UCP 2023 MINUTES OF MEETING OF THE RAIL MARKET SEGMENT PANEL

Meeting Date	08.11.2023	**Time**	10:00-18:30
Meeting Called By	EUSPA	**Location**	Seville (hybrid event)
Minutes Taken By		**Next Meeting Date**	N/A
Attendees	**Daniel Loupor , EUSPA, Session moderator** **Juliette Marais, GNSS Panel coordinator** **Arnis Kadakovskis, EO Panel coordinator** **Ricardo Campo, SATCOM Panel coordinator** **Jose-Luis Martin, Panel Support** **Axel Wion, Panel Support** **User Community Representatives (UCRs)** Complete list of attendees is in Annex 1: List of Attendees.		
Distribution (in addition to attendees)	UCP Plenary, EUSPA, Public		

Agenda Items	Presenter
1. Welcome and introduction to Rail session	Daniel Lopour, EUSPA
2. EO – Introduction to Copernicus Services and performances	Arnis Kadakovskis, EUSPA
3. SATCOM – An option for FRMCS	Ricardo Campo, CEDEX
4. Discussion	Open
5. Signalling - Independent train localizer	Valentin Barreau, SNCF
6. Signalling - Virtual Balise, Digital map	Massimiliano Ciaffi/Giusy Emmanuele, RFI
7. Non-safety Critical applications – Infrastructure maintenance	Fabio Scarpa, Hitachi Manuel Oñate, EuroUSC España Pedro Ribeiro, Evoleo
8. EO use cases and requirements for Rail	Bo Larsson, Trafikverket
9. Discussion	Open
10. Discussion: GNSS-based localization requirements in Rail	Juliette Marais, Uni. Eiffel
11. R&D activities on EGNSS additional dissemination means, improved authentication solutions for EGNOS and Galileo and contribution to Ionospheric Prediction Service	Javier Ostolaza, EUSPA
12. Discussion: EO requirements in Rail	Arnis Kadakovskis, EUSPA
13. Discussion: SATCOM requirements in Rail	Daniel Lopour and Ricardo Campo
14. Conclusions and next steps	Daniel Lopour, EUSPA

Summary

The rail session has provided an opportunity for the participants to share their insights and requirements, shaping the future of EU Space Services for Rail. It has also offered an overview of the current state-of-the-art projects in Railway signalling, Earth observation services, and the status of the preparation for user-focused preliminary activities towards possible exploitation of EU SATCOM. The user consultation itself has been split into three different parts, focusing independently on GNSS, Earth Observation and Satellite communication. This has provided the possibility to obtain user feedback for what concerns the major applications and respective requirements associated with concrete use cases, with a future outlook to ensure that the EU Space Programme can reflect the railway needs in the context of ongoing innovation within railway signalling, maintenance or other operational activities.

1 MINUTES OF MEETING

1.1 Agenda Item 1 - Welcome and introduction to the Rail. Daniel Lopour, EUSPA

Mr. Daniel Lopour extended a warm welcome to all attendees, both physically present and joining virtually, at the 2023 User Consultation Platform for the Rail Domain. He outlined the primary aims of the panel discussion and highlighted the Rail applications where the functions of GNSS and EO would be discussed in the session later in the day. In addition, Mr. Lopour emphasized several important points:

- The role of EUSPA and the Market downstream department in regards the Rail domain
- The primary focus of the EUSPA and space program is the market and its users. Undoubtedly, user needs and requirements serve as the driving force and the fundamental basis for the development and advancement of the Space Program systems and services.
- The introduction of GNSS and EO in Rail shall mean an increase of the cost efficiency/cost savings in comparison with the current technologies and services applied
- The User Consultation Platform (UCP) has proven to be an effective method for understanding and implementing user requirements. Consequently, projects such as TRENI are being developed to create potential products for market release, to meet user needs.
- After his introductory remarks, Mr. Lopour went on to introduce the EU Space Programme and the diverse space systems. With specific reference to EGNSS, Mr. Lopour noted the following:
- EGNOS is designed to handle safety-critical applications, while Galileo is geared towards non-safety-critical operations.
- The potential use of OSNMA in Rail, with a focus on addressing security concerns.
- The capabilities of Galileo HAS in the realm of Digital Automatic Coupling (DAC) applications.
- Following the Maritime sector, the Rail sector is next in line to adopt EGNOS services.
- EGNOS is not yet extensively utilized in railways. The service that users in the rail sector

expect is now clearly defined. There are ongoing research and development projects aiming to demonstrate the effectiveness of EGNOS in the future, along with works on the specifications for ERTMS.

