2025

Report on Public Transport

User Needs and Requirements

#EUSpace

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EXECUTIVE SUMMARY

Public transport across is undergoing an accelerated transformation driven by decarbonisation, electrification, digitalisation, and rising expectations for resilient and customer-centric mobility services. In parallel, the space-based enablers covered in this report, Positioning, Navigation and Timing (PNT), Earth Observation (EO), and secure telecommunications (SATCOM) are becoming increasingly relevant to daily public transport planning, service delivery, and risk management, with these needs potentially being fulfilled by a range of space based assets and services, including European systems such as Galileo, EGNOS, Copernicus, and emerging secure connectivity initiatives.

The 2025 update confirms that GNSS already underpins day-to-day public transport operations (automatic vehicle location, control room decision support, passenger information, fleet and depot management, demand-responsive transport, eco-driving, and early automation pilots). However, user needs have evolved: stakeholders are moving from "having GNSS" to needing higher accuracy, higher robustness in difficult environments (urban canyons, tunnels, depots), better quality metadata, and trusted/authenticated positioning to enable safety-related, operational, and commercial use cases. New Galileo differentiators, most notably the High Accuracy Service (HAS) and OSNMA authentication, are seen as well aligned with these emerging needs, but are not yet consistently reflected in procurement, legacy fleets, or operational guidance, and users request clearer, scenario-based performance characterisation for dynamic/urban contexts.

EO is increasingly viewed as a strategic enabler for network planning, infrastructure health monitoring, and climate resilience, especially for flood risk, heat exposure, vegetation overgrowth, terrain deformation along rail/tram corridors, and construction change detection. Yet EO remains a "background" input for many operators: the key blockers are latency, spatial resolution, and integration effort, alongside limited internal capacity and awareness within many PTAs/PTOs to turn Copernicus services into decision-ready operational products. Users emphasised the need for faster end-to-end product chains (hours not days for critical events), more tailored "analysis-ready" layers, and simpler access via APIs/plugins compatible with common transport software environments.

Across both GNSS and EO, the 2025 update also highlights that adoption barriers are often structural rather than purely technical, including extended procurement cycles and departmental silos. Stakeholders therefore call not only for service evolution, but also for practical adoption measures such as reference tender language, guidance on receiver capabilities and authentication, and standardised integration approaches that help move from pilots to institutional deployment.

Current & prospective use of EO, GNSS & SATCOM: GNSS is operational today and expanding toward higher accuracy, integrity concepts, and cyber-resilience; EO is growing in planning/resilience use and needs improved timeliness and usability to become operational; SATCOM is expected to become increasingly relevant for resilience and secure connectivity (backup communications and continuity of operations), particularly under disruptive events and in connectivity dead zones, as European secure connectivity capabilities mature.

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1 SCOPE AND METHODOLOGY

1.1 Scope

This report captures user needs and application-level requirements for the Public Transport segment, focused on the use of space enabled Positioning, Navigation and Timing (PNT), Earth Observation (EO), and secure telecommunications (SATCOM) capabilities in public transport operations and planning. Where relevant, these needs may be addressed by European space assets and services, including Galileo, EGNOS, Copernicus, and future secure connectivity systems. The segment scope includes urban and regional passenger transport (bus, tram, metro, suburban/commuter rail, and demand-responsive services), and the enabling digital ecosystem (fleet management/AVL, passenger information, ticketing, asset management, ITS, and planning tools). The report considers requirements from the perspective of public transport authorities (PTAs), public transport operators (PTOs), and their supporting supply chain (ITS and ticketing providers, digital mobility service providers, and space-data/service providers).

The 2025 update builds on the 2023 public transport user needs baseline and follows the UCP approach of combining desk review with targeted stakeholder consultation and validation during the UCP Summit. For the 2025 cycle, the public transport workstream included outreach to 50+ stakeholders across Europe and 18 structured interviews (10 focused on GNSS, 8 focused on EO), conducted from August to October 2025, followed by in-person validation during the Public Transport UCP session (Prague, 04.12.2025). Stakeholders represented operators and authorities, city mobility agencies, ITS/ticketing suppliers, and technology and space-data service providers. Inputs were consolidated into updated needs and gaps, then validated with the user community during the Summit session and integrated into the User Requirements Database update logic.

The User Consultation

The User Consultation Platform (UCP) is a process developed at the European Union Agency for the Space Programme (EUSPA) to collect user needs and requirements and take them as inputs for the provision of user driven space data-based services by the EU Space Programme.

The objective of this report is to provide a reference for the EU Space Programme and for the Public Transport segment community, reporting the most up-to-date user needs and requirements in the Public Transport market segment for the use of Position, Navigation and Timing (PNT), Earth Observation (EO) and secure telecommunications (SATCOM) technologies. Its scope is to cover needs and requirements from the user perspective, considering the market conditions, regulations, and standards that influence them. The report serves as a reference for end users, service providers and the whole EO community in planning and decision-making activities for those concerned. The report is also intended to serve as an input to more technical discussions on systems engineering and to shape the evolution of the European Union’s satellite navigation systems, Galileo and EGNOS and the Earth Observation system, Copernicus, and in the future Space Situational Awareness, GOVSATCOM and IRIS2.

The UCP process contains a regular event, where users from different market segments meet to discuss their needs and application-level requirements relevant for PNT, EO and SATCOM and the conclusions are presented in this document. This report is a living and evolving document that is regularly updated by EUSPA. It served as a key input to the UCP, that is continuous process to reflect the evolution of the user needs, market and technology captured during the event. The report does not represent any commitment of the EU Space Programme to address or satisfy the listed needs and requirements in the current or future versions of the services and/or data delivered by its different components.

This report is organized as follows:

- Section 2.1 addresses the prospective use of EO/GNSS/SATCOM in the Public Transport segment, with identified trends, and innovations

- Section 2.2 presents the market evolution and key trends in the Public Transport segment, together with definitions of main user groups and actors in the value chain, followed by Section 2.3, that describes the market drivers (regulations, standards etc.)
- Section 2.4 describes applications and operational scenarios relevant for EO/GNSS/SATCOM, presenting main user needs and expectations towards services and data to serve operational scenarios, together with limitations and gaps identified by end users. Some applications are more detailed as they have been assessed specifically during the 2025 UCP.
- Section 2.5 summarizes the main User Requirements for the Public Transport segment in the applications domains analysed in this report.

1.2 Methodology

The UCP process follows systematic steps that are implemented in a continuous, repetitive manner. The logical steps allow transparency and continuous updates of the results, considering the new market developments and evolving user needs and requirements.

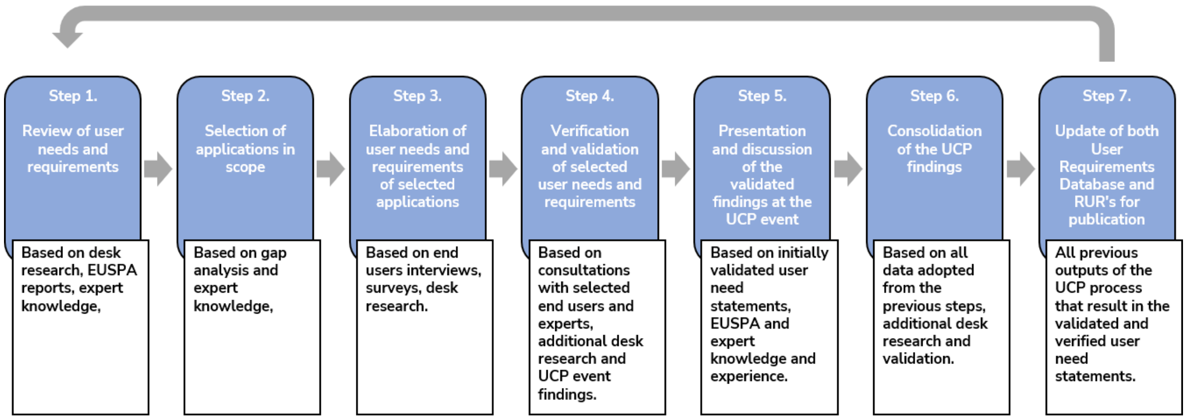

Figure 1: Public Transport segment user requirements analysis methodology

Each Market Segment has its peculiar evolution due to the changes in legislation, standards, technological trends and so forth, therefore the update of the Report on User Need and Requirements can occur with a time distance of at least two years.

UCP user needs and requirements collection and analysis is based on one hand side on desk research and on the other, on stakeholders' consultations and experts' knowledge.

The UCP process starts with review and analysis of the most up-to-date sources related to the user needs and requirements in selected market segments. This step leverages on the previous UCP Reports on User Requirements, latest EUSPA EO and GNSS Market Report, Technology Reports and other expert publications and knowledge. The selection of relevant applications in each market segment is made based on the market analysis, the gap analysis from the earlier editions of the UCP and EUSPA, as well as external experts' know-how.

After the initial desk research, the stakeholders' consultations are carried out, both representing end users and intermediate users (service providers), in order to validate the findings and collect missing information (Step 3). Validation of user needs requires additional feedback from relevant users' representatives that review the draft version of the Report on User Needs and Requirements, prepared in advance of the UCP event.

The UCP event is organized by EUSPA on an annual basis and offers a forum to present and discuss the finding, being additional layer of updates and gaps filling in the process. All the information and data gathered during the previous steps are consolidated in the segment-specific, presented here Report on User Needs and Requirements (RUR) and later on in the EUSPA User Requirements Database (Step 7).

2 PUBLIC TRANSPORT

2.1 The role of the European Space Programme to meet the evolving user needs

The role of EUSPA

EUSPA (European Union Agency for the Space Programme) plays a pivotal role in the context of the EU Space Programme, acting as a key operational agency that is user-oriented and focused on promoting and maximizing the uptake of satellite-based services across various sectors, through the following activities:

1. User-Centric Approach

- EUSPA adopts strategies that prioritize the needs and requirements of users. It aims to enhance the accessibility and integration of satellite services, ensuring that a broad spectrum of users, including governmental bodies, businesses, and citizens, can benefit from services related to Earth Observation, Satellite Navigation, and Connectivity.

