential for improving the program and ensuring that it meets the needs of various user communities, including public administrations, government agencies, research institutions, companies and businesses operators;
- promotion and awareness: the Forum promotes the use of Copernicus data and services within Italian industries and companies. It raises awareness about the program's capabilities and encourages more organisations and individuals to leverage the data for their specific applications;
- networking: the Forum facilitates networking and collaboration among different stakeholders involved in Earth observation and environmental monitoring in Italy. This includes public administrations, government agencies, research organisations, end users and companies and non-governmental organisations;
- support and training: the Forum provide support and training to help users effectively access and utilise Copernicus data and tools. This support can range from technical assistance to capacity-building activities;
- policy and strategy input: the Forum provides recommendations on Italy's national policies and strategies related to Earth Observation and environmental monitoring. This input can help align the Country's priorities with the broader EU Copernicus program applications and capabilities.

Latvia: The Latvian 2021-2027 Space Strategy is aimed at organising and harmonising space-related policies within the country. The strategy recognises that, in response to Latvia's societal, economic, and environmental needs, satellite-based services and applications originating Earth Observations programs and EGNSS applications and downstream services are increasingly being integrated into the Latvia public sector at both local and national levels. These contributions primarily include information related to security, emergency and disaster management, resilience, search and rescue operations, land use, and various services provided by Copernicus for Earth Observation and Galileo for navigation. While Copernicus and Galileo data and information are generally available at no cost, certain data, such as those offered by the Copernicus Emergency Management Service and Copernicus Security Service, or Galileo Public Regulated Service are restricted to authorised governmental users. These services hold significant economic and security-related importance, enhancing citizens safety, aiding decision-making in various policy domains (e.g., land use, forestry, energy, land and marine environment management, safety and defence, green economy, etc.), and improving processes when

integrated with other technologies. Additionally, through the EU Space Programme, encompassing Galileo, Copernicus, and EGNOS, opportunities exist for developing Latvia services in areas like navigation for the development of fleet management, transportation, agriculture, tourism, search and rescue, climate change forecasting, atmospheric monitoring, marine environment, land cover, land use, security and emergency response, and more.

With a focus on the goals set for 2027, the strategy intends to:

- develop sustainable Earth Observation and navigation services in Latvia, incorporating advanced data analytics capabilities for various governmental sectors;
- sustain the operations of Latvian companies and users involved in non-space markets that have integrated space-based capabilities into their commercial service offerings.

Lithuania: The Lithuanian Space Sector Development plan, approved in 2022, points out the growing needs from the Lithuanian institutions, public administrations, businesses and societal users to use and exploit the potential of space services and applications. The plan emphasises the pivotal significance of data and services originating from EU Space Programme, most notably Galileo and Copernicus. These programmes are deemed as an invaluable foundation upon which new opportunities can be developed for citizens, users, and public entities within the country. Hence, Lithuanian private stakeholders and users are encouraged to leverage the resources deriving from EGNSS downstream services and EO data to develop commercial applications and products, while public actors, including public administration and government agencies are invited to make a better use of satellites data and applications to enhance their decision-making processes and the public services they offer. As a result, Lithuania's commitment to these EU Space Programs not only bolsters its technological advancement but also holds the potential to catalyse economic growth and environmental sustainability in the country.

Luxembourg: Luxembourg's Stratégie Spatiale 2023-2027 is primarily focused on sustainability goals. In accordance with the EU space policies, it aims at the exploitation of space services and technologies to improve the sustainability of activities on earth and in space and to promote the sustainable use of space resources Key initiatives to facilitate these objectives involve the exploitation of the huge potential of current and strategic projects such as the National Space Agency (LSA) Data Centre, with the aim of facilitating access to Copernicus Earth Observation space data, thus accelerating the development of the downstream sector of value-added applications and services, as well as ENGSS services and applications.

The overall objective of the Data Centre is to continue supporting the development of commercial services in the benefit of Luxembourg citizens. This will be complemented by the creation of the Space Campus which will provide promotes collaborations and synergies, a platform for public-private cooperation in the space field, as well as a shared research infrastructure accessible to all stakeholders, both private and public.

Malta: The Maltese National Space Strategy considers the objectives and priorities of several EU, national and other sectoral strategies in order to implement its main pillars:

- supporting the development of an agile and sustainable space sector through fiscal incentives to attract economic actors;
- supporting the development of space research activities in upstream, downstream and space-derived applications, concentrating on potential long-term user needs both in the public and private sectors;
- supporting the development of a legal framework for the registration of space objects and the exploration and use of space resources;
- supporting the development of research opportunities and commercial applications resulting from the interweaving of space and emerging technologies.

Under the Strategy, the Maltese Government will undertake a review of the various responsibilities of public sector organisations, agencies and administrations in order to determine which entities could potentially benefit from the application of space-related services. Copernicus is considered by the strategy as able to provide a vast array of data and measurements to service providers and public authorities and space-based technology can help facilitate Government's responsibilities. Moreover, Galileo system and EGNSS downstream applications services and the accurate satellite-based navigation information it provides are considered useful for public officials to effectively carry out their duties and may strengthen Malta's search and rescue capabilities, aid Government's response to other emergencies or crises, and engage in better border and maritime surveillance.

