



Railway

Working Group Charter

Executive Summary

This charter proposal captures the vertical technology work within the DIA with Railway **ICT systems and their enabling technologies** in the scope of this proposed WG. The proposal provides background and a rationale for its initiation for the community to review and base their work upon. The bulk of the charter is dedicated to outlining its themes and activities within those themes to start the work of the Railway WG. These themes have been agreed upon discussions with the community executing their activities. The themes and activities are not intended to be limiting the WG's future work and can be extended, revised, and broadened over time with updates posted as new versions of this document and in revisions of the accompanying webpages.

Version	Authors	Changes	Date
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1 Background & Drivers

Railway transport has always been playing a major role in transportation since the first practical locomotive was invented in 1829 by George Stephenson.

Train is a symbol of industrial development and national pride for many European countries, and the importance of railways shows no sign of waning. Passenger kilometres have grown by more than 10 percent in the past five years, and rail has been winning passengers from air travel on major intercity routes. Around 8 percent of passenger traffic in Europe runs on the railways, compared with less than 1 percent in the Americas. The European Green Deal, along with national regulations, pushes railway travel even further.

Rail transport has many economic advantages over other transport methods. As a matter of fact, Railways are often considered one of the most environmentally friendly modes of transportation.

Here are some key points about their environmental impact:

- **Low Emissions:** Trains emit significantly fewer greenhouse gases compared to cars and airplanes. For instance, high-speed trains produce about 66-75% less carbon emissions than flying.
- **Energy Efficiency:** Railways are highly energy-efficient, consuming less energy per passenger or ton of freight compared to road and air transport.
- **Sustainable Transport:** The rail sector accounts for less than 2% of total transport emissions while handling around 8% of passenger and 16.8% of freight transportation.
- **Noise Pollution:** Modern trains are designed to minimize noise pollution, making them a quieter alternative to road traffic.
- **Land Use:** Railways require less land compared to highways, reducing the impact on natural habitats and ecosystems.
- **Electrification:** Many rail networks are electrified, which can further reduce emissions, especially when the electricity is sourced from renewable energy.

These factors make railways a crucial component in efforts to create a more sustainable and environmentally friendly transportation system.

For example, rail transport has the highest energy efficiency compared to air and road transport; trains have higher carry capacities than trucks, and rail tracks occupy about 50 % less space than roads. Rail transport is also less susceptible to adverse weather conditions and has more predictable schedules than other transport means.

In addition, expanding rail transport is a promising solution to boost sustainability and reduce negative environmental impacts such as greenhouse gas (GHG) emissions and pollution.

The mission of the Railway ICT Enabling Technology WG (Railway WG) is to identify the emerging ICT enabling technologies and architectures and by capturing those increasingly complex relations of industry requirements, regulations and standardization efforts as well as relevant systems solutions, aims to propose to the industry suggestions on application of ICT emerging/new technologies as well as updated system solutions, training classes, conferences and publications.

1.1 Challenges

European global demand for railway transport is growing fast.

Planned to more than double for both passengers and freight services by year 2050.

EU political institutions and regulators look at it as the most efficient alternative to road/air for short-to-medium distance to decrease the

consumption of fossil fuel and carbon emission.

Digitalization is driving, as key enabler, the transformation of railways in 4 areas.

Evolutionary Area	Challenges	Solutions enabled by digitalization
Serve the forecasted increase of traffic through higher operations efficiency , service quality, and punctuality	<ul style="list-style-type: none"> Trains not enough fast, frequent (limited usability in the range 200-500km) Lack of punctuality 	<ul style="list-style-type: none"> ETCS L2 to enable higher speed, density FRMCS to replace GSM-R in obsolescence for enhanced train communications and IT services AI applied to the railway operations
Further increase of security , in particular on new technologies (FRMCS)	<ul style="list-style-type: none"> ICT introduction opens up security issues due to lack of expertise 	<ul style="list-style-type: none"> FRMCS Cybersecurity measures to make service safer and more reliable
Make whole railway transportation sector even greener	<ul style="list-style-type: none"> Poor integration with public transport Lack of real-time travel monitoring 	<ul style="list-style-type: none"> ICT integration to enable multi-modal transport
Reduce railway infrastructure and management Capital and Operational Expenses (CAPEX and OPEX)	<ul style="list-style-type: none"> Optimize at best the available funding 	<ul style="list-style-type: none"> Simpler infrastructure, enhanced operations and maintenance to reduce failures and relevant impact

The Railways WG aims to promote any activity that contributes to expand the adoption of digital technologies in the areas above, including studies, analyses, publications, research projects, educational and technical exchange events.

