RAIL SESSION MOMS

Meeting Date	04.12.2025	**Location**	Prague
Meeting Called By	EUSPA		
Minutes Taken By	Juliette Marais, Univ. Gustave Eiffel		
Representatives & Speakers	**EUSPA Representatives:** Daniel Lopour (MDI Officer) Arnis Kadakovskis (External EUSPA Consultant) Ettore Canestri (EUSPA Engineering Officer) **Speakers / Moderators:** Jose Bertolin (UNIFE) Marc Sarrat (SNCF) Nerea Canales (RFI) Valentin Barreau (SNCF) Pierre Le Corre (SNCF) Juliette Marais (Univ. Gustave Eiffel) Lene Bøgebjerg Bøgvad (Banedanmark) Danijela Ristic-Durrant (OHB Digital Services) Joanna Balasis-Levinsen (EEA, Copernicus Land Monitoring Service) Giuditta Montesanti (DG DEFIS) Ricardo Campo (EU-RAIL) A complete list of attendees can be found in Annex 1.		
Distribution (in addition to attendees)	UCP Plenary session; EUSPA; Public		

AGENDA

Agenda Items	Presenter
1. Market status and upcoming opportunities for GNSS, Copernicus and SATCOM	Daniel Lopour (EUSPA MDI Officer)
2. Major application developments and state of the art in the rail domain: EU-SPACE for ERTMS - Horizon Europe – CLUG Demonstration of Readiness for Rail (CLUG 2.0) Project, - Hybrid Virtualized Testing for Certification of EGNSS in Railway Train Positioning (VICE4RAIL) Project, - EGNOS4RAIL: Cooperation between ERA, EU-RAIL, EUSPA, ESA and rail stakeholders on GNSS introduction in ERTMS - Updates on the Status and broader context Roundtable on and next steps related to GNSS in rail signalling	Jose Bertolin (UNIFE) Nerea Canales (RFI Contractor) Daniel Lopour (EUSPA MDI Officer); Ettore Canestri (EUSPA Engineering Officer) Valentin Barreau (SNCF)
3. EU SATCOM – Recent updates and examples - Horizon Europe – SatCom and 5G Link - Edge, Cyber telecommunication (S5LECT) Project	Pierre Le Corre (SNCF)
4. User requirements on GNSS – State of the art and update of URD: evolution achieved within EUSPA and EU R&D activities	Juliette Marais (Univ. Gustave Eiffel)
5. User needs and requirements for Copernicus	Panel discussion moderated by Arnis Kadakovskis (EUSPA) With Lene Bøgebjerg Bøgvad, (Banedanmark); Danijela Ristic-Durrant (OHB Digital Services); Joanna Balasis-Levinsen (EEA, Copernicus Land Monitoring Service)
6. User requirements on EU SATCOM – State of the art and update of URD	Ricardo Campo (EU-RAIL); Daniel Lopour (EUSPA MDI Officer) Giuditta Montesanti (DG DEFIS)
7. Remarks and conclusions	

SUMMARY

Summary

The Rail panel of the User Consultation Platform (UCP) 2025 took place on 4 December 2025 as a mix on-site/online event in Prague. The event was divided in two main parts: the morning session, covering updates on recent projects: CLUG2.0, VICE4RAIL and EGNOS4RAIL for GNSS, and S5LECT for satcom and 5G link. The afternoon session was dedicated to the update of URD on GNSS, Copernicus and EU SATCOM respectively.

The sessions gathered around 30 participants on-site and 25 remotely per session.

The panellists provided in-depth presentations towards progresses made in the introduction of GNSS in ERTMS application, which require the highest level of performance and coordination of the different stakeholders to finalise the mandatory definitions of TSI (Technical Specifications of Interoperability) and the definition of the EGNOS service for rail as well as test methodologies. The use of Satcom was addressed as well in the morning session.

This broad coverage generated interest from the participants and helped start good interactions via the chat and live.

The most tangible needs (or areas requiring specific action) identified are the following:

- GNSS-based solutions for safety-critical applications are now at the level of demonstrations. They will need multi-sensor fusion, FDE and redundant chains to reach the SIL4 level of performance required.
- An important step under development is dedicated to the definition of methodologies and tools for certification
- The EGNOS version dedicated to rail is under investigation; parameters needed to meet the safety requirements shall be validated, and the EGNOS certification approach defined.
    1. Neither HAS, nor OSNMA are exploited, because of a lack of awareness and priorities in investments and developments. But most of the applications developed in rail will benefit from these new services.
- New applications are identified as potential uses of GNSS in freight: for train composition detection, or later, in automated shunting operations. They will require low energy consumption to face wagon maintenance constraints and low cost.
- While Remote Train operations demonstrated feasibility mainly based on perception sensors, the use of GNSS-based locomotive localisation should allow a more complete and accurate perception of the situation.
- For communications, European railways are transitioning from GSM-R to FRMCS to support data-intensive, safety- and mission-critical applications (ETCS signalling, real-time monitoring, voice, operational data).
- SATCOM integration is considered a key to guarantee a cost-effective service, especially in rural, remote and cross-border areas for redundancy and global coverage.
- Continuous alignment between SATCOM system capabilities and railway requirements will be essential to ensure smooth long-term use of SATCOM in railway operations. Relevant railway scenarios have already been successfully identified.
- Satellite communication to be implemented as part of a hybrid solution within a multi-bearer network approach.
- In the future FRMCS context, regional lines present strong opportunities to accelerate implementation.
- Current user needs and requirements for satellite communication remain valid, with additional technical aspects now being considered.