Netherlands: Government Ministries that participate in the NSO steering group, in collaboration with the Netherlands Organisation for Scientific Research (NWO), collectively establish the Dutch space policy and its corresponding budget. The Ministry of Economic Affairs and Climate Policy, acting as the official secretary on behalf of their counterparts, submits a memorandum to the Dutch House of Representatives every three years. This document outlines the fundamental principles of Netherlands space policy and the financial resources allocated to it.

The last memorandum was released in June 2019, defining the vision and goals of the Dutch space sector, as well as proposing a toolkit required to realise these objectives. The central theme of this vision and ambition revolves around prioritising the utilisation of space for scientific, societal, and economic applications at both public and private levels. The memorandum, states that as part of the "space-based services for societal challenges" of the Sentinel-5P mission of the EU's Copernicus program, the Dutch TROPOMI instrument provides valuable information for monitoring greenhouse gases and air quality in the Netherlands.

In line with the Netherland's Space Office priority framework, the Netherlands will prioritise registration in ESA's optional Earth observation program and INCUBED+, including to enable Dutch participation in new ESA and EU Earth Observation missions within the limited budget framework, including those to monitor anthropogenic CO2 emissions. The government also supports preparatory technology development for satellite (scientific) instrumentation at the national level. Finally, the government continues to encourage public and private use of observational data on the Earth, including in national government agencies and public

administrations services, as well as to develop and encourage private companies and end-users' space and satellite related activities.

Norway: As indicated by the Government's strategy for Norwegian space activities, the country plans to:

- facilitate utilisation of space activities as a cost-effective solution to meet important needs of society and users;
- ensure that Norwegian technology communities are able to procure space-based solutions to meet the needs of Norwegian users;
- facilitate national and cross-sectoral use of small satellites, including for the purpose of meeting the needs of users in the High North and at sea;
- improve coordination between civil and military space activities;
- ensure that Norwegian users of Earth Observation data have access to data from Norwegian and international satellites and that Norwegian R&D communities contribute to innovative and cost-effective cross-sectoral solutions;
- provide easy public access to information about the environment in line with the principles behind the Environmental Information Act;
- work to ensure that Norwegian space research and expertise maintain a high international level;
- continue work on the Space2030 agenda under the auspices of COPUOS;
- contribute to increased use of satellite data, in the international effort to achieve the Sustainable Development Goals, in cooperation with the EU, relevant UN organisations and the Group on Earth Observations (GEO).

In line with EU space policies goals, an increased number of Norwegian ministries and public agencies are also referring to Earth Observation applications and data and Copernicus program and services in their work plans and agendas. The modernisation and digitalisation of public sector is indeed a key driver of these plans, aiming at enhancing existing systems and consequently services using Earth Observation. For space activities, the country dedicates a budget for national infrastructure and technical activities for stimulating use of Copernicus data and products, as well as GNSS services and data. Norway develops and supports agencies for integrating Copernicus data in their systems and workflow as well as data access (downlink, storage, etc.) and processing.

Norway strategic actions to uptake the use of space services and applications at private and users level is also favoured by the work of thematic national expert groups, preparatory meetings with thematic experts for each Copernicus that is in focus in the upcoming Copernicus User Forum, the Eionet Land System group (subgroup for HRL Copernicus) as well as thematic expert groups for each Copernicus service is under development following the establishment of CAMS National collaboration program.

Poland: In line with the European space policies objectives, the Polish Space Strategy set out few strategic goals and objectives in the near future:

- Polish economy, public institutions and administrations to have access to satellite infrastructure enabling them to meet their needs, especially in the field of security and defence;
- Polish public administration to use satellite data for faster and more effective implementation of their tasks
- domestic enterprises to be able to fully meet the internal demand for satellite and space services and data deriving from key EU Space Programme such as Copernicus ang Galileo, therefore developing and exploit Earth Observation data and EGNSS downstream services and applications in order to export them to other markets.

As core part of the strategy, Poland drafted the National Strategy Information System (NSIS) for receiving, storing, processing and sharing satellite data, with the purpose of providing monitoring services, information products, services and analytical tools along with the necessary infrastructure. Within the NSIS, Copernicus, EGNSS and other European and global programs, including commercial ones in the Polish constellation, are deemed as the main sources of data and applications able to provide useful services public administration, entrepreneurs, research and higher education institutions and citizens.

Portugal: The Portuguese Space Strategy 2020-2030 provides an overview of the current status of implementation of the national space strategy, the main challenges as well as a guide for the future.

The strategy summarises ongoing national projects in place towards advancing the scientific competence and increasing scientific and technical capabilities. This has as final goal the democratisation of access to space Earth Observation data, Copernicus services and EGNSS services and applications.

Through multiple projects and the Copernicus User Uptake activities, Portugal is investing into:

- increasing the awareness of potential users as well as the development of downstream applications and services connecting space to non-space sectors and engaging into new business models. Portuguese public administrations, academia and research institutes, companies and start-ups which are considered as main users of Earth Observation data and Copernicus program, as well as EGNSS downstream services and applications and their coordination and training, aiming at identifying skills and needs and other current and potential users in mapping existing skills, resources and needs;
- raising awareness through dedicated info sessions, national conference and dedicated website;
- building capacity through training courses, international co-operation;
- creating business opportunities promoting business innovation events and the SMEs internationalisation.