- There exists a challenge in the railway sector to incorporate EGNSS into safety-related applications.
- In terms of regulatory architecture, the EU strategy (Resolution of July 2021) promotes the use of EGNSS by ERTMS. Consequently, the EUSPA has fostered close cooperation with ERA and ERJU to encourage the uptake of EGNSS (ERTMS CR1368, EU Rail Demonstrators have agreed to demonstrate the viability of using GNSS in Rail signalling). -GOVSATCOM has also been briefly introduced, with the key message explaining its purpose and justification. Therefore, GOSVSATCOM is undoubtedly a crucial asset in a crisis situation to either maintain or augment the resilience of other systems. Although SATCOM was not initially designed for Rail, potential opportunities for its usage are being considered.
- Various funding mechanisms, such as the EUSPA fundamental elements programme, EGNOS Adoption Grants, EUSPA Horizon calls, among others, exist to support studies exploring the use of EGNSS in signalling.

In conclusion, Mr. Lopour underscored EUSPA's responsibility as a service provider in assisting Rail stakeholders to enhance Rail operations and business. He emphasized that EGNSS could have a substantial impact in terms of cost savings for both stakeholders and users.

1.2 Agenda Item 2 – EO – Introduction to Copernicus Services and performances. Arnis Kadakovskis, EUSPA

Mr. Arnis Kadakovskis began his presentation by introducing the Copernicus programme, including the satellites (Copernicus Sentinel-1 and Sentinel-2) and associated services. He described various services applied in Rail, detailing their primary capabilities such as resolution and update frequency.
Mr Kadakovskis highlighted that the main application of these services in the Rail sector primarily supports the management of the network infrastructure. He went on to detail various aspects:

- The role of land monitoring and the European ground monitoring service, which observes ground motion.
- The Copernicus Emergency Management service, which aids National Emergency entities by providing different mappings and early warnings when an emergency is identified, thereby facilitating anticipatory response and/or support during recovery (for instance, in the event of floods in Greece).
- He discussed the benefits of the Copernicus inSAR technology along with its limitations.
- He mentioned the use of Copernicus climate data to aid critical infrastructures like Road & Rail.
- Lastly, he provided a mapping between the Rail Infrastructure needs and the products and services offered by Copernicus.

In conclusion, Mr. Kadakovskis explored the future evolution of the Copernicus Space segment, including additional satellites and systems of interest for the Rail sector, such as ROSE-L (L-band Radar) and LSTM (Land Surface Temperature Monitoring).

1.3 Agenda Item 3 - SATCOM – An option for FRMCS. Ricardo Campo, CEDEX.

Mr Ricardo Campo introduced the two key concepts in Rail:

- ERTMS (European Rail Traffic Management System), as the standard for signalling and control to enhance the interoperability and safety across European railways.

- FRCMS (Future Railway Mobile Communication System), as the new communication system to replace the GSM-R technology currently used ensuring interoperable, secure, and high-capacity communication.

Mr Campo also presented the ERTMS and the related enabling technologies demand capacities beyond the GSM-R capabilities which will be fulfilled instead by FRCMS (e.g. ATO, GNSS-based odometry, Digital map…).
About FRCMS, Mr Campo shared the feasible integration of SATCOM in Rail due to its relevance for multi-bearer system concept. Thus, even though 5G is already consolidated as the preferred technology in FRCMS up to version 3 by key stakeholder, SATCOM could be potentially adopted for FRCMS version 4. Additionally, Mr Campo also presented the suitability of IRIS^2 programme and the services already defined to cope with the safety-critical mission requirements demanded in Rail operations.
Mr Campo presented the potential benefits to Rail stakeholders (Infrastructure Manager) associated to the adoption of SATCOM in FRCMS: reducing costs and rapid deployment in regional lines as well as increasing the robustness and continuity of the business, scalability in terms of enabling advanced concepts enabling safety-critical and non-safety-critical applications, etcetera.