- Capital costs are mainly linked to space programs while operating costs will be clarified in the next steps.
- Ongoing projects within FA2–FA6 of Europe's Rail Joint Undertaking (EU-Rail) and S5LECT are showing strong advancement in the implementation of satellite communications for railways, with technical solutions, field/laboratory tests and pilot projects already underway across several EU countries.
- Major needs from EO are: A new, high-resolution (10m or better) Digital Elevation Model (DEM) for Europe, freely available, to support flood modelling and topography mapping. The current Copernicus DEM is outdated (>10 years old). It is recommended to create and publish a 10m DEM for Europe to enable rail infrastructure managers to baseline land topography and compare flood model outputs to actual events.

- **EO Data Requirements:**
  - **SAR Systems:** Current C-band SAR (5–20m, ~6-day revisit) is adequate for regional oversight but insufficient for tracking soil deformation along rail lines.
  - Next-gen open-source SAR should target 3–5m spatial resolution, 1–3 day revisit.
  - L-band SAR for soil/vegetation penetration; X-band SAR for built structure detail—enabling early detection of small displacements and continuous instability tracking.
  - **Vegetation Monitoring:** Need to identify hazard trees, canopy extent, and health status along railways.
  - Sentinel-2 (10m, 5-day revisit) is insufficient; IMs rely on commercial imagery, aerial photos, or drones.
  - Future sensors: 5m resolution in Visible/NIR, 10–20m in SWIR, 2–3 day revisit; hyperspectral sensors for species classification and soil condition.
- **Service Integration & Usability:**
  - EO services must be easily integrated into rail operational platforms (compatible data formats, APIs).
  - Real-time/near-real-time alerts for critical parameters (rail temperature, vegetation encroachment, slope instability) to enable predictive maintenance and proactive safety.
  - Services should be user-friendly, interoperable, and directly usable in daily rail operations.
  - Strong engagement between EO providers and rail operators is needed to ensure services meet actual needs.
- **Additional Recommendation:**
  - Develop a database linking past climate-related disasters to actual costs for the rail industry, in collaboration with EU institutions and infrastructure managers (as highlighted by DG-MOVE study).

MINUTES OF MEETING

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

Daniel Lopour, Rail segment leader at EUSPA, welcomed all participants to the User Consultation Platform (UCP) session and introduced his co-moderators. He provided a brief overview of the session's scope and objectives, and presented the practical organisation of the session, with a first sub-session dedicated to the presentations of project updates, followed by three sub-sessions dedicated to (i) GNSS, (ii) Satcom, and (iii) EO for rail respectively.

Daniel reminded the objective that is the use of space as a tool to decrease the OPEX or improve the capabilities. Satellite-based localisation is now widely adopted in rail for non-safety critical applications. GNSS receivers are now equipping more than 180 000 wagons for freight track and trace. For ERTMS integration, satellites are today in some products for improving accuracy of the train odometer, and R&D projects are coordinated to focus on more introduction. EO and Copernicus can help support IMs situational awareness within their maintenance operations and increase the resilience of rail infrastructure to climate change impacts. Finally, Satcom is being investigated as a market preparatory activity for potential adoption of IRIS² for FRMCS.

Daniel mentioned that Rail is looking for a dedicated EGNSS service. The users confirmed the interest to implement GNSS for fail-safe train localization in ERTMS. Daniel Lopour reminded the recent steps supported by EUSPA: EP resolution rom 7/7/21, participation of EUSPA in the EU rail system pillar and innovation pillar; funding of R&D projects to support the evolutions towards GNSS uptake in ERTMS, and participation in the EGNOS4RAIL project to finalize architecture, standardization approach and roadmap towards GNSS (ASTP) adoption.

Copernicus, the second topic of the day, is identified as a potential for increasing IM's situational awareness within maintenance: for example hydrogeological stability, vegetation management and third party activity next to track.

Satcom in rail is the third topic addressed. EUSPA is supporting the S5LECT project to experiment a solution for seamless handover between 5G terrestrial network, satellite link and GSM-R communication system. The goal is to establish a coordination and work plan as well as define user requirements on EU Satcom as done since a couple of years with the GNSS.

Daniel Lopour concluded on how to cooperate: more engagement of the IM community is needed to drive the case of GNSS-based train localization to a successful end; indicate of rail user needs for Copernicus; support the EU Satcom user needs definition. New HE calls are opened with a deadline on 24/02/2026 (https://www.euspa.europa.eu/opportunities/horizon-europe

Daniel reminded that the objective of the day is to discuss the user requirements, to hear from the user community what is needed, to increase the content of the Report on Rail User Requirements.

Agenda Item 2 - Presentation of Major application developments and state of the art in the rail domain: EU-SPACE for ERTMS

Horizon Europe – CLUG Demonstration of Readiness for Rail (CLUG 2.0) Project, Jose Bertolin (UNIFE) and Marc Sarrat (SNCF).

Jose Bertolin and Marc Sarrat presented the CLUG 2.0 project results and future activities. CLUG2 is the follow-up of the CLUG project and was leaded by SNCF. Jose Bertolin reminded that the objectives

of the project were to develop and demonstrate absolute safe train positioning by applying the existing and future European Global Navigation Satellite System (GNSS) and the European Geostationary Navigation Overlay Service (EGNOS) and multi-sensor functionality for train localization. User needs and system requirements have been consolidated for: along track, SoM (Start of Mission) and track selectivity.

CLUG 2 is part of the roadmap for GNSS introduction into rail signalling solutions. It was closely linked to other R&D and standardization activities such as R2DATO, X2Rail5, EGNOS4Rail. The final goal is to drive the definition of the future CCS TSIs.

Marc Sarrat presented the main results and conclusions. The ambition is to prepare a full set of requirements to prepare certification of the LOC-OB solution. Main performance requirements to be tested were that half of the confidence interval shall not be larger than 10m in constrained area and 60m in open lines. Velocity half confidence interval is bounded by 2km/h + [2 12] ramp as a function of the speed. Open points remained to be clarified at the sector level: unavailability of the CCS-onboard architecture and unclear functional allocation between the CCS-onboard constituents.