2. Service Provisioning

EUSPA is responsible for providing state-of-the-art services in areas such as:

- Positioning, Navigation, and Timing: Through the Galileo and EGNOS systems.
- Satellite Communications: It facilitates communication services for governmental applications through GOVSATCOM and is working on the new IRIS2 initiative.
- Space Surveillance: EUSPA manages Front Desk services for the EU Space Surveillance and Tracking program, ensuring safety and security in space operations.

3. Enhancing the European Space Ecosystem

EUSPA works to foster a robust European space ecosystem by:

- Providing market intelligence and technical expertise to innovators, SMEs, and academia.
- Leveraging EU funding programs such as Horizon Europe to stimulate innovation and research in space-related technologies.
- Supporting startups and developing partnerships that enhance technological advancements.

4. Ensuring Security

- EUSPA plays a critical role in the security of the EU Space Programme. By operating the Galileo Security Monitoring Centre (GSMC), it implements and monitors the security of satellite services, thereby bolstering the overall security framework for EU Member States.

5. Stakeholder Engagement

- EUSPA actively engages stakeholders from the entire space value chain, including industry leaders, academic institutions, and end-users. It facilitates feedback mechanisms where users can express their needs and satisfaction levels regarding EU satellite services. This engagement is crucial for the continuous evolution of the EU Space Programme.

EUSPA conducts various essential activities which include:

- User Consultation Processes: These are designed to gather insights and perceptions from users to improve service delivery.

- Market and Technology Monitoring: EUSPA analyses trends and forecasts in the space industry to inform strategic decisions.
- Research and Development Funding: The agency identifies funding needs for R&D initiatives and ensures their implementation.
- Pilot Programs: EUSPA supports the testing and piloting of innovative applications to explore new possibilities in space services.
- Commercial Acceleration Programs: Through the CASSINI Programme, EUSPA promotes innovative commercial ideas and facilitates their growth in the marketplace.

In summary, EUSPA serves as a cornerstone of the EU Space Programme, bridging the gap between technological advancements and user needs. By providing innovative satellite services, fostering a collaborative space ecosystem, ensuring security, and engaging with a wide array of stakeholders, EUSPA is crucial in advancing the EU's strategic interests in space and enhancing the overall benefit of space technologies for society.

The role of European Global Navigation Satellite System (EGNSS)

EGNSS is the European satellite navigation program designed to provide highly accurate and reliable positioning, navigation, and timing services on a global scale and ensuring Europe's technological autonomy. EGNSS offers high-precision and multi-constellation capability. There is a free positioning service available to the public, as well as encrypted services for government and commercial use, like the Public Regulated Service (PRS) for government-authorized users. EGNSS includes two main systems:

- **Galileo** is the European satellite navigation system that provides highly accurate global positioning and timing information. It offers several unique features, including higher accuracy (especially in urban areas), improved availability, and an authentication service to prevent signal spoofing. Numerous EU economic sectors rely on Galileo, from transport and agriculture to border management and search and rescue. Its 20cm accuracy makes Galileo a game changer for autonomous driving and commercial drones. Already more than 3.5 billion smartphones are Galileo-enabled.
- **EGNOS** (European Geostationary Navigation Overlay Service) is a satellite-based augmentation system (SBAS) that improves the accuracy, integrity, and reliability of the navigation services to aviation, maritime and land-based users in over 30+ countries.

For the Public Transport segment, Galileo provides highly accurate and reliable **Positioning, Navigation and Timing, PNT**, information that is essential for efficient, safe, and increasingly digital public transport operations. Galileo enabled positioning supports a broad range of applications including fleet management, automatic vehicle location, real time passenger information, timetable adherence monitoring, demand responsive transport, connected driver advisory systems, ticketing and payment related services, and emerging automated bus and tram use cases. Galileo's unique features, such as higher accuracy, improved availability, authentication, and high accuracy services, make it a valuable asset for current and future public transport applications.

Compared with earlier single constellation deployments, Galileo strengthens public transport systems by improving the precision and resilience of positioning, especially where vehicle location feeds control room decision making, digital passenger services, contractual reporting, or ticketing and compliance functions. Galileo is therefore increasingly relevant not only for traditional fleet management and passenger information systems, but also for more demanding applications such as dense urban tracking, trusted geofencing, precise depot positioning, and early automated mobility services. In this sense, Galileo is already being used as a cornerstone technology for smarter and more sustainable public transport, and its role is expected to expand further as advanced services mature and become easier to integrate into off the shelf public transport solutions.

GNSS is operationally indispensable to public transport authorities, operators, and their digital service providers because it underpins core day to day functions such as **vehicle tracking, dispatch, real time passenger information, depot management, DRT operations, and increasingly ticketing and compliance workflows.**

The 2025 UCP showed that the market is moving beyond simply having GNSS available and toward requiring positioning that is more accurate, more robust in difficult operating environments such as urban canyons and tunnels, and more trustworthy for functions involving safety, cybersecurity, or financial implications. This is especially important as operators seek **better ETA reliability, stronger geofencing, and more dependable positioning** during **disruptions or severe weather events.** As a result, higher accuracy, stronger resilience to interference, richer quality metadata, and trusted or authenticated positioning are becoming the next layer of user expectations.

Table 1: Takeaways for GNSS from the 2025 UCP

The role of COPERNICUS

Copernicus is the Earth Observation component of the European Union's space programme, looking at our planet to support the management of the environment, mitigate the effects of climate change and ensure safety and civil security across Europe. Copernicus delivers its data and services with a free and open policy. It consists of three main components:

Space Component, which delivers data from a fleet of dedicated observation satellites (the 'Sentinels') and other Copernicus Contribution Missions (CCM). Six Sentinel satellites families are designed to serve a wide range of users and are provided with a free and open access globally. They ensure an independent and autonomous Earth Observation capacity for Europe with global coverage. The satellites provide observations which serve a wide range of users for a multitude of applications in the areas of climate, land and ocean services, emergency management, atmosphere and air quality, among others.

- Sentinel-1A, -1C, and 1D provide all-weather, day and night radar imagery for land and ocean services. Sentinel 1-B was retired in 2022.
- Sentinel-2A, -2B, -2C provide optical imagery for land and emergency services.
- Sentinel-3A & -3B provide optical, radar and altimetry data for marine and land services.
- Sentinel-5P provides atmospheric data, bridging the gap between ENVISAT and future Sentinel-5 data.
- Sentinel-4 & Sentinel-5 launched in 2025 monitor air quality, trace gases and aerosols over Europe at high spatial resolution and very high frequency.
- Sentinel-6 provides radar data to measure global sea surface height observations for climate monitoring and ocean and seasonal forecasts. It continues a time series of mean sea level rise measurements dating back to 1992.

CCMs complement the data portfolio in the Sentinel satellites missions with another layer of value to meet user needs, providing data from commercial data providers. There are around 30 existing or planned to contribute missions, encompassing various technologies like SAR, optical sensors, spectrometers and altimetry systems.

In-Situ Component collects data acquired by a multitude of sensors at air-, sea- and ground-level, and includes geospatial reference data.

Service Component of Copernicus programme transforms the various data into timely and actionable information products. The Copernicus Services deliver value-added information products in six thematic areas:

Atmosphere Monitoring Service (CAMS)	Climate Change Service (C3S)	Emergency Management Service (CEMS)	Land Monitoring Service (CLMS)	Marine Environment Monitoring Service (CMEMS)	Security Service (CSS)[1]

Figure 2: Relevant Copernicus services for Public Transport

For the Public Transport segment, the most relevant Copernicus services are the **Copernicus Land Monitoring Service (CLMS)**, the **Copernicus Atmosphere Monitoring Service (CAMS)**, the **Copernicus Climate Change Service (C3S)**, and the **Copernicus Emergency Management Service (CEMS)**. Together, these services provide a single public framework for access to a broad portfolio of scientifically validated products, delivered under a free and open data policy. Copernicus provides both multi-year datasets and near real time products, derived from Sentinel satellites, Copernicus Contributing Missions, in situ measurements, and numerical models. For the public transport segment, these products support stakeholders such as PTAs, PTOs, municipalities, infrastructure managers, and specialised service providers through information on land use, vegetation, ground motion, air quality, climate exposure, flooding, and other environmental conditions relevant to transport planning and operations.

Copernicus is increasingly important for public transport planning, infrastructure resilience, and climate adaptation. While it still feeds more directly into evidence-based planning and preparedness than into minute-by-minute operational control, its role is expected to grow as products become faster, more localised, and easier to integrate into asset management and GIS workflows. In the public transport context, Copernicus can support route and network planning, exposure assessment of stops and corridors, identification of climate sensitive infrastructure, and analysis of how urban growth and land use change affect service needs and accessibility. The Copernicus Land Monitoring Service, for example, provides products such as **Urban Atlas** and the **European Ground Motion Service**, which are directly relevant to urban mobility planning and infrastructure stability assessment.

First, in terms of **environmental and infrastructure monitoring**, satellite derived information can be used to monitor land use change, urban density, vegetation state, heat exposure, and terrain movement affecting public transport assets and corridors. In practice, this supports applications such as identifying areas where network expansion may be needed, assessing exposure of bus and tram corridors to urban heat or flooding, monitoring vegetation encroachment, and detecting ground instability near rail and tram infrastructure. Copernicus is already being used in combination with commercial EO data and local datasets to create more detailed and transport specific products and is increasingly viewed as a key baseline source for long term public transport planning and resilience analysis.

For **disaster and disruption management**, EO data, including public Copernicus products and complementary datasets, are increasingly relevant for monitoring floods, storms, wildfires, landslides, and other events that affect public transport services and infrastructure. In particular, the Copernicus Emergency Management Service provides rapid and risk and recovery mapping products that can support emergency planning, impact assessment, and prioritisation of interventions for transport networks and critical infrastructure. Copernicus based products are often considered a more scalable and cost-effective complement to field inspections, aircraft, or drones when wide urban or regional networks must be assessed quickly and consistently.