1.2 Technology Areas Interested by Digitalization

Punctuality and operations efficiency:

- Automatic Train Operations (ATO-GoA2)(*),
- Prognostic and Health Management (PHM)(*),
- Digital Automatic Coupler (DAC),
- European Train Control System (ETCS) level 2(*),
- IoT(*),
- Digital Twin(*)

Security:

- FRMCS Cybersecurity(*)

Green transportation and energy efficiency:

- reversible power supply substations,
- energy metering,
- **passengers/freight multimodality (*)** (including multiple carriers, integrated ticketing and real-time travel information)

CAPEX and OPEX reduction:

- Legacy systems,

- ETCS level 1 and GSM-R obsolescence and replacement by ETCS level 2 and 3 and **Future Railway Mobile Communication System (FRMCS)**.

NOTE:

The areas **in bold** are those that conjugate interest from the industry and technical novelty, making them suited for study/research/publication by the Railway WG. It is therefore among them that a first set of working themes have been derived in the next chapters.

The asterisk (*) indicates that the theme is an AI-based research/analysis.

The following chapters depict the first set of Themes to be worked out in the Railway WG and a set of Themes for future activities whenever proper expert champions have been identified and appointed.

The split in 2 categories has also been made based on the following parameters:

- Market and technology readiness
- Industry availability to work in public groups on these subjects without releasing proprietary IP
- Railway WG current experts' availability in these fields

2 Railway WG Objectives

The Railway WG targets research towards the system solutions/technologies/processes and standards that are the basis to realize the whole Railway system, its operations and organization activities and processes relevant to the ICT segment.

For this, the Railway WG will undertake activities within themes in the area of (i) **challenges and roadmapping** to identify future work and trends, (ii) **Railway system architectures, systems and sub-systems, technologies**, (iii) **analyse standards, sector policies and EU Regulations and Directives**.

For this, the Railway WG will establish, undertake but also revise the relevant **themes** in collaboration with other suitable vertical activities. It will also interface with the relevant horizontal WGs on systems and enabling technologies, sustainability and experimentation.

Each theme will define a set of **activities** and **outcomes**, which can be monitored to ensure progress of discussions over a given time. Themes will be led by an identified set of **champions** that provide support and/or drive the activities undertaken by the theme. Championship (within a theme) may be ephemeral, driven interest in the specific activities undertaken, handed over to other champion(s) to ensure continuity of activities within the theme or, in agreement with the WG leaders, brought to conclusion (of the theme).

3 Themes & Activities

The Railway WG will undertake the following activities, subject to revision, including addition of new themes and activities, in a future re-chartering of the WG.

3.1 Proposed Themes

1. Theme 1: Cybersecurity on FRMCS

The predicted obsolescence of GSM-R, combined with the long-term life expectancy of ETCS and of the increasing needs of railway operations, has led UIC (International Union of Railways) to set up a specific program to identify a successor for GSM-R, namely the UIC FRMCS (Future Railway Mobile Communication System) Program.

The UIC FRMCS Program was initially developed in the European context, due to the strong level of interconnection between the various countries of the European Community and then an even stronger necessity to anticipate the migration of GSMR trackside and on-board systems.

This Program is based on the usage of 5G StandAlone and MCX (Mission-Critical) 3GPP architectures, to make the system perennial over time. In this context, a first set of UIC FRMCS Specifications (UIC FRMCS V1) was produced and published at the end of 2023. The evolution of this set of specifications, UIC FRMCS V2, is currently under finalization for a publication expected in the middle of 2025.

As a follow up, a key part of this plan is the delivery by UIC, in the frame of its FRMCS Program, of the FRMCS V3 specifications, also named "FRMCS 1st Edition", corresponding to the first implementable version of the new system, for their inclusion in a new CCS-TSI in 2027.

Starting from the final UIC FRMCS V2 Specifications & V3 target requirements, as a result of the ERA EECT process, there will be consequently a need to verify, complete or amend these V2 Specifications & V3 target requirements through a full testing of FRMCS functions and system, leading then to market ready V3 Specifications. This operational testing is precisely the objective of FP2-MORANE-2 (MOBILE radio for RAILway Networks in Europe).

Meanwhile the Standardization Development Body (SDO) International Electrotechnical Committee (IEC) via its Technical Committee 9 (Electrical equipment and systems for railways) has been preparing the International Standard IS 63452 – Cybersecurity specifically applicable to the Railway sector.

Such under-preparation standard is expected to be completed by end of 2025 and become published by mid 2026.

From a first evaluation of such drafted standard, it seems very likely that its contents is not properly facing the typical cybersecurity issues for a 5G-based FRMCS telecommunication system.

On top of the previously described activity, the WG would also like to evaluate potential application of AI to the cybersecurity on FRMCS.

This will most likely be an innovation both in terms of cybersecurity itself as well as to its specific application to the Railway sector.