Marc then presented a consolidated architecture and the associated safety concepts and RAMS analysis. Two variants have been considered in the project relying either on single or dual chains. Dual chain allows to relax the safety constraints on each chain with a clear independency between the two chains. The main conclusions are:

2. the use of EGNOS for rail service is required to achieve the safety target,
3. different faulty scenarios have been tested: all satellites are faulty, only X-satellites are faulty or all fault-free
4. to consolidate the safety approach, a full characterization of the different FDEs will need to be performed to validate their expected failure rates
5. the certifiability of Kalman Filter is considered very difficult to reach SIL4 with a single chain; seems feasible but still need to be demonstrated in SIL2 for the dual chain.

Considering the use of LOC-OB in the ETCS, the project concluded that:

6. The gap analysis highlighted the level of maturity of LOC-OB specifications and the technology readiness, notably the remaining open points to be solved.
7. The gaps between the current ETCS and the future ETCS compatible of LOC-OB have been analysed, concluding that introducing LOC-OB will have significant impact on TSI CCS
8. Backward compatibility between trackside (balise layering) and onboards (train equipped with LOC-OB or not) will be an important factor in decision-making

Marc Sarrat presented the data collected as well as some performance with regards to the capacity of the single and dual chain to reach the level of performance required. Considering the single chain: In all faults free conditions, most of the positions were computed within the confidence interval requirements; Speed requirements have been achieved in almost all trips, except in very constrained conditions of reception where algorithms will need to be tuned. In the dual chain solution, some differences between the GNSS-based chain and the map-matching based ones have shown some penalisation of the SIL level output.

Future activities intend to continue the development of the solutions based on the background acquired in the project. The main improvement is to increase the TRL level of the solution focusing on

the development of the second chain and the combiner to validate the performance. The FDE should also be better characterized to consolidate the achievable safety level and associated CI. A compromise should be found in the integrity concept between safety and availability to optimize performance. The LOC-OB shall also be tested with real DFMC data.

Horizon Europe – Hybrid Virtualized Testing for Certification of EGNSS in Railway Train Positioning (VICE4RAIL) Project, Nerea Canales (RFI)

Nerea Canales introduced the context of the VICE4RAIL project and its objectives. VICE4RAIL aims to support the standardized and safe integration of GNSS into ERTMS by contributing to the development of future certification frameworks. The mission is to provide support for defining a standardized methodology for certifying GNSS-based train positioning systems and develop innovative tools to test satellite technologies in both real and virtual scenarios. The project is coordinated by RFI. Nerea highlighted that the project is fully aligned with the European initiatives and in particular with the STIP (Standardisation and TSI input Plan) managed by the Europe's Rail System Pillar and with the full ASTP strategy.

The project is developing HyVICE platform which represents the technical backbone of the initiative which combines both real-world testing and laboratory-based simulation.

The high-level requirements of the project are a near zero on-site testing; performance evaluation across all relevant physical rail environments; reach equivalence to real-world testing through accurate modelling of GNSS signal characteristics as well as the simulation of rare events as well as various configurations encountered in the railway operational environment.

EGNOS4RAIL: Cooperation between ERA, EU-RAIL, EUSPA, ESA and rail stakeholders on GNSS introduction in ERTMS, Daniel Lopour (EUSPA MDI Officer), Ettore Canestri (EUSPA Engineering Officer)

Daniel Lopour explained the purpose of the EGNOS4RAIL initiative and the next steps from the perspective of the market and adoption support. EGNOS4RAIL is a project that facilitates cooperation between EUSPA, ERA, EU RAIL and ESA in order to address the remaining issues before the introduction of GNSS in ERTMS, requiring commitment from both the rail and space sectors. The topics addressed deal with the delivery of EGNOS data and the development and certification of receivers to facilitate market readiness.

Ettore Canestri presented the EUSPA service engineering process and support to EGNOS4RAIL. The current state of work for rail is at the mission definition review stage, to start the process. Ettore Canestri presented the main objectives of the EGNOS for rail activities that are: preparing an EGNOS for rail demonstrator data to be used by the ASTP demonstrators of the ERJU flagships projects (R2DATO and FutuRe); defining the boundaries of a future EGNOS for rail service in line with rail needs and prepare the certifiability.

EUSPA will be delivering a DFMC EGNSS service demonstrator (ESD) that can be made available in EU-RAIL, not as a part of the EGNSS operational system but as a campaign-based approach. The main objective is to implement an optimized scheme that allows benefiting from the synergies among similar activities identified for the different programmes. First DFMC internet data distribution is expected in 2026; expected DFMC Signal in Space for 2027.

Updates on the Status and broader context, Valentin Barreau (SNCF)

Valentin Barreau reminded that ASTP is the Advanced Safe Train Positioning module, targeting a SIL4 level and defined as a grey box with standardised interfaces. The expected benefits of ASTP are: integration of less complex technologies in the vehicle (such as radars or tachometers); a module with

standardised interfaces to allow the supplier to choose their solution; one localisation function on board for all users, that will limit the amount of equipment in the train and on the roof and limit the associated costs… This will Significantly reduce the number of trackside equipment's used for location purposes.

The activities in R2DATO are almost finished (2026). A full scope of ASTP requirements has been defined based on CLUG2 results. Specifications have been provided as inputs for the System Pillar work. 8 demonstrators based on multi sensor fusion will present results; All of them use GNSS, 6 of them EGNOS to achieve SIL4.

EGNOS4RAIL was initiated as a complementary initiative and tightly linked to R2DATO.