Secondly, in **service planning, climate resilience, and network optimisation**, Copernicus atmosphere, climate, and land products are becoming central to solutions aimed at reducing exposure to environmental risks and improving long term service design. Accurate weather and climate information, air quality monitoring, and land use analysis can help public authorities and operators assess how heatwaves, flooding, pollution, or urban growth affect public transport demand and network resilience. CAMS products can support air quality analysis, C3S products can support climate trend and adaptation planning, and CLMS products can support route, stop, and corridor planning through land cover, land use, and urban form analysis.

EUMETSAT also operates a fleet of geostationary and low Earth orbit satellites that provide continuous weather monitoring and forecasting capabilities highly relevant to public transport operations and planning.

- Meteosat Second Generation and the upcoming Third Generation provide continuous weather monitoring and forecasting over Europe.
- Metop first generation and the upcoming second generation deliver high resolution atmospheric data for weather prediction and climate monitoring.
- Sentinel 3, Sentinel 4, Sentinel 5, and Sentinel 6 enhance the Copernicus programme with additional observations for land, atmosphere, emergency response, and climate monitoring.

In the public transport segment, these capabilities are particularly relevant where severe weather, air quality, heat, flooding, and longer-term climate impacts affect service planning, passenger safety, and infrastructure resilience.

EO is increasingly relevant to public transport in areas such as **flood and heat risk assessment, infrastructure condition monitoring, vegetation overgrowth detection, and construction change analysis.** However, the 2025 UCP confirmed that most PTAs and PTOs do not consume EO directly in daily operations, because the key barriers are still data latency, spatial resolution for asset scale use cases, and the effort required to translate EO outputs into operationally usable formats. Stakeholders repeatedly emphasised that EO will become significantly more operationally relevant only when it is delivered as **decision ready products**, for example **corridor-based alerts, GIS ready layers, and simple APIs**, with refresh rates and responsiveness aligned to real transport planning and disruption management needs. In this sense, the challenge is not access to imagery alone, but the conversion of EO into timely, interpretable, and workflow compatible information.

Table 2: Takeaways for EO from the 2025 UCP

European Secure SATCOM

The EU Secure Satellite Communication System, known as **GOVSATCOM** is an investment made by the EU, which aims to provide secure and cost-efficient communication capabilities to security and safety-critical missions and operations. **IRIS², ,** the new multi-orbital constellation of 290 satellites will provide secure connectivity services to the EU and its Member States as well as broadband connectivity for governmental authorities, private companies and European citizens, while ensuring high-speed internet broadband to cope with connectivity dead zones**.** The program is part of the EU's broader strategy to strengthen its autonomy, security, and defence capabilities, especially in response to increasing geopolitical challenges and cybersecurity threats and should be operation by 2030.

2.2 Market overview & trends

Public transport is evolving from a service model primarily focused on scheduled operations toward one increasingly defined by data driven performance management, digitally enabled passenger information, and service tools, integrated multimodal journeys, electrified fleets, and climate resilient infrastructure planning. This evolution increases dependence on trustworthy positioning and environmental intelligence, and raises expectations for interoperability, cybersecurity, and operational continuity.

Across the EU, this evolution is being reinforced by a wider set of policy and regulatory developments that have moved from strategy into implementation in recent years. In particular, Directive (EU) 2023/2661, which revised the ITS framework, together with Delegated Regulation (EU) 2017/1926 on multimodal travel information services as amended by Delegated Regulation (EU) 2024/490, have increased expectations for standardised interfaces, interoperable data exchange through National Access Points, and reliable real time operational data. In practice, these rules strengthen the role of positioning as a foundational enabler for passenger information, multimodal journey planning, and wider digital mobility services, while also reinforcing the need for data quality, metadata, and system interoperability.

2.2.1 Market Evolution and Key Trends

Public transport in Europe continues to shift from a scheduled service model toward an integrated, digital mobility ecosystem defined by data availability, interoperable interfaces, electrified fleets, and resilience planning. Since 2023, the most material change is not a wholesale reset of priorities, but the move from policy direction to implementation and compliance: data sharing obligations for multimodal travel information have matured, public sector buyers increasingly expect standardised interfaces and quality metadata, and cybersecurity and service continuity have become more explicit requirements.

This evolution increases dependence on trustworthy positioning and reliable operational data pipelines because real time vehicle location and service status are increasingly treated as core network infrastructure, not a value add. At the same time, climate impacts and disruption risk are pushing operators and authorities to formalise resilience expectations for both physical assets and the digital systems that support operations, including cybersecurity and continuity planning.

2.2.1.1 GNSS Key Market Trends

GNSS is already widely embedded across fleets through automatic vehicle location systems, passenger information, and operational analytics. Since 2023, EU level policy and market practice have converged toward treating reliable positioning as a baseline input to digital mobility, especially where vehicle location feeds journey planners, multimodal services, and passenger information.

Key trends include:

1. **Standardisation driven ubiquity of real time positioning.**

   Expanded multimodal travel information obligations, implemented through National Access Points, have effectively made reliable, continuous vehicle location a baseline requirement for many operators, because location feeds are now central to passenger information, third party journey planners, and multimodal integration.

2. **Higher accuracy and urban availability**

   Users increasingly expect sub metre accuracy for day-to-day operational systems, and centimetre level performance in specialised use cases such as automation pilots, precision docking, or advanced driver advisory functions. This is pushing increased uptake of multi constellation GNSS and augmentation approaches where operationally justified.

3. **Higher integrity and robustness.** Rising awareness of jamming and spoofing and broader cybersecurity expectations are increasing demand for integrity monitoring, trusted data pathways, and solutions that can demonstrate quality, confidence, and traceability.

4. **Authentication, resilience, and cybersecurity readiness**

Awareness of jamming and spoofing risks is rising, and GNSS requirements increasingly include integrity, interference awareness, and stronger cyber protections. Procurement language is slowly evolving from "GPS equipped" to "trustworthy positioning" with explicit performance and resilience expectations.

5. **Interoperable location with quality metadata**

   Location data is increasingly expected to include quality descriptors, such as confidence indicators, correction method, and signal quality flags, so that downstream systems can make safer and more auditable decisions.

6. **Higher accuracy where operationally useful.** Interest in sub metre performance is growing for applications such as priority at signals, curbside and depot management, and early automation trials. The availability of Galileo High Accuracy Service (HAS) and the operational start of Galileo OSNMA strengthen the plausibility of authenticated, higher accuracy positioning becoming a procurement expectation for selected use cases over the next cycle.

2.2.1.2 EO Key Market Trends

Although less routinely used, EO is becoming more relevant as public transport authorities and operators intensify efforts on climate adaptation, asset management, and network planning under environmental stress. EO is used today mainly for planning, risk assessment, and occasional event analysis (e.g., floods and fires), while operational use remains limited. Demand is growing for "decision-ready" products that can be incorporated into standard workflows: flood extent layers, ground motion/deformation monitoring along corridors, urban heat exposure mapping around lines and stops, vegetation overgrowth indicators, and construction/change monitoring.

With this in mind, two patterns dominate:

1. **EO consumed through intermediaries.** EO is most often used via specialised SMEs and public agencies that translate satellite derived environmental parameters into decision ready products for infrastructure and service planning.

2. **EO linked to climate resilience and asset risk.** Increased attention to heat, flooding, wildfire smoke, landslide risk, subsidence, and corridor condition monitoring is driving demand for products such as deformation monitoring along alignments, flood extent layers, heat exposure mapping around stops, vegetation and encroachment indicators, and construction change detection.

Regarding key trends over the past several years, several trends emerge when it comes to EO use in public transport applications, including:

1. **Growth in "decision ready" EO products and workflows**

   Demand is rising for packaged outputs that can plug into existing planning and asset workflows, including flood extent layers, ground motion and deformation monitoring for corridors, urban heat exposure mapping around lines and stops, vegetation indicators near rights of way, and construction or change detection around critical nodes.

2. **EO adoption via intermediaries, not only via operators**

   EO use in public transport contexts is increasingly mediated by specialist external providers that translate EO and earth parameter data into transport relevant insights, rather than being directly operationalised inside control centres.

3. **EO as a resilience input for cross agency coordination**

   EO is increasingly framed as an enabling input for preparedness and public safety functions, supporting earlier warnings, prioritisation of protective actions, and better targeting of infrastructure upgrades.

2.2.1.3 SATCOM Key Market Trends

For most urban operations, terrestrial connectivity remains the primary channel; however, the sector is increasingly concerned with continuity of operations under disruptions, cybersecurity threats, and coverage gaps (rural routes, depots, tunnels, and disaster contexts). European secure connectivity initiatives are therefore viewed as a potential medium-term enabler for resilient and secure communications supporting safety- and security-critical transport operations. This is expanding interest in satellite communications not only as a contingency tool, but also as an operational complement in specific contexts.

Key trends include:

1. **Continuity under disruption and crisis operations**

   SATCOM is increasingly considered for resilient fallback communications during major incidents and extreme events, especially where terrestrial networks may be unavailable or degraded.

2. **Coverage gap mitigation for routine operations**

   Beyond emergencies, SATCOM relevance is rising for routine fleet activity on routes or assets with known coverage limitations, including rural or peri urban services, depots, remote terminals, and specific infrastructure segments where connectivity is unreliable.

3. **Operational telemetry and monitoring use cases**

   Routine low bandwidth fleet telemetry is an emerging application area, supporting operational monitoring, safety status reporting, and basic command and control continuity for vehicles or remote assets when terrestrial connectivity is intermittent.

4. **Secure connectivity expectations in the medium term**

   European secure connectivity initiatives are viewed as potential enablers for more resilient and secure communications supporting safety and security critical transport operations.

2.2.2 Main User Communities

The public transport user community can be grouped into nine primary categories, with an important clarification since 2023: GNSS is predominantly owned and operationalised inside PTAs and PTOs, while EO is most commonly consumed via specialist intermediaries and cross sector public agencies. These user groups are as follows:

Primary public transport actors

1. **Public transport authorities (PTAs).** PTAs set service objectives, define required performance and reporting, and translate policy requirements into procurement language. Since 2023, PTAs have an expanded role in ensuring compliance with EU expectations for multimodal data availability and interoperability, which directly influences location data requirements, metadata, and interface expectations.