In relation to other programs in place, the Copernicus database in Portugal reaches all levels of users and all sectors, mapping skills, needs and interests related to Copernicus Programme and

aims at developing a better knowledge of Copernicus ecosystem, at planning training and at disseminating opportunities linked to the programme.

Objectives of the Portuguese Earth Observation program are;

- to develop and implement a national soil occupation monitoring program that will benefit the entire public administration system;
- to reinforce and maintain, together with IPMA, the IP Sentinel platform, optimising the availability of satellite images for the whole public administration, including for example the provision of satellite-related services, which support an entire infrastructure linked to digital communications, allowing for resource efficiency improvements (e.g. mobility, increased agricultural productivity, resource management such as potable water, monitoring of forest fires, water resources, floods, water availability, and the issue of transboundary basins, in particular the Guadiana basin, etc.);
- to contribute to Portugal's commitment to achieving carbon neutrality by 2050, facilitating its implementation.

In this context, instruments of the Portuguese Earth Observation program are;

- to contribute to the next generation Copernicus and FutureEO programmes to maintain and further develop its thus-far acquire competence;
- to develop subsystem and system competence through concrete projects which are user-driven and/or industry proposed preferably in co-funded schemes as much as possible (such as InCubed+).

Furthermore, by diversification of the fleet of satellites available to end-users, the Portuguese strategy and the Copernicus programs aim at enabling the development of applications and services tied to the developing of small systems, thus contributing to larger systems, and also aims at supporting end-users (incl. integrating space in solutions to their specific problems) through the amplification of the BIC/Incubator concept to centres across the nation and invest in a new generation of services based on Earth Observation systems as well as PNT.

Romania: the National Strategy for Research, Innovation and Specialisation Smart 2022-2027 is focused on the overall establishment of an open Romanian strategic autonomy in the development, deployment and use of global space infrastructure, services, applications and data. In line with EU space policies and objectives, this will be done considering the impact that space technologies and their applications have in making the Romanian economy regionally and globally attractive, secure and dynamic, as well as agile with data from EGNSS applications and Earth Observation services and programs. In the strategy, Romania stresses the importance of aunting the quality of life and security of users and citizens through space technologies applied and exploited by public administrations and entities. This, through;

- new materials and advanced technologies with applicability for the space domain;
- space technologies for the efficiency of the activity of institutions and public authorities;
- new equipment and advanced materials for future space missions;

- the development of niche technological advantages to the development of autonomous EU space systems and infrastructure;
- national capabilities for space robotics;
- development of national capabilities for satellite positioning and navigation (EGNOS/Galileo, PRS).

Slovakia: The Conceptual Framework of Space Activities in the Slovak Republic, in line with EU space policies and objectives, starts from setting our four pillars and basic considerations for evaluating the state of space activities in the Slovak Republic:

- the exploration and exploitation of space are for mankind generally, and for Slovak citizens and users specifically are deemed extremely beneficial activities;
- EU provides globally strategic programs such as Galileo/EGNOS and Copernicus which makes available highly valuable technical data and information deriving from Earth Observation programs in order to develop expertise, technologies and human capacity; Slovakia has great potential in the field of space activities, primarily though the long-term traditional Slovak research and development in IT, the development of new materials, biomedicine, and others.

In the strategy the exploration and use of space and the exploitation of EGNSS downstream services and data, as well as data deriving from Earth Observation services and Copernicus program, considered key factors to bring new knowledge, the transfer of which to everyday life is continuously improving the quality of life for users, citizens and public entities in Slovakia. In addition, the strategy highlights the importance of EGNSS downstream services and applications, the functionalities of which helps the country in the distribution of ultra-accurate time (synchronisation of energetic, financial and other transactions), and in the positioning, navigation services for air, sea and land.

Earth Observation data and more generally the Copernicus program, are deemed essential for the monitoring of Slovakian environmental quality, forest health, the state of watercourses and oceans. It is used in monitoring development and planning of Slovakia urbanisation, as well as in predicting crop yields and it is an integral part of weather forecasting in the country, also contributing to the physical security of Slovakia citizens and users.

Both segments are considered relevant for the overall development of public regulated service: applications and services approved by the government, such as civil defence services, customs and policy are considered essential to provide continuity of services for government users in emergency situations or crisis situations. In addition to, the strategy considers the need to develop a more robust national infrastructure to exploit the true potential of space services and applications for the development of everyday life experiences by Slovakian users.

Slovenia: To become a full member of ESA, Slovenia is drafting the national space strategy, envisaged to be adopted by the end of 2023. The Slovenian Space Strategy will encompass the

guidelines and support for further enhancement of the space sector in Slovenia until 2030, striving to expand the borders of knowledge and innovation and inspire green, digital and sustainable future.

A Draft of the strategy, shared in April 2023, sets out priorities and terms for governmental space actions. It focuses on space sustainability and space applications to improve everyday life experiences for Slovenian users, companies, public administrations and citizens. It also focuses on the development of R&D and STEM education, as well as putting Slovenia's capacity for entrepreneurship and the promotion of space innovation programmes.