Activities focused on the legal framework and certification approach with: an overall authorisation and certification approach for EGNOS in ERTMS, an EGNOS for rail legal framework, and an ongoing review at rail sector level. Although the needs of rail and the ASTP requirements have been defined in R2DATO (WP21), the interface between the EGNOS servers and the train depends heavily on the scope and roadmap of FRMCS.

Preliminary MOPS for GNSS onboard receiver are in progress and need to minimize as much as possible the requirements on the GNSS receiver and lower as possible the Rx price.

The system performance evaluation and tooling is performed with ESA, who provides datasets to the rail sector for R2DATO demonstrators and will need to get feedback from the demonstrator.

Valentin Barreau concluded with the steps to come among which the consolidation of the SARPS+ and integrity concept, the demonstrator performance and the preparation of the EGNOS4RAIL scope associated to R2DATO Wave 2.

The discussion with the participants in the room and online addressed the following topics:

Q (from the audience): In VICE4RAIL, you intend to create a standardised approach for certification across all modes of transport. What does "across all modes" mean? (because rail has specified standard)

A (Valentin Barreau, SNCF): The goal is to understand how other modes of transport are certified and to adopt other transport practices.

The certification process will need the agreement of all the participants, but we will pave the way to certification with a first step and in agreement with a NoBo.
Q (from the audience): and the focus of certification is ASTP?

A (Valentin Barreau, SNCF): yes.

Q (Andreas Wenz, SBB): How are you going to validate your testbed and that it represents the real world?

A (Valentin Barreau, SNCF): at the moment, we miss some information about ASTPs, that are not fully ready. As a first step, we will prepare the tests and assess the platform performance based on comparison of experimental campaigns. This will help increase the next steps when the full chain will be available. The NoBos are involved in the process to investigate how the platform can be validated.

Q (Ricardo Campo, EU-Rail): will there be interactions with R2DATO?

A (Valentin Barreau, SNCF): We intend to stay aligned with these projects. Some partners of the projects are involved in R2DATO that facilitate the link but not all. We are trying to share documents as possible (and ask for making it easier from the agency to share)

Daniel Lopour completed by informing that the agency supports the share of the document and encourages the project too, but respects the decisions of the project leaders to decide whether they can share or not every document.

Q Philippe Laviron: When will the testbed be available for testing?

A (Valentin Barreau, SNCF): Tests are planned for the end of 2026, and the end of the project is 2027.

Q (from the audience): When will the documents be available for MOPS and what is the link with the documents done for aviation?

A (Valentin Barreau, SNCF): ERJU participant can access this document as well as the data.

A: (Ettore Canestri, EUSPA): the starting point is the aviation SARPS but the rail work focuses on EGNOS mainly.

Agenda Item 3 - Presentation of EU SATCOM – Recent updates and examples

- Horizon Europe – SatCom and 5G Link - Edge, Cyber telecommunication (S5LECT) Project

Pierre Le Corre introduced the needs for communication in rail. The railway network is not always covered by the private network so, the objective is to provide coverage across the entire network. GSM-R only covers half of the SNCF domain today. The aim is to migrate from legacy networks to FRMCS around 2030. A roadmap for migration to FRMCS was presented but doesn't integrate yet the satcom (depending on when the satcom service will be available). The use case identified targets secondary lines, also call LDFT in French. Different opportunities were reviewed for rail: as a backup of operational network, as an additional coverage for secondary network, to enhance coverage for some infrastructure or as a multibearer approach.

Pierre Le Corre presented the S5LECT project and its use cases. The project is coordinated by SNCF Reseau, and started in March 2024. The use cases identified for Govsatcom are crisis management, surveillance and key infrastructure management. FRMCS applications will be in critical applications (train movement, safety, mandatory actions), performance applications (telemetry, surveillance, maintenance and business applications (internet on board).

S5LECT focuses on 3 services: ETCS level 2, critical voice and video (CCTV), all of them having different KPIs in terms of latency, data rate, or Jitter.

Pierre Le Corre introduced the field trial test setup relying on public 5G (Orange) and Oneweb Satcom, and the laboratory implementation devoted to validate the technical architecture and ensure compliance with ANSSI standard to have a full secure system against cyber-attacks. The S5LECT solution will rely on a hybrid system, enabling the dynamic pairing of multiple Radio Access Technologies through technology switching mechanisms based on technology availability.

Finally, Pierre shared the SNCF Vision for Satcom acceptance in railway. The key advantages of satcom are that it will provide an immediate connectivity solution without requiring the deployment of extensive terrestrial solution, however standardization is essential, as well as long term durability of equipment, long-term viability of satellite constellation technologies.

An important question is what the cost of the service will be. If the solution is not economically viable, low-density lines will remain without solutions.

Q (Andreas Wenz, SBB): do you need LOS of satellite? Are bridges (and others) issues for the system?

A (Pierre Le Corre, SNCF): There is no coverage In tunnels ; LOS is needed. In S5LECT the goal is to have a solution that can switch between systems to ensure service availability.

Q (Jose Bertolin, UNIFE): is there any continuation of activity of your project with other programs?

A (Pierre Le Corre, SNCF): I would like to. We have a lot of ideas to continue!

A (Daniel Lopour, EUSPA): in this project, the main objective is moving the opex and capex to make the overall service cheaper because service makes sense.

Agenda Item 4 - Presentation of User requirements on GNSS – State of the art and update of URD: evolution achieved within EUSPA and EU R&D activities

Juliette Marais presented the outcomes of interviews performed as a UCP preparation to collect some requirements update and new application requirements for rail.

The following requirements were proposed for discussion with the audience:

Enhanced Command & Control Systems (CCS): Three different tables were identified in the previous RUR - GNSS user requirements for Track Identification, for Cold Movement Detection, for Enhanced Odometry. The audience was invited to react to the following questions and proposal:

Q (Juliette Marais, Univ. Gustave Eiffel, to the audience): Is CMD really a use case for GNSS?