2. **Public transport operators (PTOs).** PTOs operate services and implement operational systems such as AVL, driver support tools, passenger information, dispatch, and incident response. Operators are also increasingly responsible for demonstrating data quality, cybersecurity posture, and continuity of operations.
3. **Passengers and end users.** End users drive demand for reliable real time information, accessibility, integrated journeys, and consistent service quality. Their expectations increasingly translate into requirements through authority level contracts and platform level service quality metrics.

Industry, delivery, and integration ecosystem

4. **OEMs and system integrators.** Vehicle and system suppliers increasingly deliver turnkey packages combining vehicles, positioning, communications, and platform integration, often aligned with public transport interoperability specifications and national data publication norms.
5. **Tier 1 and component suppliers.** This group provides onboard units, receivers, antennas, and communications modules, and is critical for embedding multi constellation positioning, integrity features, and secure update and logging capabilities.
6. **Digital mobility platforms and data aggregators.** Since 2023, a larger share of public transport operational data is being consumed through multimodal platforms, journey planning services, and National Access Point ecosystems, increasing the importance of standardised data models and consistent GNSS derived feeds.

Standards, research, and public sector ecosystem

7. **Standardisation and interoperability communities.** These include bodies and frameworks that define how operational and passenger facing data is structured, exchanged, tested, and procured. They increasingly influence how positioning and EO derived information must be packaged, validated, and audited.
8. **Research institutions and EU funded projects.** Research and demonstration projects continue to validate new use cases, quantify benefits, and develop reference architectures that later migrate into procurement.
9. **Public agencies beyond transport.** For EO in particular, national meteorological agencies, civil protection agencies, climate and planning bodies, and critical infrastructure actors often define alerting and risk information workflows that then shape how public transport organisations consume EO derived insights.

2.2.2.1 GNSS Key Users

Primary GNSS users include PTAs and PTOs operating or overseeing digital operations and service delivery, especially operations and control centres, fleet and depot management teams, passenger information service teams, demand responsive transport dispatch systems, and ticketing and compliance functions. GNSS also supports a widening set of connected vehicle use cases, including geofencing, speed related functions, payments linked services, and emerging automated operations and advanced driver advisory tools.

2.2.2.2 EO Key Users

EO is less routinely used directly by PTAs and PTOs, and is most commonly operationalised through two core user groups:

1. **External specialist providers and SMEs** who process EO and earth parameter data, such as terrain, ground movement, infrastructure change, and climate and hazard indicators, and convert it into decision ready outputs for transport planning, asset management, and resilience prioritisation.
2. **Public agencies focused on public protection and environmental intelligence**, such as national weather agencies and climate, planning, and civil protection bodies, who generate alerts, risk

products, and longer-range assessments that are shared with public transport stakeholders to support preparedness, operational diversion planning, and infrastructure protection.

Within PTAs and PTOs, the internal users most likely to consume EO derived insights include planning units, infrastructure and asset management teams, climate adaptation and risk functions, and engineering teams responsible for corridor condition monitoring and resilience investment decisions as well as operations teams for disruption impact assessment and recovery prioritisation.

2.2.2.3 SATCOM Key Users

Potential SATCOM users include security and emergency management functions, control room continuity planning, infrastructure managers responsible for operations in known coverage gaps, and operators seeking resilient backup communications channels under disruption scenarios. SATCOM is also relevant for routine fleet activity in specific contexts, including remote depots or terminals, rural or peri urban lines, and any fleet operations where intermittent terrestrial connectivity constrains monitoring, telemetry, or command and control functions.

2.3 Key market drivers – Policies, Regulations, Standards

Public transport needs and requirements are increasingly shaped by EU priorities and policy on digital mobility, interoperability, decarbonisation, safety, and resilience. The dominant trends are clear:

1. increasing availability and sharing of multimodal travel and operational data
2. interoperability and standardisation across operators and service providers
3. stronger expectations for trusted positioning, secure data exchange, and continuity of operations and improved safety abilities

Since 2023, the key shift is that several frameworks have moved from direction setting to implementation, meaning requirements are now appearing more directly in procurement, service contracts, and compliance monitoring.

The following policies and regulations drive users' needs and requirements in the Public Transport sector.

2.3.1 Policy and regulatory drivers

Multimodal travel information services, MMTIS, and National Access Points

The EU framework for multimodal travel information services has matured into a direct operational market driver. Delegated Regulation (EU) 2017/1926, supplementing Directive 2010/40/EU, requires the availability of relevant transport datasets through National Access Points and reinforces expectations for standardisation, discoverability, and interoperability of data exchange. The subsequent amendment by Delegated Regulation (EU) 2024/490 extends and clarifies several dataset obligations, which in practice increases the importance of reliable, well structured, and reusable location derived real time operational data in public transport.

Implications for public transport requirements include:

- near real time vehicle location feeds as an operational expectation, not a pilot feature
- standardised data structures to support reuse by third parties
- clearer responsibilities for data quality, update rates, and metadata

Multimodal Digital Mobility Services policy trajectory, MDMS

EU policy work toward multimodal digital mobility services continues to push the market toward interoperable journey planning, comparison tools, booking, and ticketing integration across modes. This is reflected in the European Commission's proposal for a Regulation on Multimodal Digital Mobility Services, COM (2023) 753 final, which seeks to improve access to and use of mobility data and to support more integrated digital mobility ecosystems. Even though the legislative process is still ongoing, the proposal is already influencing expectations among authorities, operators, and integrators regarding consistent data interfaces, trusted operational feeds, and interoperable digital services.

ITS and digital mobility priorities, with stronger emphasis on security and resilience

The ITS policy environment continues to promote interoperable deployment, trusted digital enablers, and stronger attention to cybersecurity and resilience. In particular, Directive (EU) 2023/2661 updates the EU ITS framework and strengthens expectations around interoperable digital services, data availability, and secure deployment of ITS solutions across transport modes. In practical terms, this raises expectations for positioning quality, authentication readiness, integrity monitoring, and resilience planning for operational systems that depend on positioning and connectivity.

Decarbonisation and fleet transition drivers

EU and national decarbonisation rules continue to accelerate electrification and energy performance management in bus fleets. Relevant drivers include Directive (EU) 2019/1161, which amends the Clean Vehicles Directive, and wider implementation of Green Deal and urban mobility objectives. This increases the value of positioning data for energy aware operations, charging planning, route optimisation, and fleet performance reporting, while also increasing the relevance of EO for planning, environmental exposure mapping, and climate resilience assessment.

Safety and operational risk drivers

Vehicle safety requirements and operational risk expectations continue to strengthen the need for reliable, auditable operational data. In particular, Regulation (EU) 2019/2144, the General Safety Regulation, supports the deployment of mandatory safety technologies in new vehicle types, including those that depend on digital map information and vehicle positioning. More broadly, the combination of safety regulation, operational monitoring, and cyber resilience expectations reinforces the need for trustworthy GNSS feeds, secure data chains, and resilient communications architectures.

2.3.2 Relevant organizations

Key organisations influencing requirements, procurement language, and standardisation include:

- **EU institutions and agencies:** EU institutions and agencies: European Commission, including relevant Directorates General such as DG MOVE, DG ENV, and DG CLIMA, the European Union Agency for the Space Programme, EUSPA, the European Union Agency for Railways, ERA, the European Environment Agency, EEA, and, where cybersecurity and digital resilience are concerned, the European Union Agency for Cybersecurity, ENISA. These organisations collectively shape transport policy, interoperability, environmental reporting, resilience planning, railway integration, and the cybersecurity context in which public transport systems operate.
- **National transport ministries and competent authorities,** including National Access Point owners and operators.
- **Standardisation bodies:** CEN, ISO, and relevant telecommunications and cyber standards ecosystems.
- **Public transport interoperability communities:** ITxPT and communities around CEN public transport data models and interfaces (for example Trans model, NeTEx, and SIRI implementers).
- **Cybersecurity authorities and guidance bodies:** European Union Agency for Cybersecurity (ENISA), plus national cybersecurity agencies responsible for implementation guidance.
- **Sector associations and deployment networks:** UITP, ERTICO, and other communities that translate standards and policy into practical procurement and deployment guidance.

2.3.3 Selection of applicable regulations, treaties, and conventions

The following EU level instruments are particularly influential for public transport requirements connected to GNSS, EO, and resilient connectivity.

Revised EU ITS framework

Directive (EU) 2023/2661 updates the EU framework for interoperable Intelligent Transport Systems deployment. The revised framework reinforces EU wide expectations for data availability, interoperability, and secure deployment of digital ITS services, which indirectly raises baseline requirements for positioning quality, traceability, and cybersecurity for location enabled services in public transport.

Multimodal Travel Information Services and National Access Points

Delegated Regulation (EU) 2017/1926 sets requirements for the provision of multimodal travel information services through National Access Points and reached a key implementation milestone by the end of 2023. The subsequent amendment via Delegated Regulation (EU) 2024/490 extends and clarifies dataset expectations and reinforces the policy push for standardised data availability across Member States. In practice, these measures intensify demand for reliable real time operational data pipelines, including GNSS derived vehicle location feeding passenger information, journey planning, and multimodal data products.

Multimodal Digital Mobility Services policy trajectory

The European Commission's proposed regulation on Multimodal Digital Mobility Services, advanced through the Passenger Mobility Package, continues to push the market toward interoperable interfaces for journey planning, booking, and ticketing integration, and toward clearer data access and governance rules. Even where still under negotiation, the MDMS trajectory is already influencing expectations among authorities and integrators about consistent data quality, platform interoperability, and trusted exchange of operational information.

Cybersecurity and resilience requirements

Horizontal EU cyber and resilience obligations are increasingly shaping transport ICT procurement, including operational data systems, positioning infrastructure, and communications networks. This is reflected in the growing use of requirements related to risk management, incident handling, access control, logging, secure updates, and supply chain assurance, and in the expectation that critical service operators can demonstrate continuity planning for degraded connectivity scenarios.