The Draft recognised that the global space sector, which includes many different economic activities, is constantly and continuously expanding and developing, including not only launch systems and space exploration, but also many concrete applications which could potentially benefit Slovenian citizens and users' experiences such as e.g. satellite communications, satellite navigation EGNSS enabled services, and Earth observation programs and data.

The number, quality and influence of Slovenian companies and research institutions actively engaged in space activities has been steadily increasing over the past decade, partly driven by international new space trends and the wider recognition of space as an economic enabler for many industries and activities. This led to the development of the expertise and capabilities that exist in Slovenia today, including the design and production of components and platforms, the development of equipment for the ground segment, and the utilisation of space data and signals for downstream applications for the overall benefits of public services and administrations, companies, national and local institutions and Slovenian citizens and users.

In addition to the ESA programs, Slovenia participates in leading programs of the European Union, especially in the Copernicus and Galileo programs and EUMETSAT. Slovenian stakeholders are also successfully involved in various international research, development and innovation frameworks, including Horizon2020 and Horizon Europe. In the Copernicus program, Slovenian industrial and academic stakeholders not only developed far-reaching cooperation with European stakeholders, but also supported the expansion of midstream and downstream services.

All this considered, Slovenia will strive to upgrade our excellence in the field of Earth observation and to expand Slovenian industrial activities in other segments as well. Slovenia will promote greater use of data deriving from EGNSS services and information in commercial applications, building on Slovenian industry's successes in international funding schemes.

Spain: The Spanish Space Agency was established in March 2023. It is responsible for managing all national space policies and effectively coordinating all space services and activities to support the Government of Spain's strategic action in the field of space. As of today, no Space National Strategy has been published or mentioned.

Sweden: The Swedish strategy for space activities has been set up as a platform for Sweden's long-term work on space activities and, in line with EU space policies objectives, it highlights the importance of international cooperation for the peaceful and sustainable use of space. It sets

out for Sweden the objectives of develop the use and exploitation of Earth Observation data and those deriving from EGNSS downstream services and applications, as well as those deriving from the Copernicus program, that should be used across Sweden society and users. To promote such initiatives, the Swedish User Forum was established already during the GMES initial operations phase in 2011.

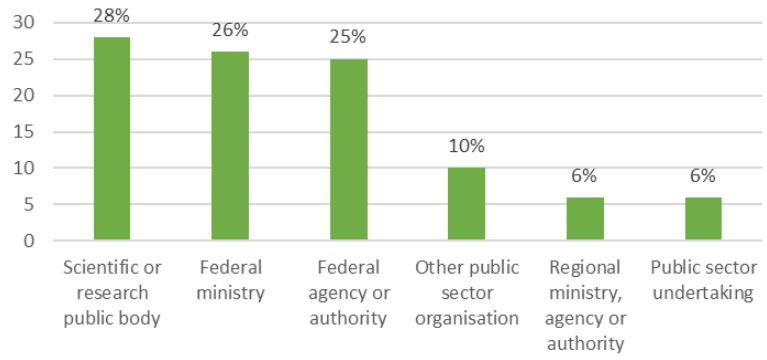
The Swedish User Forum consists of public national authorities, public sector users and private sector users and suppliers. This Forum is based on voluntary/in kind contribution, is organised in Network Groups run by the different services themes (e.g. land, marine, atmosphere, emergency, security and climate change), it cooperates with other governmental agency networks where needed (e.g. on climate change adaptation) and set up specific thematic working groups. One of this working groups is related to the Space data lab and sets up to promote the national strategy initiatives related to EO data.

The Swedish Space Data Lab has been set up as a collaborative initiative among the Swedish National Space Agency, Research Institute of Sweden, Luleå Technical University and AI Sweden. The Space data lab is engaged in 10 pilot studies to promote users' interactions and users' needs collection.

E. Annex E. Survey of public sector users

This annex presents insights derived from an analysis of extensive information gathered from various studies, initiatives, workshops, and stakeholder consultations. It also incorporates recent findings from a dedicated 2023 survey conducted among public administrations and private entities to identify obstacles to the adoption of space data and services. The survey aimed to understand challenges faced by public and private users in integrating space-related technologies, focusing on specific hurdles hindering widespread adoption. Through targeted inquiries and collaboration, the survey gathered 140 valid responses between October 2 and October 22, 2023. This section, focusing on public sector users, analyses 101 responses primarily from federal authorities and scientific or research organisations within the public sector.