A: The majority of the participants considered that the existing solutions will probably be preferred to a GNSS-based solution as already existing, validated and cost-effective but it is agreed that we can keep them for other applications or further developments mentioning in the report that it will be an alternative but not the main solution.

Q (Juliette Marais, Univ. Gustave Eiffel, to the audience): Can we replace in the RUR the requirements for track identification by a more generic requirement table as described in the R2DATO project and entitled "ASTP requirements"?

A: The audience accepted but it was decided that some precisions will be added: the ASTP requirements represent the requirement for the function and cannot be GNSS requirements; It will be added a short text to explain the importance of confidence interval in the integrity concept; explain that, for railway stakeholders, 1D correspond to along-track dimension, 2D the horizontal plan; considering that track identification will be defined and validated independently.

It was also requested to add the SIL4 requirement in the table. And that TTA still need to be defined in a future UCP.

The table for Trackside personal protection was presented for review. It was discussed if a TTA and a SIL level must be defined for such an application.

The table was considered still up-to-date. In a context where the system is for track workers and not for the train, TTA/SIL can be removed. If the system shall become safety-critical and ensure safety of the workers in the future, then they must be kept.

Two new applications were proposed and defined:

1. Remote train operations, that involve controlling and operating trains from a remote location using advanced communication and control technologies.
2. Automated shunting that refers to the use of autonomous or semi-autonomous technologies to move rail vehicles within rail yards, depots, or industrial sidings. Two versions can be identified: First the use of an automated shunting locomotive (the road towards autonomous trains); second the use of GNSS to locate wagons, deduce order and composition of the freight train, check train integrity before or during operations…

The tables on user requirements were approved by the audience. It was requested to split the shunting applications into two different tables to clearly distinguish between the two applications. The main

difference will concern the SIL level that is required for the shunting locomotive, but that difference is not so high for freight train composition.

A number of other applications have been discussed, that have been identified during the interviews: GNSS-based infrastructure monitoring, Driver assistance to park for hydrogen refuelling, Ticketing, Pantograph monitoring (on hybrid locomotives), train integrity…

Juliette Marais has dedicated the last part of the session to summarize User representative feedback on the use of HAS and OSNMA services and invited the audience to react and complete.

She mentioned that some test campaigns have been performed in Czech Republic with OSNMA for regional line and shunting in test track, as well as in Switzerland in the EGNSS MATE project.

The feedback is that the convergence time remains too high in challenging environment that do not allow to reach higher performance. An identified application is the start of mission that needs very high accuracy initial position without any time constraints that allow convergence. It was agreed that a convergence time below 10 seconds could change the view and transform the interest into high.

The conclusion was that convergence time must be reduced to enable uses in more applications; that integrity for this service would also be a game changer; and that HAS should be better promoted into the railway community. A final point concluded was that the use of OSNMA still needs a business case for the railways.

Agenda Item 5 - Presentation of User requirements for Copernicus

Arnis Kadakovskis (EUSPA) opened and moderated the panel discussion on how Copernicus can support the resilience of rail infrastructure to climate change, covering topics from climate resilience planning to Earth Observation (EO)-supported adaptation measures.

Daniel Lopour informed participants about the ongoing call on railway resilience, closing on 24 February. EUSPA expressed interest in hearing from companies active in this field, noting that this part of the EU Space Programme is still underexploited and offers significant potential. The discussion touched on rail infrastructure management, climate adaptation, and the development of a rail buckling risk system.

Arnis explained that the session would present existing capabilities and solutions, with the aim of inspiring the community to develop new applications. He introduced the User Requirements Document (URD) and underlined that EUSPA is funding related R&D activities.

He presented the topic of ground instability and InSAR-based monitoring of ground motion, referring to the European Ground Motion Service (EGMS). He noted that user needs are already well known and that standards exist for traditional methods. Several companies have more than 20 years of experience with InSAR. In the traditionally conservative rail sector, standards are essential, and InSAR-related standards (ISA) are now included in an annex, showing that requirements are maturing.

Arnis then referred to different applications in the report and their evolving requirement mapping. For the current year, the work includes a deeper focus on adaptation to climate risks, while leaving room to expand to new applications in the future.

He noted that the second edition of the URD focuses specifically on climate risk assessment and adaptation. Existing frameworks and studies, such as UIC's RERA, were taken into account. This was complemented by a local-level view on companies, interviews, and an online survey, which was launched during the session.

Agenda item 5.1 Banedenmark

Lene Bøgebjerg Bøgvad presented on the impacts of climate change on Denmark's railway network and the corresponding climate adaptation strategy developed by Banedanmark. She explained that climate change is already having a significant effect on the railway infrastructure. Approximately half of the Danish railway network is situated on dams, which makes it particularly vulnerable to changing weather conditions and rising water levels.

She described the overall strategy, which begins with a comprehensive risk analysis to identify which assets are exposed to specific climate risks. This is followed by a more detailed risk assessment based on GIS-data analysis, from which action plans are created. Implementation and continuous evaluation follow as part of a cyclical approach to adaptation.

The data necessary for these analyses include information on tracks, drainage systems, construction sites, and other infrastructure elements, all collected and managed within ArcGIS. Monitoring of water levels plays a central role in providing early warnings, helping to prevent disruptions and damage.

Lene emphasised the strong need for precise technology and integrated datasets. National data must be combined with Banedanmark's own datasets to fully understand the relationships between vulnerabilities, hazards, and potential impacts. To effectively predict and monitor risks, she noted the importance of gathering and analysing diverse parameters—such as rainfall, visible and unseen surface water, groundwater levels, and movements of cut sections and dam sides. She concluded by underscoring that train operations are sometimes halted as a preventive measure to mitigate risks when certain thresholds are reached.