2.3.4 Other standards, practices, and guidelines

Public transport interoperability specifications

Public transport interoperability frameworks continue to define how operational data is structured, exchanged, and procured. The requirement trend is toward consistent interfaces, alignment with shared data models, and explicit handling of data quality metadata. Key frameworks shaping procurement language and integration patterns include:

- IT architecture and interoperability specifications used in public transport procurements, especially those referenced by authorities to ensure modular integration and vendor neutrality.
- CEN public transport information model and exchange standards that underpin many national profiles and National Access Point implementations, ensuring that operational data can be exchanged across operators, platforms, and borders.

Data model and interface standards for passenger and operational information

Common standards for schedules and real time services, and their associated national and European profiles, increasingly influence how GNSS derived information is packaged and distributed, especially where it is published via National Access Points. Practical implications for requirements include:

- Clear mapping between onboard AVL outputs and external real time passenger information feeds.
- Consistent use of identifiers, stop and route referencing, and service status semantics so that third parties can fuse datasets reliably.
- Inclusion of location quality metadata where possible, for example confidence indicators, timestamp integrity, and update cadence, to improve downstream prediction and analytics.

The National Access Point policy framework is a primary driver of this standardisation pressure because it rewards solutions that can publish interoperable data with minimal bespoke transformation.

GNSS performance, testing, and receiver classification

GNSS related standards and technical specifications provide a stronger basis for procurement language, comparability of solutions, and verification methods. The practical requirement trend is toward:

- Clear performance classes for onboard receivers aligned to intended applications, such as routine AVL, compliance and reporting, and higher integrity operational use cases.
- Explicit test and acceptance methods that cover urban availability challenges, latency, interference resilience, and integrity monitoring.
- Clear expectations on quality metadata and monitoring outputs delivered alongside position feeds, enabling operational users and integrators to assess fitness for purpose.

Cybersecurity and assurance practices

Procurements increasingly embed cybersecurity requirements for positioning and communications systems, including secure update processes, integrity monitoring, access control, event logging, and vulnerability management. The most common requirement pattern is to treat positioning data and fleet communications as part of the critical digital service perimeter, meaning:

- Secure configuration and authenticated update mechanisms for onboard units and receivers.
- Auditability of data pathways from vehicle to back office to published feeds.
- Operational monitoring for anomalous location behaviour and interference indicators.
- Alignment with EU level cybersecurity guidance and national transposition requirements.

2.3.5 Relevant Standards for EO

EO standards in public transport are less unified than GNSS standards, largely because EO is typically consumed through derived products and intermediaries rather than embedded directly in operational control systems. EO requirements are therefore most often shaped by three families of standards and guidance.

Geospatial interoperability, metadata, and traceability

EO derived products must interoperate with GIS environments, asset registers, and planning tools. Requirements are commonly shaped by:

- Geospatial data product interoperability norms, especially for map services and datasets intended for integration into existing GIS workflows.
- Metadata and traceability expectations, including documented methodology, provenance, coordinate reference handling, and data quality descriptors.

Alignment with Copernicus datasets and downstream services

In EU contexts, EO use in planning and risk workflows is frequently tied to Copernicus ecosystem products, including land monitoring, climate services, atmospheric information, and emergency management mapping. Requirements therefore tend to prioritise:

- Use of recognised baseline datasets for comparability across regions and over time.
- Ability to link derived indicators to Copernicus or equivalent reference layers, so that planning decisions can be defended and replicated.

Operational integration constraints, decision ready delivery

The dominant EO adoption constraint is not imagery access, it is workflow fit. EO must be delivered as decision ready layers, dashboards, or alerts that match planning and asset management processes. Practical EO requirement patterns therefore focus less on raw imagery specifications and more on:

- Product interpretability and documented methodologies.
- Update cadence and event responsiveness, including clear triggers for rapid updates during floods, fires, and heat events.
- Integration into asset registers, GIS, and planning tools, including export formats, API delivery, and version control.
- Clearly defined uncertainty and confidence bounds so that engineering and risk teams can apply EO outputs appropriately.

2.4 User Needs and Requirements

ID	EUSPA-GN-UR-PUB-0210, EUSPA-GN-UR-PUB-0220, EUSPA-GN-UR-PUB-0230, EUSPA-GN-UR-PUB-0270, EUSPA-GN-UR-PUB-0240, EUSPA-GN-UR-PUB-0250, EUSPA-GN-UR-PUB-0260, EUSPA-GN-UR-PUB-0310, EUSPA-GN-UR-PUB-0320, EUSPA-GN-UR-PUB-0330, EUSPA-GN-UR-PUB-0340, EUSPA-GN-UR-PUB-0350, EUSPA-GN-UR-PUB-0360.
Application	Fleet operations, AVL, real time passenger information
Users	PTO control centre, dispatch, service planners, passenger information teams, integrators
Operational scenario	Continuous vehicle tracking supports dispatch decisions, headway management, schedule adherence monitoring, stop arrival predictions, and passenger information feeds
Size of area of interest	City wide network and corridors, typically 50 to 2,000 route km
Frequency of information needed	Continuous, typically 1 to 10 updates per second
Type of service (continuous, forecasting, one-off?)	Continuous
Satellite GNSS Data Requirements	
Accuracy	Horizontal 1 m typical, vertical 2 to 3 m acceptable, graceful degradation in dense urban
Availability	Greater than 99.9 percent, rapid recovery after short outages
Robustness	Resilient in urban canyons, interference awareness, multipath mitigation, multi constellation preferred
Integrity & Reliability	Quality metadata required, confidence bounds, timestamps, gap flags, time to alert on gross errors about 10 s
TTFF (Time to first fix)	Less than 10 s
TTFaT (In hot start)	Less than 5 s
Other requirements (if applicable)	Update rate at least 1 Hz, preference 5 to 10 Hz. End to end latency under 10 s
Technology used	Multi constellation GNSS receivers, Galileo capable, dual frequency where feasible, onboard gateway integration
Data supplements	Map matching, IMU and odometry fusion, cellular time sync, correction services where available

Table 3: Applications, users and current needs and requirements (GNSS): fleet operations, AVL, real time passenger information

ID	EUSPA-GN-UR-PUB-010204, EUSPA-GN-UR-PUB-010202, EUSPA-GN-UR-PUB-010205, EUSPA-GN-UR-PUB-010208, EUSPA-GN-UR-PUB-010207, EUSPA-GN-UR-PUB-010201, EUSPA-GN-UR-PUB-010207.
Application	Demand responsive transport and microtransit
Users	DRT dispatch platform, operators, customer support, passengers, indirect
Operational scenario	Continuous tracking supports dynamic routing and matching, geofencing at pickups and drop offs, proof of service delivery, and live ETA updates
Size of area of interest	City wide or district level, typically 10 to 500 sq. km
Frequency of information needed	Continuous, typically 1 to 10 updates per second
Type of service (continuous, forecasting, one-off?)	Continuous
Satellite GNSS Data Requirements	
Accuracy	Horizontal 1 m preferred, geofencing usable in dense areas
Availability	Greater than 99.9 percent, stable performance across mixed environments
Robustness	Robust against multipath and canopy effects, platform must handle uncertainty
Integrity & Reliability	Integrity via confidence scoring and exception handling. Logs for service verification
TTFF (Time to first fix)	Less than 10 s
TTFaT (In hot start)	Less than 5 s
Other requirements (if applicable)	Strong need for consistent quality indicators to support automated dispatch decisions and dispute handling
Technology used	Vehicle GNSS or smartphone positioning plus dispatch platform, multi constellation preferred
Data supplements	Map matching, geofence logic with confidence thresholds, cellular assisted positioning, IMU fusion where supported

Table 4: Applications, users and current needs and requirements (GNSS): Demand responsive transport and microtransit

ID	EUSPA-GN-UR-PUB-010101, EUSPA-GN-UR-PUB-010102, EUSPA-GN-UR-PUB-010103, EUSPA-GN-UR-PUB-010104, EUSPA-GN-UR-PUB-010105, EUSPA-GN-UR-PUB-010106, EUSPA-GN-UR-PUB-010107, EUSPA-GN-UR-PUB-010109, EUSPA-GN-UR-PUB-030101 EUSPA-GN-UR-PUB-030102, EUSPA-GN-UR-PUB-030103, EUSPA-GN-UR-PUB-030104, EUSPA-GN-UR-PUB-030105, EUSPA-GN-UR-PUB-030106, EUSPA-GN-UR-PUB-030107, EUSPA-GN-UR-PUB-030109, EUSPA-GN-UR-PUB-050101, EUSPA-GN-UR-PUB-050102, EUSPA-GN-UR-PUB-050103, EUSPA-GN-UR-PUB-050104, EUSPA-GN-UR-PUB-050105, EUSPA-GN-UR-PUB-050106, EUSPA-GN-UR-PUB-050107, EUSPA-GN-UR-PUB-050109.
Application	Ticketing, compliance, and enforcement
Users	Ticketing vendors, PTAs, PTO revenue protection, auditors, MaaS integrators
Operational scenario	Location enabled validation supports zonal or distance-based charging, compliance evidence, dispute resolution, fraud detection, and enforcement support
Size of area of interest	Fare zones and service area, typically city or region scale
Frequency of information needed	Per trip events, plus continuous during trip where required
Type of service (continuous, forecasting, one-off?)	Continuous plus event-based triggers
Satellite GNSS Data Requirements	
Accuracy	Horizontal 1 m preferred for zone validation, repeatable performance more important than peaks
Availability	High availability with audit grade trace completeness
Robustness	High emphasis on spoofing and jamming resilience, anomaly detection
Integrity & Reliability	Trusted positioning, authentication where available, tamper evident logs, clear confidence, and evidence model
TTFF (Time to first fix)	Less than 10 s
TTFaT (In hot start)	Less than 5 s
Other requirements (if applicable)	Cybersecurity requirements, secure updates, access control, and audit logging suitable for revenue protection
Technology used	Multi constellation GNSS, authentication capable receivers where feasible
Data supplements	Cryptographic proofs and logs, anomaly detection, cross checks with vehicle movement and network topology

Table 5: Applications, users and current needs and requirements (GNSS): Ticketing, compliance, and enforcement