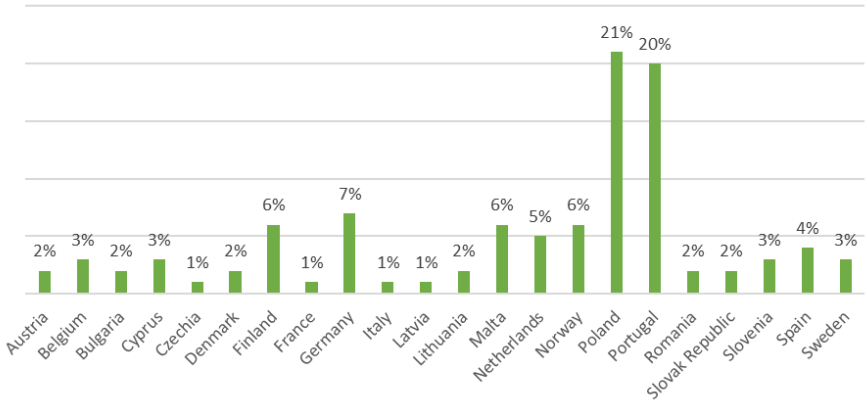
Figure 8 Public sector organisations that responded to the survey



N=101

Responses were received from 21 EU Member States and Norway (Figure 20). No responses were received from Croatia, Estonia, Greece, Hungary, Ireland and Luxembourg.

Figure 9 Countries of the survey respondents

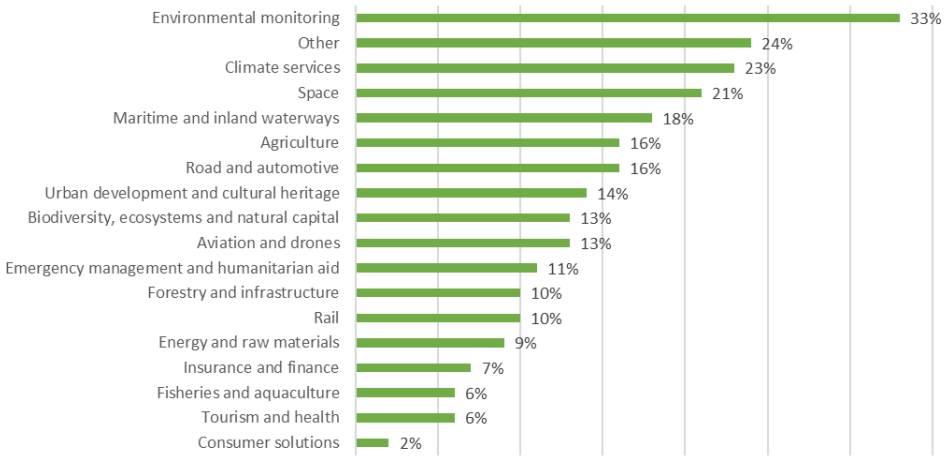


N=101

The survey respondents represented all the market segments identified in the GNSS and EO market report (Figure 21). At the same time, some segments (in particular, consumer solutions, fisheries and aquaculture, and tourism and health) were represented very lightly among the respondents, in line with the role of public authorities in these segments. Among the category “other” were public

organisations from education (4%), statistics (2%), defence (1%), law enforcement (1%), cartography (1%), land registry (1%) and digital transformation and regional development (1%).

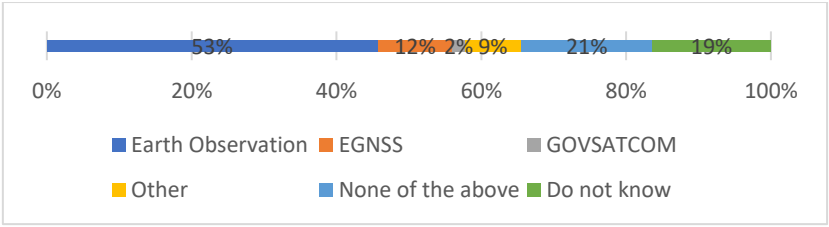
Figure 10 Sector of the survey respondents



N=101, multiple answers were possible for this question.

The majority of the survey respondents are current users of either EO or GNSS products. Most of them use EO (43%), and just over 10% user GNSS. This is due to a variety of reasons, but mainly because a key use case of EO (and Copernicus) is to enable of monitoring of policy progress.

Figure 11 Types of space-based products used by the survey respondents



N=101

The survey includes with a series of questions regarding their countries national space strategies, in case they have one, with the aim of understanding the aspects covered by these strategies regarding both the EU Space component and the sectors covered.

When it comes to the sectors, the results show the immense prevalence of Copernicus over Galileo and EGNOS, which matches the results of the following question, showing that the main sector targeted by the national space strategies is environment. This provides useful insights on the priorities of the Member States and aligns with the preceding findings, as Copernicus is designed for public use, facilitates its integration into public policies and the development of new policies centered around its utilisation.

Figure 12 Which components of the EU Space Programme does the strategy cover?