Finally, Mr Campo shared the following main conclusions in regards the integration of SATCOM in Rail (FRCMS):

- SATCOM integration in FRCMS requires the support and endorsement of Railway Industry
- IRIS^2 to be potentially selected as the SATCOM technology for FRCMS
- Integration of SATCOM and MNOs in FRCMS encouraging the modernization and digitalization in Rail also leveraging the capabilities and new technologies based on ERTMS, either for regional lines
- ERTMS and FRCMS means safety improves compared to national signalling systems

1.4 Agenda Item 4 - Discussion

- No question from the audience.

1.5 Agenda Item 5 - Signalling - Independent train localizer. Valentin Barreau, SNCF

Mr Valentin Barreau made a brief but conscious introduction to CLUG 2.0 project scope and the main objectives. Indeed, it is mentioned the demonstration of the readiness of an on-board safe localisation system based on GNSS+EGNOS multi-sensor fusion for enabling an absolute safe train positioning for signalling in an ETCS frame. As part of the project, and in line with the UCP, it is remarked the consolidation of user needs and system requirements as a relevant input to the User Requirement Document to be produced after the meeting.

Mr Barreau also presented the roadmap and reasoning followed to for the technology developed in CLUG 2.0 project, detailing the original projects (CLUG, EGNSS-R and X2RAIL) which developments and outcomes have been leveraged as inputs for CLUG2.0. In this regard, the main objective of this roadmap is to consolidate the outcomes of the projects as inputs/demonstrators in the ERJU Innovation Pillar (IP), introducing EGNOS for Rail (R2DATO Test Bed – 2025), and the ERJU System Pillar (SP) and finally to be consolidated as part of the standardisation in the next TSIs (Technical Specification Interoperability).

Following the previous introduction, Mr Barreau detailed the architecture of the CLUG localisation on-board system which fuses different sensors (e.g. GNSS and EGNOS, IMU, speed sensor, balise…) to enable a safe train positioning and navigation (and so providing integrity information).

Mr Barreau also presented the WBS and the scope of the different WP that lead the project activities. In this regard, it is detailed the WP2 as the one in charge of defining and consolidating the user needs, operational context, initial assumptions. The outcomes from this WP will be reviewed and accepted/converged outside of the project as part of the FP2-R2DATO with ERJU.

Additionally, the projects specify RAMS requirements to demonstrate the safety targets for the technology developed in the project.

Additionally, Mr Barreau commented the additional testbed to be developed in the project to showcase the performances that can be achieved in Rail applications (validate/test performance requirements). In this regard, simulations will be done modelling the whole system. Also, an EGNOS emulator will be developed to emulate EGNOS for Rail service data that will be used together with the real sensor data collected on the fields to test the performance of the CLUG solution.

Other activities as CBA, Trade-off analysis, Gap Analysis and other dissemination activities are also highlighted by Mr Barreau.

1.6 Agenda Item 6 - Signalling - Virtual Balise, Digital map: Massimiliano Ciaffi, Giusy Emmanuele, RFI

Mr. Massimiliano Ciaffi began his presentation with a brief overview of RFI's experience with ERTMS and GNSS in the ERSAT (2012) project. This project focused on the "virtual balise" concept, which was successfully validated in Sardinia on a dedicated pilot line where ERTMS has already been activated, albeit with physical balises.

Subsequently, Mr. Ciaffi detailed the anticipated benefits of integrating GNSS navigation into ERTMS, highlighting how this navigation technology could potentially meet various needs.

He then explained the "virtual balise concept," presenting it as a game-changing technology capable of replacing or rationalizing current physical balise systems installed in rail infrastructures. He asserted it as a practical solution for the gradual introduction of GNSS into ERTMS.

Mr. Ciaffi drew attention to the potential advantages of this virtual balise concept, which include: an easier transition from physical to virtual balises, resolution of odometer limitations (like the slip/slide phenomenon), rationalization of physical balises leading to cost reduction (both capital and operational), the possibility of using moving blocks, increased capacity, and improved sustainability, thanks to new solutions developed for train integrity and cold movement detection applications.