ID	EUSPA-GN-UR-PUB-0210, EUSPA-GN-UR-PUB-0220, EUSPA-GN-UR-PUB-0230, EUSPA-GN-UR-PUB-0270, EUSPA-GN-UR-PUB-0240, EUSPA-GN-UR-PUB-0250, EUSPA-GN-UR-PUB-0260, EUSPA-GN-UR-PUB-0310, EUSPA-GN-UR-PUB-0320, EUSPA-GN-UR-PUB-0330, EUSPA-GN-UR-PUB-0340, EUSPA-GN-UR-PUB-0350, EUSPA-GN-UR-PUB-0360, EUSPA-GN-UR-PUB-0410, EUSPA-GN-UR-PUB-0420, EUSPA-GN-UR-PUB-0430, EUSPA-GN-UR-PUB-0440, EUSPA-GN-UR-PUB-0450, EUSPA-GN-UR-PUB-0460.
Application	Connected driver advisory, eco driving, energy management
Users	PTO operations, driver advisory system vendor, electrification team, depot management
Operational scenario	Position and speed combined with timetable targets and route context supports energy efficient driving guidance, charging strategy optimisation, and performance analytics
Size of area of interest	Route and depot level, typically 1 to 200 km corridors
Frequency of information needed	Continuous, typically 1 to 10 updates per second
Type of service (continuous, forecasting, one-off?)	Continuous
Satellite GNSS Data Requirements	
Accuracy	Stable lane level or stop level accuracy sufficient for advisory, typically 1 m
Availability	Very high availability, smoothness, and continuity valued
Robustness	Robustness to multipath and transient losses, smoothing acceptable
Integrity & Reliability	Integrity via plausibility checks and confidence metadata
TTFF (Time to first fix)	Less than 10 s
TTFaT (In hot start)	Less than 5 s
Other requirements (if applicable)	Update rate preference 5 to 10 Hz where driver advisory uses more frequent speed and position inputs
Technology used	GNSS plus onboard sensors, integration with energy and telematics systems
Data supplements	IMU and odometry, map matching, route grade context, charging state of charge feeds

Table 6: Applications, users and current needs and requirements (GNSS): Connected driver advisory, eco driving, energy management

ID	EUSPA-GN-UR-PUB-0210, EUSPA-GN-UR-PUB-0220, EUSPA-GN-UR-PUB-0230, EUSPA-GN-UR-PUB-0270, EUSPA-GN-UR-PUB-0240, EUSPA-GN-UR-PUB-0250, EUSPA-GN-UR-PUB-0260, EUSPA-GN-UR-PUB-0310, EUSPA-GN-UR-PUB-0320, EUSPA-GN-UR-PUB-0330, EUSPA-GN-UR-PUB-0340, EUSPA-GN-UR-PUB-0350, EUSPA-GN-UR-PUB-0360.
Application	Automated operations, precision docking, depot manoeuvres
Users	Automation pilot operators, OEMs, safety managers, integrators
Operational scenario	High precision positioning supports docking, manoeuvres, lane keeping, and automated shuttle or bus pilots, including safety relevant control loops
Size of area of interest	Localised area such as depot, terminal, lane segment, typically 0.1 to 10 sq. km
Frequency of information needed	Very high frequency, typically 10 to 20 updates per second
Type of service (continuous, forecasting, one-off?)	Continuous
Satellite GNSS Data Requirements	
Accuracy	0.1 m target for precision docking, centimetre level for advanced automation, vertical as required by application
Availability	Very high availability, minimal outages
Robustness	Strong robustness to interference, multipath, and spoofing required
Integrity & Reliability	Safety relevant integrity concepts, time to alert sub second to a few seconds depending on function, continuous monitoring
TTFF (Time to first fix)	Typically, not critical once running, but rapid reacquisition needed
TTFaT (In hot start)	Typically, not critical once running
Other requirements (if applicable)	Update rate 10 to 20 Hz. Latency sub second. Strong sensor fusion and augmentation assumed
Technology used	High accuracy GNSS, RTK or PPP RTK, tightly integrated sensor fusion stack
Data supplements	IMU, wheel odometry, lidar or camera localisation, HD maps, integrity monitoring, and alerting

Table 7: Applications, users and current needs and requirements (GNSS): Automated operations, precision docking, depot manoeuvres

ID	EUSPA-EO-UR-PUB-01, EUSPA-EO-UR-PUB-02, EUSPA-EO-UR-PUB-03.
Application	Infrastructure monitoring and maintenance planning
Users	Infrastructure and asset teams, engineering teams, corridor managers, external EO service providers
Operational scenario	Deformation and subsidence monitoring, vegetation indicators, corridor screening, prioritisation of inspections and maintenance
Size of area of interest	Corridor level, typically 10 to 500 km, buffers of 50 to 500 m
Frequency of information needed	Weekly to monthly, higher cadence in hotspots
Type of service (continuous, forecasting, one-off?)	Continuous monitoring products
Satellite EO Data Requirements	
Spatial resolution	0.25 to 1 m where asset level detail is required, 10 m sufficient for screening
Temporal resolution	Weekly to monthly
Spectral resolution	SAR for deformation, multispectral optical for vegetation
Data latency	Standard under 24 h for product refresh where automated. Longer acceptable for strategic products
Pre-processing needs	Radiometric and geometric correction, InSAR processing, classification into decision ready indicators
Other requirements (if applicable)	Clear methodology, uncertainty bounds, integration ready GIS layers, reliability above 99 percent
Technology used	Sentinel 1 InSAR, Sentinel 2 optical, commercial VHR where needed
Data supplements	Asset registers, GIS layers, ground truth inspections, engineering context data

Table 8: Applications, users and current needs and requirements (EO): Infrastructure monitoring and maintenance planning

ID	EUSPA-EO-UR-PUB-04, EUSPA-EO-UR-PUB-05, EUSPA-EO-UR-PUB-06, EUSPA-EO-UR-PUB-07
Application	Climate resilience and disruption impact assessment
Users	Climate and risk units, operations planning, emergency coordination, PTAs, external EO providers
Operational scenario	Flood extent mapping, fire and storm impact assessment, recovery prioritisation, vulnerability mapping
Size of area of interest	City and region scale, 100 to 10,000 sq. km
Frequency of information needed	Event driven with rapid updates during incidents
Type of service (continuous, forecasting, one-off?)	Event driven plus periodic baseline products
Satellite EO Data Requirements	
Spatial resolution	10 m often sufficient for city scale risk and extent mapping, VHR for critical assets
Temporal resolution	Every 4 to 8 hours for critical event monitoring where feasible, otherwise daily
Spectral resolution	SAR essential for rapid flood mapping, optical for land cover and burn scars
Data latency	Under 8 h for urgent response products. Under 24 h for standard event layers
Pre-processing needs	Automated processing chain, cloud handling, alerting, and dashboard outputs
Other requirements (if applicable)	Event responsiveness and clear confidence statements. Fit for operational decision making
Technology used	Sentinel 1 SAR for floods and cloud independent mapping, Sentinel 2 for burn scars and land cover
Data supplements	Weather forecasts, hydrological models, DEM, local incident reports

Table 9: Table 9. Applications, users and current needs and requirements (EO): Climate resilience and disruption impact assessment

ID	EUSPA-EO-UR-PUB-08, EUSPA-EO-UR-PUB-09, EUSPA-EO-UR-PUB-10.
Application	Construction and change monitoring around corridors and depots
Users	PTAs, PTO planning, project delivery teams, external monitoring providers
Operational scenario	Change detection for works near corridors, encroachment risk, monitoring progress and impacts
Size of area of interest	Corridor and sites, 1 to 500 sq. km
Frequency of information needed	Weekly to monthly, higher cadence during active works
Type of service (continuous, forecasting, one-off?)	Continuous monitoring products
Satellite EO Data Requirements	
Spatial resolution	0.25 to 1 m preferred for construction monitoring, 10 m for broad change screening
Temporal resolution	Weekly to monthly
Spectral resolution	Optical for change detection. SAR optional depending on use case
Data latency	Under 24 h for monitoring updates where automated
Pre-processing needs	Change detection workflows, object-based classification, integration into GIS
Other requirements (if applicable)	Traceability, reproducible methodology, false positive management
Technology used	Sentinel 2 plus commercial VHR, SAR where useful
Data supplements	Planning permits, work schedules, cadastral data, engineering drawings

Table 10: Applications, users and current needs and requirements (EO): Construction and change monitoring around corridors and depots

ID	EUSPA-EO-UR-PUB-11, EUSPA-EO-UR-PUB-12, EUSPA-EO-UR-PUB-13.
Application	Environmental intelligence for planning and communication
Users	PTAs, planners, sustainability teams, communications teams
Operational scenario	Urban heat exposure around stops, green cover indicators, environmental context for planning and reporting
Size of area of interest	City scale, 50 to 1,000 sq. km
Frequency of information needed	Seasonal to annual, plus targeted studies
Type of service (continuous, forecasting, one-off?)	Periodic products
Satellite EO Data Requirements	
Spatial resolution	10 m sufficient for heat and vegetation pattern mapping at city scale
Temporal resolution	Seasonal to annual
Spectral resolution	Multispectral optical, thermal where available
Data latency	Days to weeks acceptable depending on planning cycle
Pre-processing needs	Standard corrections plus derivation of exposure indices
Other requirements (if applicable)	Strong interpretability guidance, consistent baselines, documented methodology
Technology used	Sentinel 2, land surface temperature products where available, Copernicus services
Data supplements	Local land use, socio demographic layers, health and exposure indices

Table 11: Applications, users and current needs and requirements (EO): Environmental intelligence for planning and communication

Case Study / User Story
GNSS: At EMT Valencia, the Head of Research and Innovation described long standing use of GNSS, including Galileo enabled receivers, to support bus fleet management, vehicle tracking, and speed monitoring, particularly to understand risky driving behaviour when buses return to depots after service hours. They reported that latency and occasional positioning gaps limit the operational value of these feeds, making it harder to generate reliable ETAs, keep passenger information accurate, and optimise dispatch and driver scheduling in real time. During disruption events, including severe storms such as the DANA event in October 2024, they emphasised that near real time updates and richer quality metadata would strengthen control room decision making, speed up communication with drivers, and improve the ability to reroute and manage service safely under fast changing conditions. EO: In interviews with ICEYE, the company explained how it delivers decision ready EO products to regional authorities and municipalities who support public transport operators, with a focus on flood and severe weather monitoring to enable earlier action and safer operations. ICEYE highlighted that its constellation can support revisit times on the order of hours, enabling more frequent situational updates than traditional open data sources in many scenarios, and that it can complement its outputs by cross checking with Copernicus data for context and verification. They noted that if Copernicus revisit and responsiveness were to reach consistent sub day timeframes for relevant emergency mapping layers, it would materially expand how EO could be integrated into routine disruption planning and real time operational readiness for PTAs and PTOs, improving safety outcomes for both staff and passengers.