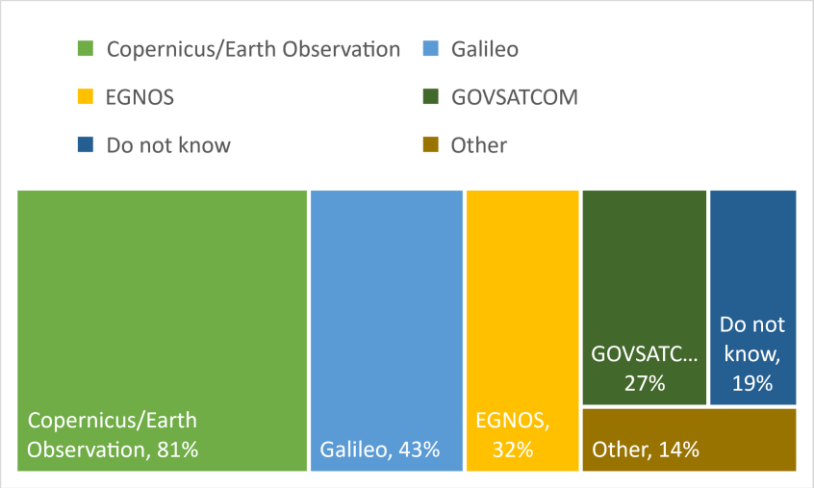
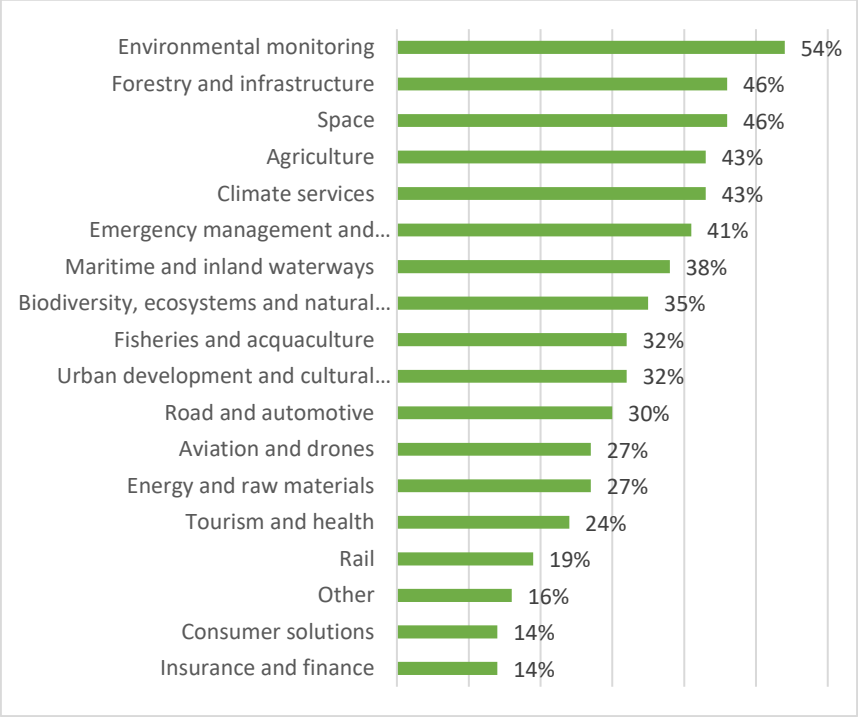


Figure 13 Which sector(s) does this strategy target?



The survey also explored the respondents' use of space data, services and applications, followed by a series of questions aimed at determining the level of adoption of these technologies and the reasons for the lack of adoption, if any.

A fundamental question investigated what is **stopping** public administrations from adopting space-based services, data, and applications. On this, the results of the survey conducted confirm that potential users lack the dedicated budget necessary to test and apply the solutions offered. This lack of budget can also mean that they lack dedicated geospatial departments that would allow them to come in contact with new solutions in an organic way, which relates to the lack of awareness, identified by Galileo/EGNOS users as the second cause and by Copernicus users as the third, and a lack of skills which for Copernicus users is the second reason for not becoming users. Thus, the lessons learned

when it comes to access to capital and awareness raising (see more in section 6.3.1 and 6.1.3) prove fundamental for this initial stage.

Figure 14 GNSS. What keeps you from becoming a user?

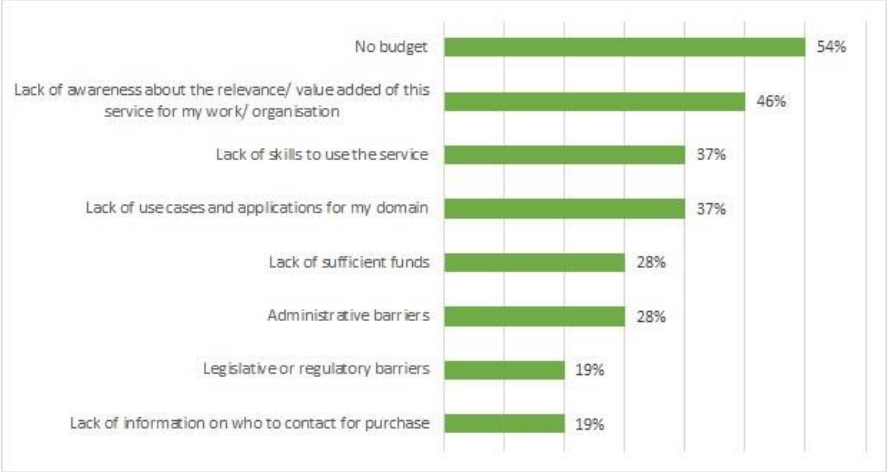
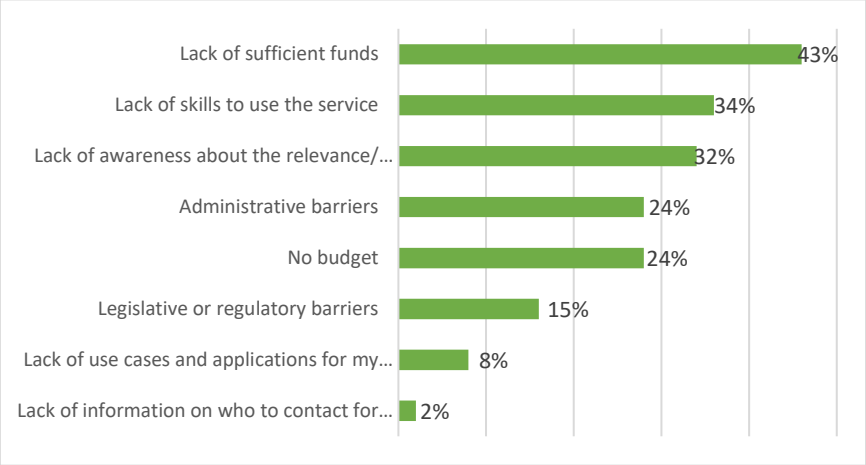