Agenda Item 5.2 OHB rail buckling risk prediction for extreme heat – user needs.

Danijela Ristic-Durrant from OHB Digital Services presented the use of Earth Observation (EO) data to develop services for various application fields, with a focus on utilities and land transport, including the railway sector. She highlighted the gap that previously existed in EO-based solutions addressing rail track temperature monitoring and introduced a new approach designed to fill this need.

She explained that high rail temperatures—reaching or exceeding 60°C in hot conditions—can cause track buckling, posing severe safety risks such as derailments and failures in signalling and control systems. These incidents have led to significant operational impacts, including around 240 days of train delays across the EU. Rail buckling also results in financial losses through increased maintenance costs, schedule disruptions, and energy inefficiencies.

Danijela Ristic-Durrant compared current monitoring practices, which rely on weather forecasts and in-situ measurements. While the latter are precise, they are highly costly and lack scalability. Satellite-based rail temperature estimation, by contrast, offers a cost-effective, scalable, and precise alternative. She presented the SPATRA (Satellite-based Prediction for Rail Track Risk Assessment) solution as a novel application of EO satellite data and artificial intelligence for predicting rail track temperature and rail lateral displacement, key indicators of buckling risk.

The SPATRA solution is composed of three main modules:

1. Real-time temperature estimation from Land Surface Temperature (LST) data.

2. Forecasting of rail track temperatures through the Rail Track Temperature Prediction (RTTP) model.

3. Buckling prediction through rail lateral displacement analysis.

The approach demonstrated higher precision than current practices, leading to operational improvements such as shortening restriction periods by approximately four hours in the evenings and identifying earlier morning windows for introducing speed restrictions. These advances can support infrastructure managers in making timely decisions on imposing low-speed orders to mitigate safety risks.

To further refine the solution, additional data are required to retrain the predictive models, while preliminary operational use by stakeholders and continuous feedback collection are planned to validate and improve SPATRA before broader deployment.

Agenda item 5.3 Joanna Balasis-Levinsen on the EEA's offering and CLMS

Joanna Balasis-Levinsen from the European Environment Agency (EEA) introduced the Copernicus Land Monitoring Service (CLMS), which is implemented jointly by the EEA and the Joint Research Centre (JRC). She explained that the service provides detailed geographical information on land cover and land use, as well as changes occurring at both European and global levels, supporting a wide range of environmental and climate-related applications. All CLMS products and manuals are free, open, consistent, and harmonized, in full alignment with the broader objectives of the Copernicus Programme, which aims to deliver standardized and interoperable datasets.

She presented three key product groups under the CLMS relevant to infrastructure planning and monitoring, particularly for the railway sector. The first is the European Ground Motion Service (EGMS), which provides annual information on ground movements across Europe with millimeter-level precision and a spatial resolution between 20 and 100 meters. This service supports the assessment of potential impacts from ground instability phenomena such as landslides, subsidence due to flooding or drought, and thawing permafrost, all of which can pose significant risks to rail infrastructure.

She then discussed the vegetation layers, which map tree cover and forests across Europe. These datasets are valuable for railway operations, as they may be used to, e.g. identify trees at risk of falling on tracks during storms or heavy snowfall and to support vegetation management and risk mapping.

Joanna also introduced the land surface phenology product, which provides insight into vegetation cycles and productivity with a spatial resolution of about 10 meters. This dataset tracks temporal variations in vegetation growth and health, offering a range of parameters to monitor environmental change and enable predictive maintenance planning for assets affected by vegetation dynamics.

In closing, she invited participants to explore the CLMS Use Case Repository, which contains user stories, documentation, and links to product webinars as well as the GitHub repository, where technical details and tools supporting use of the datasets are available.

Arnis asked the audience to fill in the online survey:
https://ec.europa.eu/eusurvey/runner/EUSPA_UCP_RAIL_EO_2025 before the 19th of dec.

Following the presentation there was a Q&A session described below:

Q (Arnis Kadakovskis, EUSPA): There is a safety margin I assume—what is the specific process? What is the set of requirements to adopt such a technology? There are many requirements for the satellites. How do we ensure that we don't remove it?

A (Lene Bøgebjerg Bøgvad, Banedanmark): they are only starting to explore this topic and are still defining the approach.

Q (Arnis Kadakovskis, EUSPA): How mature is the system, and how will it be integrated into operational use?

A (Danijela Ristic-Durrant, OHB Digital Services): the system is based on machine learning and still requires further validation against in-situ measurements. The current aim is to support existing safety practices, which are mainly based on weather forecasts, rather than to replace them or be used directly for safety-critical decisions.

Q (Arnis Kadakovskis, EUSPA): Is there a practice of sharing data across infrastructure managers, particularly for in-situ data?

A (Danijela Ristic-Durrant, OHB Digital Services): there is currently no systematic data exchange between stakeholders. She noted that OHB Digital Services had bilateral agreements with Deutsche Bahn and the Serbian Railways, but there is still no broader sharing framework. She suggested that EURail could play a role in facilitating such collaboration.

A (Arnis Kadakovskis, EUSPA): EUSPA could support initiatives aimed at developing data-sharing mechanisms and promoting the use of EO solutions across European rail networks.

Q (Valentin Barreau, SNCF): Regarding SPATRA and the monitoring of temperature—it seems to have an hourly interval. Are there satellite data sources available at such frequency?

A (Danijela Ristic-Durrant, OHB Digital Services): in addition to Sentinel-3, the system also uses Copernicus Land Monitoring Service (CLMS) datasets, which together provide an hourly temporal resolution. This combination achieves both high temporal (one-hour) and spatial (around 500-meter) resolution.

Q (Valentin Barreau, SNCF): But the resolution shown on the slide was higher—how is that possible?