Table 12: Public Transport Case Study (GNSS)

2.5 User Requirements Specifications

ID	Description	Type	Source
GNSS_REQ_01	Availability greater than 99.9 percent for operational tracking services	Performance	UCP URDB
GNSS_REQ_02	Horizontal accuracy about 1 m for operational needs, with graceful degradation handling in dense urban environments	Performance	UCP 2025 MoM, core GNSS requirements
GNSS_REQ_03	Update rate at least 1 Hz, preference 5 to 10 Hz for operational usefulness	Performance	UCP 2025 MoM, core GNSS requirements
GNSS_REQ_04	End to end positioning latency under 10 s for operations, and sub second for safety critical use cases	Performance	UCP 2025 MoM, core GNSS requirements
GNSS_REQ_05	Time to first fix less than 10 s, ideally less than 5 s for hot start	Performance	UCP 2025 MoM, core GNSS requirements
GNSS_REQ_06	Rapid recovery after GNSS outages, reacquisition within about 5 s where feasible	Performance	UCP 2025 MoM, core GNSS requirements
GNSS_REQ_07	Provision of quality metadata with every position fix, including timestamp, confidence indicators, correction method, and gap flags	Data and interface	UCP 2025 MoM and interoperability practice
GNSS_REQ_08	Integrity monitoring and time to alert for gross errors on the order of 10 s for operational contexts, faster where safety relevant	Integrity	UCP 2025 MoM and assurance practice
GNSS_REQ_09	Multi constellation support including Galileo capable receivers, dual frequency preferred where feasible	Technical	UCP 2025 MoM and GNSS market practice
GNSS_REQ_10	Anti spoofing and anti-jamming awareness and mitigation, including detection, logging, and operational alerting	Cybersecurity and robustness	UCP 2025 MoM and GNSS security standards practice
GNSS_REQ_11	Authentication capability via Galileo OSNMA capable receivers where feasible for trusted positioning use cases	Cybersecurity and assurance	UCP 2025 MoM plus Galileo OSNMA service maturity
GNSS_REQ_12	Support for augmentation pathways where needed, including Galileo HAS and RTK class solutions for higher accuracy applications	Performance	UCP 2025 MoM and market capability evolution
GNSS_REQ_13	For automated bus and precision manoeuvres, centimetre level accuracy (1 to 2 cm) and high update rate (about 20 Hz) enabled through augmentation and sensor fusion	Performance and safety	UCP 2025 MoM, automated bus positioning requirements
GNSS_REQ_14	Secure update processes, access control, and audit logging for positioning and related digital mobility subsystems	Cybersecurity	Procurement practice reinforced by NIS2 expectations

Table 13: Synthesis of Requirements Relevant to GNSS (Public Transport)

ID	Application	Abstract of the Need & Requirement	Size of the area of interest	Frequency of information needed	Spatial resolution	Temporal resolution	Type of EO data
EO_REQ_01	Infrastructure monitoring and maintenance planning	Decision ready indicators for deformation, subsidence, vegetation and corridor risk, integrated into GIS and asset workflows with uncertainty statements	10 to 500 km corridor buffers	Weekly to monthly	0.25 to 1 m for asset level, 10 m for screening	Weekly to monthly	SAR InSAR plus optical multispectral products
EO_REQ_02	Disruption and climate impact assessment	Rapid flood extent and impact layers suitable for operational prioritisation and recovery planning, delivered within operationally useful timelines	100 to 10,000 sq. km	Event driven, rapid updates during incident	10 m typical, VHR for critical assets	Every 4 to 8 hours where feasible, otherwise daily	SAR for flood and cloud independent mapping plus optical for context
EO_REQ_03	Construction and change monitoring	Change detection and monitoring of works, encroachment, and land cover changes near corridors, with traceability and low false positives	1 to 500 sq. km	Weekly to monthly	0.25 to 1 m preferred for works, 10 m for screening	Weekly to monthly	Optical VHR plus optional SAR
EO_REQ_04	Environmental intelligence for planning	Interpretable heat, vegetation, and exposure layers for planning, reporting and communication, aligned with planning cycles	50 to 1,000 sq. km	Seasonal to annual	10 m	Seasonal	Multispectral optical and temperature related products where available

Table 14: Synthesis of Requirements Relevant to EO (Public Transport)

3 ANNEX

A.1 Definition of key EO performance parameters

This annex provides a definition of the most used EO performance parameters and includes additional details which are relevant for the Public Transport community.

Spatial resolution refers to the level of detail and clarity in the images, specifically the size of the smallest discernible ground features. It is determined by the pixel size, which is the smallest unit in the image that represents a spatial area on the Earth's surface. Spatial resolution is usually measured in terms of meters per pixel. Thus, a spatial resolution of 1 meter means that each pixel represents a 1 by 1 meter area on the ground.

Spectral resolution refers to the ability of a sensor to differentiate electromagnetic radiation of different wavelengths. In other words, it refers to the number and "size" of wavelength intervals that the sensor is able to measure. The finer the spectral resolution, the narrower the wavelength range for a particular channel or band. In remote sensing, features (e.g. water, vegetation) can be characterised by comparing their "response" in different spectral bands.

Radiometric resolution expresses the sensitivity of the sensor, that is to say its ability to differentiate between different magnitudes of the electromagnetic energy. The finer the radiometric resolution, the more sensitive it is to small differences in the energy emitted or reflected by an object. The radiometric resolution is generally expressed in bit, e.g. an 8-bit image has a scale of 2^8=256 nuances.

Temporal resolution relates to the time elapsed between two consecutive observations of the same area on the ground. The higher the temporal resolution, the shorter the time between the acquisitions of two consecutive observations of the same area. In absolute terms, the temporal resolution of a remote sensing system corresponds to the time elapsed between two consecutive passes of the satellite over the exact same point on the ground (generally referred to as "revisit time" or "orbit cycle"). However, several parameters like the overlap between the swaths of adjacent passes, the agility of the satellites and in case of a constellation, the number of satellites mean that some areas of the Earth can be reimaged more frequently. For a given system, the temporal resolution can therefore be better than the revisit time of the satellite(s).

Geolocation accuracy refers to the ability of an EO remote sensing platform to assign an accurate geographic position on the ground to the features captured in a scene. An accurate geolocation makes easier the combination of several images (e.g. combination of a Synthetic Aperture Radar image with a cadastral map and a vegetation map).

Spectral range refers to the wavelength range of a particular channel or band over in which remote sensing data must be collected.

Latency is the difference between the reference time of the satellite measurement and the time the final product is made available to the user (here the service provider).

A.2 Additional EO definitions

Ground deformation monitoring is the process which consists in tracking the vertical and horizontal movements of the land surface and their dynamics, whatever these movements are caused by natural phenomena (e.g. volcanic activity) or by human activities (e.g. aquifer exploitation).

Change detection is the process which aims at identifying difference in the state of "objects" (e.g. bridges, constructions, urban areas) or of a phenomenon (e.g. deforestation, soil sealing) by comparing snapshots of the situation at different times. In Earth Observation, change detection is extensively based on satellite imagery obtained through a wide variety of sensors (e.g. optical, radar, infrared, microwave, etc.

Geodesy (see [RD3]) is the earth science of accurately measuring and understanding three of Earth's fundamental properties: its geometric shape, orientation in space, and gravitational field. The field also studies of how these properties change over time. Today, geodesy goes beyond that, being the geoscience that deals among other with the monitoring the solid Earth (which includes the monitoring of displacement, subsidence or deformation of the ground and structures due to tectonic, volcanic, and other natural phenomena as well as human activity.

Interferometric Synthetic Aperture Radar (InSAR) is a technique enabling to generate surface deformation maps based on the processing of SAR images captured at different moments in time. The processing uses the fact that if the ground has moved between the times of two SAR images of the same area, a slightly different portion of the wavelength is reflected to the satellite resulting in a measurable phase shift that is proportional to displacement. The processing therefore consists in obtaining information about the vertical movements of the ground surface by calculating the phase difference between the emitted radar signal and the signal backscattered by the surface for successive images. InSAR can potentially measure deformations of millimetre-scale during periods ranging from days to years.

Near-Real-Time (NRT) refers, when used in the context of EO applications, to applications/services/products for which the time delay between the occurrence of a given event and the availability of the outcomes of the processing of the Earth observation data corresponding to that event is considered as being not significant from a user perspective. The notion of "near real-time" is therefore depending on user requirements. For Earth observation, the corresponding time delays may range from a few hours to a few days depending on the application/service/product.

A.3 Definition of key GNSS performance parameters

This annex provides a definition of the most commonly used GNSS performance parameters, and includes additional details which are relevant for the Public Transport community.

Availability: the percentage of time the position, navigation or timing solution can be computed by the user. Values vary greatly according to the specific application and services used, but typically range from 95-99.9%. There are two classes of availability:

- System availability: the percentage of time the system allows the user to compute a position - this is what GNSS Interface Control Documents (ICDs) refer to.
- Overall availability: considers the receiver performance and the user's environment. Values vary greatly according to the specific use cases and services used.

Accuracy is the difference between true and computed solution (position or time). This is expressed as the value within which a specified proportion – usually 95% – of samples would fall if measured. This report refers to positioning accuracy using the following convention: centimetre-level: 0-10cm; decimetre level: 10-100cm; metre-level: 1-10 metres.