Figure 15 EO. What keeps you from becoming a user?



When asked about the factors that **motivated** either the respondent itself or their organisation **to become users**, the main factor identified by Galileo/EGNOS users was the existence of legal or regulatory requirements, which, in the case of Copernicus, was identified as a main enabler only by 26% of respondents. For both Galileo/EGNOS and Copernicus users the existence of use cases and applications was identified as a main enabler, at the same level as participation in a dedicated project for Galileo/EGNOS users and followed by the presence of already skilled individuals within the organisation and the existence of governmental programmes for Copernicus users. Thus, the exposure to the flagship EU Space Programme components and the existence of related projects are factors that boost the adoption, as can be seen in the figure below.

Figure 16 GNSS. To what extent have the following factors motivated you/your organisation to become a user?

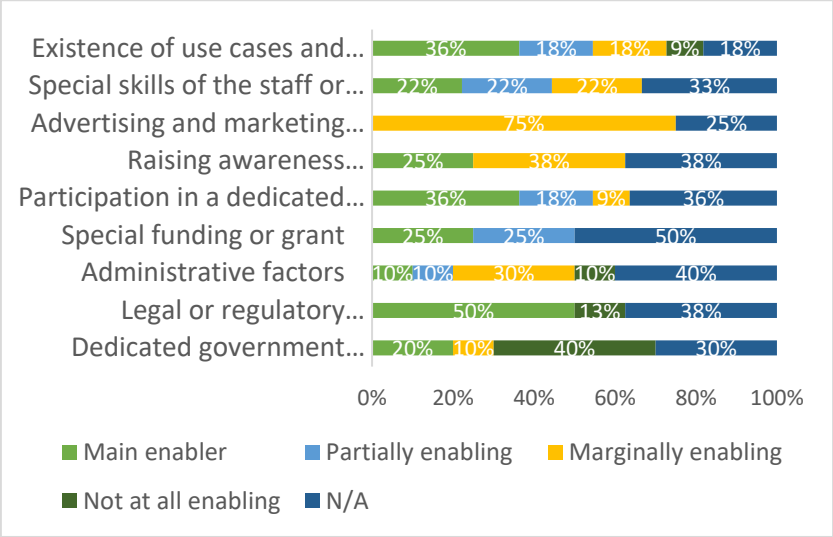
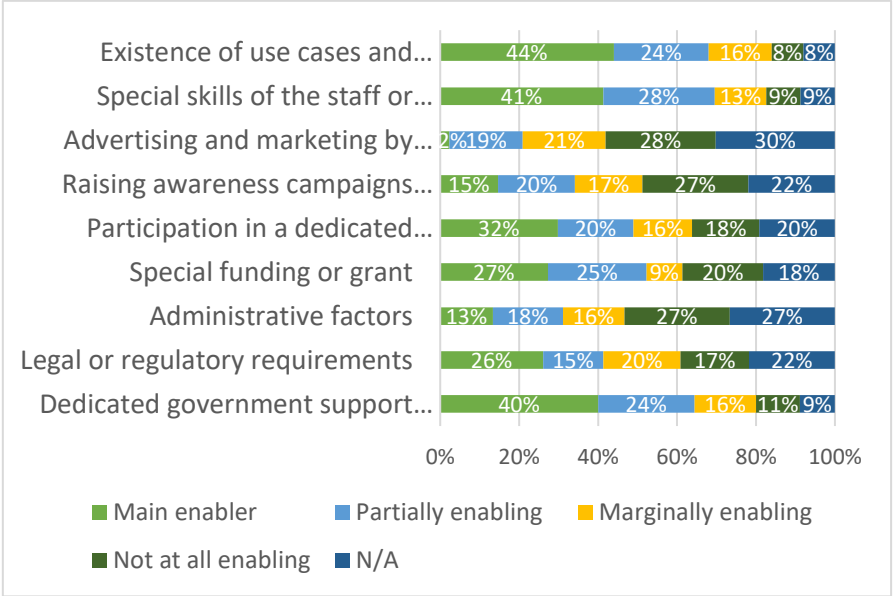
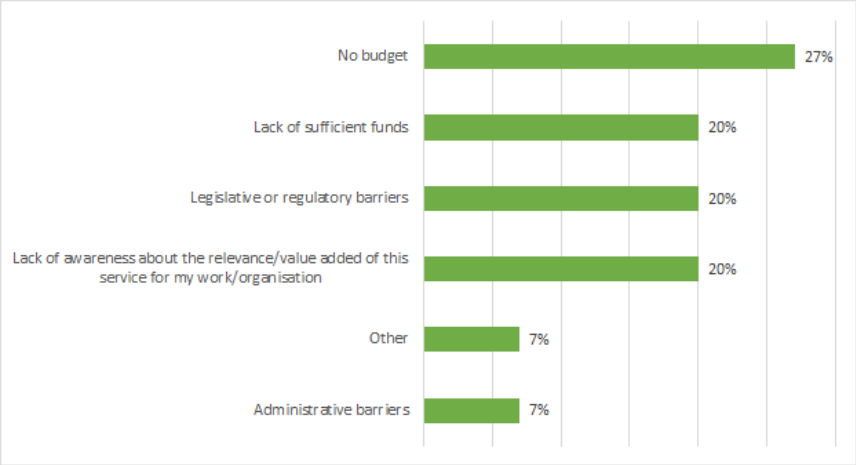