A (Danijela Ristic-Durrant, OHB Digital Services): 500 meters corresponds to typical user needs, but SPATRA can achieve up to 30-meter resolution if required by specific use cases.

Q (Andreas Wenz, SBB): We have a use case with heated switches to remove ice, and there is a need to detect faults in the heating systems. Can satellite data identify such faults?

A (Danijela Ristic-Durrant): the resolution of current satellites is not yet high enough to differentiate individual switches, which remains a limitation for such fine-scale applications.

Agenda Item 6 IRIS² and a Presentation of User requirements on EU SATCOM – State of the art and update of URD

Agenda Item 6.1 IRIS²

Giuditta Montesanti from DG DEFIS introduced IRIS², the new flagship programme of the European Union for secure satellite communications. She presented the current status of the programme and its objectives, explaining that IRIS² will provide multi-orbit broadband global coverage using both Low-Earth Orbit (LEO) and Medium-Earth Orbit (MEO) satellites, in combination with GOVSATCOM services. The constellation will consist of around 300 satellites, most of them in LEO to ensure low latency communication, with a ground segment based on a 5G core network.

She explained that IRIS² is designed to offer services similar to commercial systems such as Starlink, but with an essential difference: it will specifically target governmental users and applications requiring high levels of security and resilience. The European Union will retain ownership and management of the infrastructure, following the model of Galileo, which ensures security by design. The system will rely on open standards and 5G integration, enabling lower terminal costs through the use of commercial off-the-shelf (COTS) components and supporting application-specific terminal development.

She underlined that IRIS² is conceived as a dual-use infrastructure, serving both civilian and military users, and that it will embed state-of-the-art cryptographic mechanisms as well as resilience to cyber and radio-frequency threats.

The European Commission holds overall responsibility for the implementation of the programme, while ESA acts as the qualification and validation authority, and EUSPA is responsible for security accreditation and the provision of governmental services. The programme is being implemented as a public-private partnership (PPP) under the SpaceRise consortium, ensuring both public and private investment. Costs and operations will be balanced across sectors, with governmental users consuming bandwidth in the EU and commercial opportunities generated through bandwidth sales in other regions, strengthening the business case.

Giuditta confirmed that the contract for the concession was signed on 16 December 2024, and the programme has now entered the design phase, with initial service provision expected around 2030. She concluded by inviting members of the rail community to engage in discussions on user needs and requirements, as the Commission welcomes input to ensure that IRIS² services effectively support railway digitalisation and connectivity objectives.

The following Q&A sessions followed the presentation:

Q (Andreas Wenz, SBB): What will the user equipment be — 5G equipment or a special receiver/modem?

A (Giuditta Montesanti, EC): Yes, you will need a specific receiver. However, a specific development for the rail community might not be necessary if an existing receiver developed for another domain can meet the requirements. We expect user terminal manufacturers to engage and potentially co-invest.

Q (Pierre Le Corre, SNCF): The constellation is based on Eutelsat and SES satellites, but these are not 5G-ready today. What can be done with the satellites already deployed?

A (Giuditta Montesanti, EC): For legacy services, it's up to the operators to make the necessary updates. There will be a transition toward the new 5G services.

Q (Valentin Barreau, SNCF): The roadmap seems very ambitious — is it realistic?

A (Giuditta Montesanti, EC): It is ambitious, but we are on schedule. Since signing the contract, we've maintained the planned timeline.

Q (Daniel Lopour, EUSPA): When does the railway community need the constellation to be operational, and when do you need user requirements?

A: There are two types of requirements:

- Those that require infrastructure changes — implementing these later might be too late.

- Those that involve only operational changes — these are still doable, similar to updating software on satellites.

The sooner requirements are shared, the better. Some adjustments could be integrated in a later version if needed. With this the Q&A closed, and Ricardo Campo took over.

Agenda Item 6.2 Presentation of User requirements on EU SATCOM – State of the art and update of URD

Addressing the growing stakeholder interest in alternative bearers supporting FRMCS evolution, Ricardo Campo, EU-RAIL, Daniel Lopour, EUSPA MDI Officer

Ricardo Campo introduced Europe's rail, an R&I integration program and in particular, in the context of FA2-FA6, the multi connectivity platform developed for trains and trackside to move from GSM-R to FRMCS. Ricardo then highlighted in which railway scenarios satellite communication is the most viable within the evolution towards FRMCS and proposed: G1 and G2 lines, targeted main lines and/or all railway lines (G2 lines as the shorter term). The audience agreed with these scenarios.

Q (Ricardo Campo, EU-RAIL, to the audience): Should satellite communication be considered a standalone solution or part of a hybrid approach alongside other systems (e.g. railway mobile radio, MNO networks, or high-capacity radio)?

A (Maria José García Prieto, ERA): For main railway lines, the approach will be hybrid.

A (Pierre Le Corre, S5LECT/SNCF): On high-speed lines, satellite communication could serve as a back-up. Depending on the line and use case, the solution may vary, but hybridisation will remain essential.

A (Andreas Wenz, SBB): It must be hybrid because tunnels and stations would not be covered by satellite systems. The higher the performance of satcom, the more it can replace terrestrial systems. However, timing is key — if FRMCS is deployed first and satcom is integrated later, alignment becomes difficult.

A (Andreas Wenz, SBB): Agrees that hybrid architecture ensures availability even in tunnels where satcom cannot cover. The concern is whether satcom will mature in time to be integrated with FRMCS. There is also a question about whether it's economically justified to equip the entire fleet if trains are already fitted for FRMCS.

A (Daniel Lopour, EUSPA): FRMCS integration is not straightforward; technical and cooperative work is required. The business case will be crucial to justify investment. The ultimate goal is to potentially replace parts of the terrestrial network to achieve cost savings.

A (Ricardo Campo, EU-RAIL): The EGNOS4Rail project serves as a good example of cooperation across stakeholders.