Regarding the ERSAT project, Mr. Ciaffi shared more information about the tests conducted in Sardinia on the Novahara-Rho Pilot line. Specifically, he discussed the assessment and certification activities performed within the project, which aimed to demonstrate the following:

- The Safety Integrity Level (SIL4) of satellite hardware (HW) and software (SW) components, in reference to previously identified safety requirements.
- The Safety Integrity Level (SIL4) of the satellite Radio Block Centre (RBC) and the European Train Control System (ETCS) on board, which includes the satellite technology.
- Proof that the satellite technology does not intrude on the existing ERTMS technology already in operation on the line.
- The certification potential of interoperable components (RBC and ETCS) after integrating satellite hardware and software technology.

Supplementing Mr. Ciaffi's presentation, Mrs. Giusy Emmanuele introduced the ongoing RAILGAP project. This project seeks to develop methodologies for Digital map and Ground Truth productions, addressing remaining gaps. Mrs. Emmanuele discussed the user requirements identified in the project, the solution architecture, and the multi-sensor data fusion used (incorporating LiDAR and Camera sensors, supported by GNSS and IMU technologies). It is expected that the project will likely conclude in September 2024.

In conclusion, Mr. Ciaffi mentioned some key takeaways from RFI, notably the potential future adoption of SATCOM for FRMCS, the effort towards standardisation to enable the use of EGNSS augmentation networks, and the anticipated synergies with other sectors like Road and Transport with the use of common technologies like GNSS and 5G.

Adding to the presentations from RFI, Mr. Lopour underscored the gradual convergence of stakeholders on the needs for the space segment, despite differences in the development of various technologies. He urged further discussions within the UCP framework as an appropriate venue for reaching consensus on user requirements related to the space segment. Mr. Lopour noted that the EGNOS railway service is critical for the rail sector and is on schedule.

1.7 Agenda Item 7 - Non-safety Critical applications – Infrastructure maintenance: Fabio Scarpa, Hitachi ; Manuel Oñate, EuroUSC España ; and Pedro Ribeiro, Evoleo

Mr. Fabio Scarpa initiated his presentation by discussing the challenges encountered during the maintenance of railway infrastructure, such as the vast network, remote locations, and ongoing traffic

during maintenance. According to Mr. Scarpa, the RADIUS project offers an alternative to traditional maintenance methods through the use of unmanned aerial systems (UAS) for monitoring and maintenance. The use of UAS not only allows for system maintenance and continuous infrastructure monitoring but also facilitates the creation of continuously updated digital models based on collected flight data. Mr. Scarpa concluded by highlighting the benefits of this new maintenance concept, such as increased inspection frequency, cost reduction, and enhanced safety for maintenance and operations.

Following Mr. Scarpa's presentation, Mr. Manuel Oñate provided additional details about the prototype solution being developed in the RADIUS project, which is set for railway validation in 2024. He emphasized the importance of communication between the UAS and ground assets, such as the TMS, to ensure safe UAS operation considering rail traffic conditions. Given the complexities of the rail environment, Mr. Oñate underscored the use of EGNSS to ensure the UAS's precise and reliable geolocation, thus facilitating safe operation.

Lastly, Mr. Pedro Ribeiro discussed the platform developed in the RADIUS project, noting that its connection to other rail systems like the TMS would enable UAS fleet management, real-time UAS vision, and identification of track elements. He also mentioned potential opportunities within the project, including improvements in 3D GNSS capabilities, high-precision PPP, and the implementation of anti-jamming and anti-spoofing capabilities in the GNSS receiver.

Following the RADIUS project presentations, Mr. Lopour reflected on the efforts made in recent years towards introducing EGNSS elements into the Specific Operational Risk Assessment (SORA) due to their importance in ensuring the safety of UAS operations.

1.8 Agenda Item 8 - EO use cases and requirements for Rail, Bo Larsson, Trafikverket

Mr Bo Larsson, representing Swedish Transport administration, introduced several projects in different domains where it is leveraged the use inSAR mainly for ground water measurements. To mention:

- E4 Stockholm Bypass Project: Tunnel, InSAR measurement for follow-up on ground water (started to use InSAR in 2018)
- West Link: Tunnel, mostly clay, construction phase, ground water
- East Link – upcoming: 160km of railway – also monitoring ground water related behaviour due to construction
- Four Tracks Uppsala – upcoming: 25km railway, inc. tunnels, and clay

Mr Larsson also commented on the further developments in regards InSAR, being a technology useful also for monitoring of infrastructure, climate adaptation, condition assessment... Finally, Mr Larsson introduce the synergies among InSAR and other technologies, for instance on the feasibility of developing a satellite-based monitoring system to integrate different maps to improve the accuracy of the displacement estimation.