Figure 17 EO. To what extent have the following factors motivated you/your organisation to become a user?



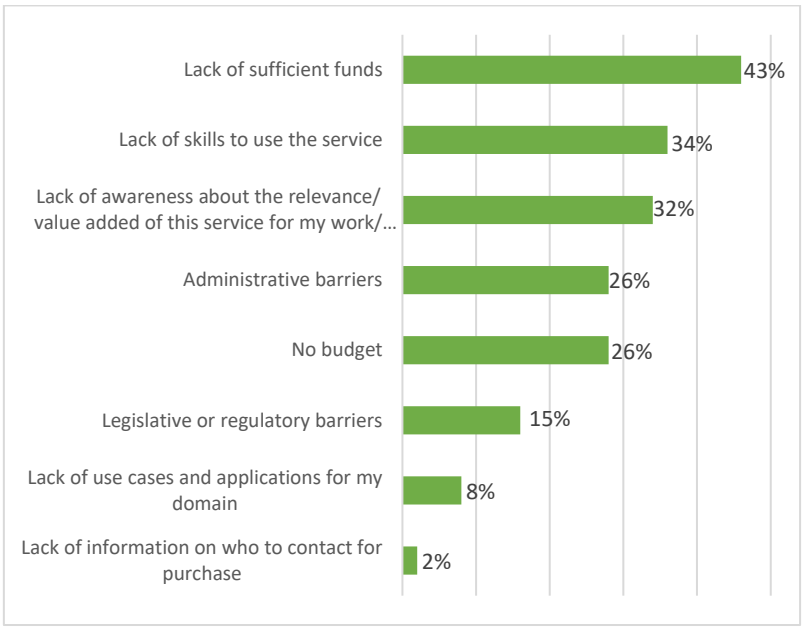
Respondents also identified barriers hindering **adoption after initial use**, after having become initial users. One of the most common barriers for an organisation to become an initial user is once again, the lack of budget which appears to be a constant barrier in all phases, followed one again by a lack of awareness and a lack of skills. This could be linked to a lack of **internal procedures and technical interfaces** that allows it to exploit the outputs of EGNSS or Copernicus, or the lock-in with past solutions. If the organisation does not count with procedures for investigation or adoption of innovative solutions, it seems that the adoption of space-based data and services from an initial stage will be constantly hindered.

Figure 18 What prevents your organisation from using these GNSS products and services more fully?



Another barrier especially relevant for EO and confirmed through the survey was the **lack of appropriate skills**. Staff with adequate technical skills (i.e. for handling and exploiting geospatial data, or properly embedding GNSS services in positioning solutions and systems) is essential for an effective use of Copernicus data. There is a long-reported shortage of such skills in public organisations and corporate actors. This highlights the importance of analysing the actions already carried out (see section 4.2.4.3 and 6.1.6) and focus on an approach that will cover the user needs.

Figure 19 What factors prevent your organisation from gaining experience and expertise in using EO data, products or services?



Although not represented graphically, **several other patterns** were identified when analysing the process leading to operational uptake. Within the legislative and regulatory barriers identified in the previous question, in the case of Galileo/EGNOS, the barriers originated mostly in public administration rules. For Copernicus, in addition to public administration rules, standardisation and interoperability of the system, licensing rules and data access and sharing were mentioned.

Finally, regarding the administrative barriers that respondents faced when trying to achieve (full) **operational uptake**, users of Galileo/EGNOS and Copernicus identified as main issue lock-ins with systems/providers and lengthy internal approval procedures to use space data, products or services. Galileo/EGNOS users indicated issues with budgetary cycles and Copernicus users highlighted difficulties with interoperability of the organisation's systems and lack of clarity related to obtaining necessary permissions or checks.

Although rules and standardisation are positive in some respects, overregulation can be counterproductive, it is essential to analyse what measures promote user uptake. Finally, budget issues were mentioned throughout the whole survey, which shows that funding is a transversal issue, affecting all users at all stages of uptake of Galileo, EGNOS and Copernicus.