Continuity is the ability of a system to perform its function (deliver PNT services with the required performance levels) without interruption once the operation has started. It is usually expressed as the risk of discontinuity and depends entirely on the timeframe of the application. A typical value is around 1*10-4 over the course of the procedure where the system is in use.

Indoor penetration is the ability of a signal to penetrate inside buildings (e.g. through windows). Indoor penetration does not have an agreed or typical means for expression. In GNSS this parameter is dictated by the sensitivity of the receiver, whereas for other positioning technologies there are vastly different factors that determine performance (for example, availability of Wi-Fi base stations for Wi-Fi-based positioning).

Integrity is a term used to express the ability of the system to provide warnings to users when it should not be used. It is the probability of a user being exposed to an error larger than the alert limits without timely warning. The way integrity is ensured and assessed, and the means of delivering integrity-related information to users are highly application dependent. Throughout this report, the "integrity concept" is to be understood at large, i.e. not restricted to safety-critical or civil aviation definitions but also encompassing concepts of quality assurance/quality control as used in other applications and sectors.

Latency is the difference between the reference time of the solution and the time this solution is made available to the end user or application (i.e. including all delays). Latency is typically accounted for in a receiver but presents a potential problem for integration (fusion) of multiple positioning solutions, or for high dynamics mobile devices.

Robustness relates to spoofing and jamming and how the system can cope with these issues. It is a more qualitative than quantitative parameter and depends on the type of attack or interference the receiver is capable of mitigating. Robustness can be improved by authentication information and services.

Authentication gives a level of assurance that the data provided by a positioning system has been derived from real signals. Radio frequency spoofing may affect the positioning system, resulting in false data as output of the system itself.

Power consumption is the amount of power a device uses to provide a position. It will vary depending on the available signals and data. For example, GNSS chips will use more power when scanning to identify signals (cold start) than when computing a position. Typical values are in the order of tens of milliwatts (for smartphone chipsets).

Probability of false alarm refers to the likelihood of the receiver to indicate the presence of a signal when no signal is present.

Probability of detection refers to the likelihood of a receiver to detect the presence of a GNSS signal when a signal is indeed present.

Time To First Fix (TTFF) is a measure of time between activation of a receiver and the availability of a solution, including any power on self-test, acquisition of satellite signals and navigation data and computation of the solution. It mainly depends on data that the receiver has access to before activation: cold start (the receiver has no knowledge of the current situation and must thus systematically search for and identify signals before processing them – a process that can take up to several minutes.); warm start (the receiver has estimates of the current situation – typically taking tens of seconds) or hot start (the receiver understands the current situation – typically taking a few seconds).

Time To First accurate Fix (TTFaF) is a measure of a receiver’s/solution's performance covering the time between activation and output of a position within the required accuracy bounds.

A.4 Definition of key SATCOM performance parameters

Link type refers to the type of communication link used for transmitting voice or data.

Availability is qualitative indication of the reliability and uptime of the communications system. It refers to the percentage of time the communication system is operational and meets the required quality of service when the application is in use.

Latency refers to the delay between the transmission of a signal and the reception of the response. This is the time it takes for a signal to travel from the sender to the receiver and back.

Bandwidth (bit rate) is a qualitative indication of the anticipated rate of data transfer when using the application. It is the amount of data that can be transmitted over the communication link in a given amount of time, usually measured in bits per second (bps).

Coverage is an indication of the geographical area that can be reached by the service. It defines the regions where the satellite signal is available and can provide communication services.

Symmetry Up/Down is the ratio between the uplink traffic (data sent from the ground to the satellite) and the downlink traffic (data sent from the satellite to the ground). This ratio indicates whether the communication link is symmetric (equal uplink and downlink capacity) or asymmetric (different uplink and downlink capacities).

Distribution refers to the method and extent to which the communication service is distributed across different regions or users. It can include the distribution of signal strength, service availability, and user access.

Setup refers to a qualitative indication of the time required to establish a voice or data communication session with the application. It refers to the acceptable duration for setting up a communication link that is sufficient to perform the intended operation, such as railway operations.

Speed: the speed at which a user is traveling, with a maximum value specified. In satellite communication, this can affect the ability to maintain a stable communication link, especially for mobile users.

Security protection refers to the measures and protocols implemented to ensure the security of the communication link. This includes protecting the data from unauthorized access, interception, and ensuring the integrity and confidentiality of the transmitted information

A.5 Other performance parameters

EO

Agility corresponds to the ability of a satellite to modify its attitude and to point rapidly in any direction to observe areas of interest outside its ground trace. High agility can improve the temporal resolution compared with the revisit time of the satellite.

Swath corresponds to width of the portion of the ground that the satellite "sees" at each pass. The larger the swath, the bigger the observed area at each pass.

Off-nadir angle corresponds to the angle at which images are acquired compared with the "nadir", i.e. looking straight down at the target. In practice, objects located directly below the sensor only have their tops visible, thus making it impossible to represent the three-dimensional surface of the Earth. High resolution images are therefore generally not collected at nadir but at an angle. A large off-nadir angle enables a wider ground coverage at each pass and the identification of features not visible at nadir, but it reduces the spatial resolution. For optical imagery, typical off-nadir angles are in the range of 25-30 degrees.

Sun-elevation angle corresponds to the angle of the sun above the horizon at the time an image is collected. High elevation angles can lead to bright spots on the imagery while low elevation angles lead to darker images and longer shadows. The most appropriate angle depends on the type of application: a high sun elevation is appropriate for spectral analysis since the objects to be observed are well illuminated while a lower elevation angle is better suited to interpretation of surface morphology (e.g. the projected shadows can enable a better image interpretation).

GNSS

Size, weight, autonomy, and power consumption. Power consumption and size are not strictly GNSS performance parameters, however they are also considered in this analysis, especially for GIS and Mapping-related applications.

- **Autonomy**. Power consumption is the amount of power a device uses to provide a position. The power consumption of the positioning technology will vary depending on the available signals and data. For example, GNSS chips will use more power when scanning to identify signals (cold start) than when computing a position. Typical values are in the order of tens of mW (for smartphone chipsets). GNSS is considered one of the heaviest drains on smartphones batteries
- **Size, weight**. Most GIS devices used by NGOs are handheld or rugged tablets/phones, which implies that they must remain small and lightweight.

Resiliency is the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions; including the ability to recover from deliberate attacks, accidents, or naturally occurring threats or incidents. A resilient system will change its way of operations while continuing to function under stress, while a robust (but non-resilient) system will reach a failure state at the end, without being able to recover.

Connectivity refers to the need for a communication and/or connectivity link of an application to be able to receive and communicate data to third parties. Connectivity relies on the integration with both satellite and terrestrial networks, such as 5G, LEO satellites, or LPWANs.

Interoperability refers to the characteristic of a product or system, whose interfaces are completely understood, to work with other products or systems, in either implementation or access, without any restrictions (e.g. ability of GNSS devices to be combined with other technologies and the possibility to merge the GNSS output with the output coming from different sources).

Traceability is the ability to relate a measurement to national or international standards using an unbroken chain of measurements, each of which has a stated uncertainty. For Finance applications, knowledge of the traceability of the time signal to UTC is essential to ensure regulatory compliance of the timestamp.

A.6 List of Acronyms

Acronym	Definition
AI	Artificial Intelligence
AVL	Automatic Vehicle Location
CCM	Copernicus Contribution Missions
CMEMS	Copernicus Marine Environment Monitoring Service
EO	Earth Observation
EUSPA	European Union Agency for the Space Programme
GIS	Geographic Information Systems
GNSS	Global Navigation Satellite System
GSMC	Galileo Security Monitoring Centre
HAS	High Accuracy System
Hz	Hertz
IMU	Inertial Measurement Unit
MMTIS	Multimodal Travel Information Services
MoM	Meeting Minutes
NIS2	Network and Information Security 2
OEM	Original Equipment Manufacturer
PNT	Positioning, Navigation and Timing
PTA	Public transport authority
PTO	Public transport operator
SAR	Synthetic-aperture radar
SATCOM	Secure Telecommunications
SME	Subject matter expert
UCP	User Consultation Platform
VHR	Very High Resolution

Table 15: List of Document Acronyms (Public Transport)

A.7 Reference Documents

Id.	Reference	Title	Date
[RD1] [RD 1]	EUSPA Market Report	EUSPA EO and GNSS Market Report (Issue 2)	2024
[RD2]	EUSPA User Consultation Report	EUSPA Report on Public Transport - User Needs and Requirements (2023)	2023
[RD3]	MoMs	UCP 2025 Minutes of Meeting	2025
[RD4]	Stakeholder interviews	Stakeholder interviews	2025

Table 16: List of Reference Documents (Public Transport)

EUSPA Mission Statement

The mission of the Agency is defined by the EU Space Programme Regulation.

EUSPA's mission is to be the user-oriented operational Agency of the EU Space Programme, contributing to sustainable growth, security and safety of the EU. In the execution of its mission, EUSPA counts on strong partnerships with the European Commission, European Parliament, Member States, European Space Agency, and private actors across the EU.

EUSPA:

- Provides state-of-the-art, safe and secure positioning, navigation and timing services based on Galileo and EGNOS, cost-effective satellite communications services for EU GOVSATCOM and soon IRIS² and Front Desk services of the EU Space Surveillance Tracking whilst ensuring the systems' service continuity and robustness.

- Promotes and maximises the use of data and services offered by Galileo, EGNOS, Copernicus, EU GOVSATCOM and soon IRIS² across a broad range of domains.

- Fosters the development of a vibrant European space ecosystem by providing market intelligence, and technical know-how to innovators, academia, start-ups, and SMEs. The Agency leverages Horizon Europe, other EU funding, and innovative procurement mechanisms.

- Implements and monitors the security of the EU Space Programme components in space and on the ground with the aim to enhance the security of the Union and its Member States. To do so, EUSPA operates the Galileo Security Monitoring Centre (GSMC).

- The EU Space Programme Security Accreditation Board is established within the Agency, representing the security accreditation authority for all of the EU Space Programme's components.

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