Q (Valentin Barreau, SNCF): What about the availability of the satellite signal and overall service?

A (Giuditta Montesanti, EC): Availability is a key factor in assessing the feasibility of any satellite-based rail communication solution.

A (Daniel Lopour, EUSPA): Availability is already a defined performance parameter for FRMCS. For rail, it is constrained by the environment (e.g. tunnels, dense urban areas). It must be combined with the right technical design and business case.

Q (Valentin Barreau, SNCF): For TGV or similar high-speed lines, could satellite be used as the primary solution if availability was sufficient?

A (Daniel Lopour, EUSPA): That depends on proving that satellite communication can meet operational requirements. If it can, there could be less need to deploy a terrestrial system.

Q (Ricardo Campo, EU-RAIL, to the audience): Should satellite-based railway architectures focus on meeting FRMCS requirements? Could Satcom requirements for G2 lines help accelerate (or potentially risk) the future FRMCS compliant implementation of G1 lines?

A (E. Mancusi): For G1 line we need to fulfill the FRMCS requirements but not for G2 lines

Q (Ricardo Campo, EU-RAIL, to the audience): What validation steps and compliance levels are necessary for satellite communications to meet railway operational and safety requirements? How can we reach full validation and what is the expected timeline?

A (Maria José García Prieto, ERA): The process will follow a full TSI certification pathway, including field tests to validate the real operational performance of satellite communications in railway use cases.

A (Maria José García Prieto, ERA): Extensive lab testing is essential — the more that can be done in the lab, the better, since it avoids operational constraints. However, field tests are still needed to assess performance under real operational conditions. Some repeated validation may need to be carried out during maintenance periods.

A (Pierre Le Corre, SNCF): We're currently in the second or even third step with S5LECT, where data is collected and used to recreate lab simulations. The final validation step — real field testing — is mandatory to achieve compliance at the highest safety level (SIL 4).

A (Andreas Wenz, SBB): It may be sensible to start with non-critical use cases where loss of data transmission would not jeopardize safety, helping to demonstrate feasibility before moving to critical services. Railway systems are conservative, so this phased approach is more acceptable.

A (Andreas Wenz, SBB): There is a natural progression from non-critical to critical services. As reliability and assurance build up, satellite communications can take on more safety-relevant functions.

A (Giuditta Montesanti, EC): For "hard-gov" services, there will be an additional layer of military-grade security, reserved for governmental or defense users. Lighter, less critical use cases could rely on

"light-gov" services operated under commercial partnerships. Such services could already be tested through Iris²'s commercial partners.

A (Daniel Lopour, EUSPA): The focus should also be on reducing infrastructure costs for railway managers.

Q (Valentin Barreau, SNCF): For the "light-gov" and commercial service segments, is this also under EUSPA's direction?

A (Giuditta Montesanti, EC): These services fall under the umbrella of commercial partners operating the light-gov components of Iris². EUSPA focuses on coordination and ensuring that commercial operators manage service delivery. Access to commercial services will go directly through Iris² private partners, while governmental infrastructure will be handled separately.

Q (Gabriele Ridolfi / EUG): It would be a big mistake not to include SatCom and Iris² in the scope of FRMCS. How can we ensure long-term compatibility and integration, especially for signalling and safety applications where resilience is critical?

A (Daniel Lopour, EUSPA): This need has already been anticipated by both the railway and space communities. EUSPA is forming a stakeholder group — similar to what was done with EGNOS 4Rail — to define interoperability elements. Coordination with DG DEFIS and DG MOVE ensures transparent cooperation and alignment of evolving FRMCS and Iris² requirements.

Q (Ricardo Campo, EU-RAIL, to the audience): How do current and future satellite communication capabilities align with the requirements discussed during the UCP 2023 workshop?

A (Pierre Le Corre, SNCF): It depends on the specific applications being addressed. Train speed is a significant parameter — performance must be validated even in open environments and at high speeds. In S5LECT, tests have already been conducted at 100 km/h, but further validation is needed for higher speeds.

A (Pierre Le Corre, SNCF, continued): Jitter must also be considered. We should include performance metrics such as jitter, packet loss, and speed from S5LECT results when building the next phase scenarios.

Q (Ricardo Campo, EU-RAIL): What is the real potential for reducing CAPEX and OPEX through satellite communications compared to RMR terrestrial solutions?

A (François, SNCF): The service must remain cost-effective. We have extensive maintenance networks and staff — if the cost of the service is too high, it will not be a viable option.

A (Giuditta Montesanti, EC): For “hard-gov” services, provision will be free of charge for authorized governmental users (using tokens). “Light-gov” and commercial services will have associated costs.

A (Daniel Lopour, EUSPA): The key factor is the stability of both cost and service over time. Without long-term stability, adoption will be challenging. A cost-benefit analysis (CBA) will be necessary to justify investment.

A (Andreas Wenz, SBB): Most of the costs will fall on the Railway Undertakings (RUs) rather than the Infrastructure Managers (IMs), since the trains need to be equipped with onboard terminals and connectivity.

A (Ricardo Campo, EU-RAIL): Both trackside and onboard infrastructure will require adaptation. The trackside elements are under the IM’s responsibility, but the RU will bear the onboard equipment cost.

A (E. Mancusi / Ricardo Campo, EU-RAIL): Since FRMCS specifications currently do not explicitly include satellite communications, alignment with existing standards will be necessary to ensure compatibility.

A (Pierre Le Corre, SNCF): Infrastructure managers have made it clear: if satellite capability is not mandated as part of the standard, they will not implement it.

A (Ricardo Campo, EU-RAIL): Therefore, a solid cost-benefit case must justify the inclusion of satellite communication in future deployments.

Daniel Lopour concluded the session.

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