1.9 Agenda Item 9 – Discussion, Open

- Q (Mrs Mª Jose García - ERA): Is IRIS^2 a good candidate for FRMCS? Any analysis comparing FRCMS REQs and needs and IRIS^2 capabilities/features?
    - A (Mr Campo – CEDEX): FRMCS enables various operations and applications with varying levels of technical requirements, though IRIS2 may not be able to meet all these requirements.
- (Mr Lopour – EUSPA) What applications should we consider to shape our systems according to those needs? The requirements of the application should always be our starting point. Following that, we must determine if space solutions need to be enhanced with extra capabilities to meet the needs of the application.
- Q (Mrs Daniela Ristic-Durrant - OHB). There is a task to introduce additional Copernicus services. Are users open to services that have not been established yet? Indeed, infrastructure monitoring in the railway should also focus on climate, as temperature impacts on certain infrastructure premises can be significant.
- Q (from the Zoom chat) to Mr Barreau. What has been the experience of using SBAS as compared to relying solely on GNSS?
    - A (Mr Barreau – SNCF). The comparison between GNSS-only and SBAS use would only be valid in terms of accuracy. Comparing their safe confidence intervals wouldn't be applicable as GNSS-only cannot achieve the required safety levels.
- Q (Mr Emmanuel Doucet) to Mr Barreau in regards the use of GNSS only to cope with rail safety levels:
    - A (Mr Barreau – SNCF). The expectation is to utilize multi-sensors, not just GNSS, to achieve the safety levels required for rail safety-critical applications.
- A (Mr Ciaffi): Regarding virtual balises, the use of GNSS is not primarily for odometry but rather for the location of the VB. Some experiments have made use of GNSS-like odometry, but typically VB is used to feed and calibrate the odometer system.
- Mr. Barreau also noted the potential necessity to maintain the current physical balise in order to overcome the limitations of GNSS, as its performance may not be guaranteed, especially in certain environments such as tunnels.
- Mr Barreau noted the ongoing discussion on converging towards a potential architecture for the standardization pillar, which was previously in Shift to Rail and is currently in ERJU.

SESSION BREAK

1.10 Agenda Item 10 - Discussion: GNSS-based localization requirements in Rail, Juliette Marais, Univ. Gustave Eiffel

Mrs Juliette Marais, the discussion's moderator, introduced the applications under review. The session's goal is to update the list of applications and the proposed values for various requirements

and parameters. Some values are pending, subject to discussions with stakeholders attending the UCP. Mrs. Marais mentioned that, compared to the current EUSPA RUR document, there are some new applications, and others have been merged or removed. These include:

- New applications: Driver Advisory System, Condition-based Maintenance and Predictive Maintenance (merged).

- Applications removed: Infrastructure Charging, Energy Charging, and Location of GSM reports. Mr. Barreau suggested that "Energy Recharging" may still be of interest and is being researched at SNCF.

- Applications merged: Cargo monitoring and Fleet Management have been combined and renamed "Rail Fleet Management." Infrastructure Charging, Gauge Survey and Structural Monitoring are merged and renamed "Infrastructure Monitoring."

Discussions on Train Integrity and Level Crossing Protection have been postponed after the last Rail UCP session, as their requirements will vary based on the chosen solution architecture (quantity of receivers, locations, etc.). These will be addressed once R&D projects have confirmed their uses and interests.

Mrs. Marais specified at the outset that vertical accuracy wouldn't be a topic of discussion for GNSS user requirements. Furthermore, the discussion will center on GNSS functional requirements related to location.

Previously, Mrs. Marais introduced the definitions of the main parameters/indicators concerning GNSS and positioning/navigation. A new requirement, "Robustness," has been included in the RUR document, representing the solution's ability to withstand jamming and spoofing attacks. Regarding this robustness requirement, Mrs. Marais asked the audience for which application this requirement would make sense. The consensus is to consider the Robustness requirement for safety-critical applications only (ones related to ETCS).

Other new requirements were also introduced, relating to the relevance of size, weight, and autonomy requirements. This primarily pertains to rail operators' use of smartphones and handheld devices required in certain applications. The audience selected the following applications using handheld or smartphone devices: DAS, Trackside Personnel Protection, and Passenger Information.

In the discussion, it was noted that "Passenger Information" relates to devices installed within the train and connected to the train power (not the passenger device itself), and that handheld devices could be a source for such an application in some specific trains. The autonomy criterion is also a concern for Rail Fleet Management and Hazardous Cargo Monitoring when power is not available on wagons.

Mrs. Marais introduced the new applications for discussion. In this regard, the following were mentioned:

1.10.1 NON-SAFETY CRITICIAL APPLICATIONS

- Driver Advisory System (DAS):

  - Concerning horizontal accuracy, DAS is not safety-based. Mr. Campo questioned the importance of locating the train on the track. An accuracy of 1m is considered necessary for track selection.
  - Availability was also discussed.
  - A member of the audience asked why there's a need for autonomy for a handheld device, especially when most instances will involve a locomotive with electricity to power the device (tablet).
  - The response was, while modern locomotives are equipped with plugs, this is not the case for older cars.
  - It was suggested that Time to Alarm (TTA) might not be necessary as it is not safety-critical.
  - A question arose about whether the tablet should have an antenna or be connected to the antenna in the cabinet. It was explained that tablets are mass-market devices with integrated antennas, which can indeed suffer from poor reception inside the cabin.

- Condition and Predictive-based Maintenance: Condition-Based Maintenance is a strategy that monitors the real-time condition of tracks and trains. The resulting large datasets provide pivotal information to support decision-making and boost efficiency. CBM implies a proactive approach to maintenance, achievable through continuous monitoring of an asset's conditions, which allows triggering maintenance activities only when potential asset degradation is detected. On the other hand, Predictive Maintenance uses condition-based monitoring to optimize equipment performance and lifespan by continually assessing its health in real time.

- Time to First Fix (TTFaF) is critical, according to Mr. Ribeiro. The device's operation time should be long, and based on the battery implementation, hot start may be needed (for periods of short power on, long power off, etc.), and TTFaF should be adjusted accordingly.

- Trackside Personnel Protection: No comments on this point.

- Passenger Information: It was noted that some trains could be located thanks to the driver's tablet and thus will be sensitive to size, weight, and autonomy requirements.

- Hazardous Cargo Monitoring: No comments were made.

1.10.2 SAFETY CRITICAL APPLICATIONS

Mrs. Marais pointed out that there are already several groups and projects working on these applications. She noted that the requirements specified by these groups can be challenging to summarize in simple tables, as done here.

Two families of applications are investigated here:

- First related to Enhanced Command and Control Systems, that is sub-divided into:

  - Track identification
  - Cold Movement detection
  - Enhanced odometry
- And a second on Door control supervision.

Enhanced Command and Control Systems is made up of numerous functions, some of which have positioning requirements.

- Track Identification: The proposed requirements are based on the assumption that track identification is performed using an absolute positioning solution (which isn't the case at present). The question arose on how hot start is or should be specified in the ERTMS.
- Cold Movement Detection: For cold movement detection, a hot start of 5 seconds or less is also proposed. A discussion focused on the feasibility of using GNSS for this function. The cold detector should start working when the train stops and is switched off. Then, when the train starts again and ERTMS is connected, it should ensure that the train didn't move. These devices are therefore expected to operate without a battery within a certain period. The cold detector should connect to ERTMS and provide the previous position (and the new one?).
- The discussion highlighted uncertainty about the use case and the feasibility of a GNSS-based solution for such an application. This led to the suggestion that the definition of new requirements should be postponed.

The conclusion drawn was the use of GNSS for Cold Movement Detection needs further consolidation and will have to be revised later.

- Enhanced odometry was not discussed.
- Door supervision - No comments

Finally, Mrs Marais asked the audience about additional applications to be considered in the EUSPA RUR document.

1.11 Agenda Item 11 - R&D activities on EGNSS additional dissemination means, improved authentication solutions for EGNOS and Galileo and contribution to Ionospheric Prediction Service, Javier Ostolaza

Mr Javier Ostolaza introduced two presentations on EGNSS under the Horizon Europe EGNSS Upstream "Mission and Service (MAS)." In this context, Mr Ostolaza handed over to Mr Leo Bibollet (TAS-F) to present the E-GIANTS (European GNSS Improved Authentication Solutions) and IDEEAS (Innovative Dissemination means as Enablers for EGNSS Augmentation Services) projects, as well as to explain the scope and primary objectives for each. The goal is to assess the benefits of EGNSS authentication solutions for non-aviation users.

Following this, Mr Ostolaza introduced Ionospheric Prediction as a significant source of error impacting EGNSS. He detailed the various elements to consider regarding ionospheric prediction and, specifically, he highlighted the enormous impact of Space Weather on this source of error, which varies with peaks in the Solar Cycle.

Finally, Mr Ostolaza invited the audience to participate or contribute in some way to the projects presented.

1.12 Agenda Item 12 - Discussion: EO requirements in Rail, Arnis Kadakovskis

Discussion on Soil Moisture:

- At SNCF, they use satellites from other countries for soil monitoring. Their requirement is to assess soil conditions 2-3m deep to monitor animal-made tunnels and potential landslides.
- Based on his understanding, Copernicus satellites can't achieve this performance so far, which is why they use other providers.
- The issue of fog may be considered in the future because it impacts rail management in large areas. This is related to problems with visibility, necessary for ensuring safe operations.

Regarding Earth Observation (EO) applications, SNCF and others uses them to classify vegetation species and are embedded in operational services. This helps them understand the types of equipment needed for vegetation management and maintenance. SNCF aims to use high-resolution EO data to differentiate between various types of vegetation (i.e., grass, bushes, trees).

DB Netze combined Sentinel-1, very-high resolution optical images together with LIDAR to derive a species classification at tree level.

Soil moisture conditions are of major influence for a variety of decision-making processes attending sectors like Operations, Infrastructure Monitoring up to long-term activities like Planning, Life Cycle management and climate compliance, but up-to-now, are not embedded in the rail operators' operational workflows.

EO based soil moisture represents an indispensable information source for evaluation and detection of slope Instabilities, landslide risk, drought monitoring, forest fire, flooding risk and Climate Change and are freely avail accessible by Copernicus Climate Reanalysis programme.

For nearly-teal-time information about snow, ice, temperature soil moisture conditions, ERA5 data from ECMF (European Centre for Medium-Range Weather Forecasts) are distributed hourly by Copernicus. Service providers developed products like AgroSoil, combining the 9,9 km resolution ERA5 data with landscape properties, weather variables, Digital Elevation Models and soil indices to derive country-wide soil moisture product with 30 m horizontal and 1 m vertical resolution.

It has been observed that while knowledge about Sentinel 1&2 products is widespread, there is a notable lack of awareness regarding other Copernicus services. It would be highly beneficial to promote and disseminate information about the applicable Copernicus Services catered towards specific user groups.

In addition, several various operational scenarios and applications of inSAR, as it relates to railway monitoring, have been explored. The aim was to gather and understand the perspectives of participants regarding the technological maturity and market adoption of these applications. It was a valuable avenue to align understandings on the state of affairs in this field. Encouragingly, in most instances, the views from participants and the EUSPA were aligned when it comes to the potential use cases for inSAR.

1.13 Agenda Item 13 - Discussion: SATCOM requirements in Rail, Ricardo Campo

Mr. Campo presented the context and SATCOM (Satellite Communication) requirements to be considered in the Rail section of the discussion. He discussed the complexity involved in creating a safe and interoperable communications environment within rail systems' operational scenarios. In this regard, Mr. Campo mentioned the X2RAIL-3 project and the scenarios defined there. Recommendations have come from ERA representatives to complement the requirements outlined in X2RAIL-3.

Finally, Mr. Campo introduced the audience to different applications related to FRMCS (Future Railway Mobile Communication System): including critical and non-critical applications as well as the required internet connectivity for both passenger and freight trains.

Mr. Thomas Gugler (SBB) asked EUSPA how it can assist in defining the requirements for critical applications. He mentioned the railway industry's willingness to provide support to EUSPA in this regard.

Maria Jose (ERA) has suggested to review the FRMCS requirements detailed in the UIC documentation. This suggestion will be taken into account in finalizing the SatCom section of the RUR.

At the end of the session, it was suggested that SATCOM could be used as another mechanism for retransmitting augmentation data. It's necessary to analyze the balance between the latency and bandwidth of both technologies to ensure the feasibility of this mechanism, among other capabilities and limitations.

Validation of requirements

(See draft user requirement tables for EO and GNSS in Attachment 10)

The audience did not provide additional comments related to GNSS requirements at the end of the session.

The audience did not provide additional comments related to EO requirements at the end of the session.

The audience did not provide additional comments related to SatCom requirements at the end of the session.

User Needs and Requirements – Synthesis of discussion outcomes

The requirements compiled in the draft Report on User Needs and Requirements (RUR) circulated prior to the UCP were reviewed with the participants. The discussions raised the **need to refine some of the requirements and/or to add new ones**. Therefore, requirements which were reviewed and did not deserve any comment or change from the audience are not depicted in the next tables.

Requirements relevant to EO

Application/ Operational Scenario	**Parameter**	**Requirement**
Infrastructure Monitoring	Data type/resolution/accuracy	The requirement is to evaluate the conditions of the soil down to 2-3 meters in depth in order to monitor tunnels created by animals and potential landslides.
Infrastructure Monitoring	Data resolution/accuracy	To classify vegetation types (i.e. differentiating between various types of vegetation, like grass, bushes, trees), rail infrastructure managers need to understand the types of equipment needed for vegetation maintenance.
Infrastructure Construction	Data type	InSAR measurement to monitor ground water and land movements at construction phase, especially relevant for tunnels

Requirements relevant to GNSS

Application/ Operational Scenario	**Parameter**	**Requirement**
Condition based and predictive maintenance	Size, weight, autonomy	Autonomy in particular is relevant
Condition based and predictive maintenance	Update rate	Update rate shall be from 1-30m
Condition based and predictive maintenance	TTFaF in hot sart	Depending on the mode chosen for energy saving, device can be switched on/off regularly and hot start may be needed with a short TTaF

Passenger Information	Size, weight, autonomy	Information can be provided by on-board train locator but when data is collected from tablet relevance applies
DAS	Horizontal accuracy	1m is required to ensure track distinction
DAS	Availability	A high availability is required in urban canyon, natural canyon, under canopy and indoor better than 95% and 99%
DAS	Integrity	Integrity requirement is low
DAS	Size, weight, autonomy	Size, weight and autonomy requirements are relevant
DAS	Time a device can run	The device must run during a daily service driver, 8-10h
DAS	TTFaF	TTFaF in hot start shall be 1 min
DAS	Service area	The service shall cover the whole EU network
DAS	Update rate	Update rate shall be 1s
DAS	TTA	Time between the occurrence of the failure and its presentation to the user shall be 10 s
Cold Movement detection	Size, weight, autonomy	Size, weight, autonomy may be relevant as the system shall function when the train is off power
Cold Movement detection	Time a device can run	Time a device can run may cover the train stop duration
Cold Movement detection	TTFaF	TTFaF in hot start shall be 5s or less

2 CONCLUSIONS

The Rail UCP session was successfully concluded by Daniel Lopour from EUSPA.
The key outcomes of this working session were highlighted during the plenary UCP session on October 9th, 2023, by Mr. Valentin Barreau.
These results are also summarized below:

- GNSS is used for a broad range of non-safety-critical applications related to maintenance improvement, attractiveness enhancement, and train driving optimization. These include condition-based maintenance, predictive maintenance, rail fleet management, driver advisory systems (DAS), and passenger information systems. Galileo meets these applications' requirements and also supports safety-related applications such as Enhanced Command & Control Systems (CCS) and Trackside personnel protection systems.
- The potential for Earth Observation (EO) to support infrastructure monitoring, such as landslides, vegetation, and soil moisture, has been clearly demonstrated. Revisit time is an important parameter (better than one week).
- Galileo and EGNOS will be used to make the European Rail Traffic Management System (ERTMS) more efficient and fail-safe, with key requirements including availability better than 99.99%.

As potential topics for further R&D, the following three stood out during the session:

- EGNOS for rail service will be a key support to ERTMS and might provide substantial benefits in rural areas in terms of cost savings compared to standard balises.
- Considerations for potential applications and use cases for SatCOM within the FRMCS framework arose, in light of the progressive phase-out of GSM-R. This includes the IRIS² project.
- The application of EO for infrastructure monitoring (including soil moisture and vegetation) was also discussed.

3 OTHER NOTES & INFORMATION

No additional notes or information shared during the session.

4 ANNEXES & ATTACHMENTS

Annex 1: List of Attendees on-site

Annex 2: List of Attendees online