Theme 1	Activities	Outcomes	Main Actors
Cybersecurity on	<ul style="list-style-type: none"> Identify and elaborate current EU regulations (NIS2, CRA, CENELEC 	<ul style="list-style-type: none"> Speakers' series (webinars) 	UNIFE

FRMCS	<p>TS 50701)</p> <ul style="list-style-type: none"> • Monitor and support standardization/trial activities (e.g. future IEC IS 63452 editions, Morane2 feedback, completion of FRMCS...) • Cooperate with cybersecurity industry aiming to keep up to date their products/system solutions on FRMCS • Support SME to get organized and adopt cybersecurity countermeasures according to the standards (optional) 	<ul style="list-style-type: none"> • National and/or EU Research projects • White paper / technical report: <ul style="list-style-type: none"> • Threats and countermeasures • How to navigate through the applicable regulation and standards • Organization, procedures and processes to be activated to implement the cybersecurity directives 	<p>SDO</p> <p>EURA</p> <p>CIFI</p> <p>SME</p>
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Theme 1 - Railway WG Champions:

- Martin Reed
- Daniele Bozzolo

2. Planned Theme: FRMCS Technology Platform and System Solution

The Future Railway Mobile Communication System (FRMCS) is a priority technology for the future railway system. The need for FRMCS implementation is not only driven by the impending obsolescence of the Global System for Mobile Communications – Railway (GSM-R) and its associated challenges from 2030 onwards, but also due to the significant opportunities FRMCS will provide to enable and support railways' digitalisation.

While the GSM-R replacement is inevitable due to its end of life, all the SME industry that will be deeply involved in the FRMCS installation, testing, commissioning and maintenance is not well prepared and ready to take over such responsibility.

Furthermore, in order to maintain the existing GSM-R based telecommunication infrastructure in full operation while installing the FRMCS infrastructure, the full GSM-R shutdown will only be possible when all the fleet of trains (over 10,000) have been equipped and successfully tested for the final swap to FRMCS.

This issue is even more important due to the fact that over 120,000 Km or line are currently equipped with GSM-R and will have to be the cumbersome amount of work needed to install the new FRMCS infrastructure.

Theme 2	Activities	Outcomes	Main Actors
FRMCS Technology Platform and System Solution	<ul style="list-style-type: none"> • Identify key issues in the transition phase from GSM-R to FRMCS • Support the industry to properly plan the transition phase 	<ul style="list-style-type: none"> • Develop training classes to the SME in charge to perform the installations, testing and commissioning of FRMCS system • Technology webinars 	SME

Theme 2 - Railway WG Champions:

- Davide Amato
- Paolo Volpato

3. Theme 3: Applied AI on Railway Operations

Nowadays it is widely accepted that Artificial Intelligence (AI) is significantly influencing a large number of domains, including railways.

Railway WG would like to assess the current state-of-the-art of AI in railway transport and its potential applicability in the different segments and processes.

In particular, Railway WG would analyse and discussed papers from a holistic railway perspective, covering sub-domains such as maintenance and inspection, planning and management, safety and security, autonomous driving and control, revenue management, transport policy, and passenger mobility.

AI applications are promising and tend to act as a game-changer in tackling multiple railway challenges. However, at the moment, AI research in railways is still mostly at its early stages.

Future research can be expected towards developing advanced combined AI applications (e.g. with optimization), using AI in decision making, dealing with uncertainty and tackling newly rising cybersecurity challenges.

Theme 3	Activities	Outcomes	Main Actors
Applied AI on railway operations	<ul style="list-style-type: none"> • Applied research on how AI could improve efficiency in Railway operations 	<ul style="list-style-type: none"> • White paper / technical report on HOW AI can best support Railway in its day-by-day operations and the overall system transportation lifecycle • Turn key standard-based, open, modular and flexible systems solutions to the industry (blueprint) • Participation to National and/or EU Research projects 	UNIFE UIC EU's Rail SDOs

Theme 3 - Railway WG Champions:

- TBD
- TBD

3.2 Planned Future Themes

Based on the comments depicted in the previous section, the following themes are being considered as planned and become full teams once

the WG has identified proper champions.

1. Planned Theme 4: Digital Twin (AI-based)

The potential of digital twin technology has become apparent in recent literature, occurring evermore frequently in literature as the world moves on to the fourth industrial revolution. The use of digital twins in industries such as manufacturing, aerospace and aviation, and healthcare, have illustrated its value in lifecycle data management, control, monitoring, and more.

As the digital twin technology holds great promise in driving the railway industry into a new era of digital intelligence by creating a dynamic, personalized digital replica of a physical train or infrastructure, it has the potential to enable a range of advanced applications, including predictive maintenance, adaptive control, and early fault detection.

Fostering digital transformation is an objective higher than ever on the European Union's (EU) political agenda and has been identified as key for unlocking future growth in Europe. All sectors are experiencing a fast-paced evolution as the businesses, products and services fostered by digital technologies grow in sophistication. Transport is no exception, with the rail sector increasingly acknowledging its assets and importance in Europe's successful 'digital leap'.

It is undisputable that the twin challenges of green and digital transformations go hand-in-hand. The EC has made it clear that technological innovation needs to also be carried out in a way that contributes to a sustainable, climate neutral and resource-efficient economy. Digital components, in this regard, will also be key in reaching the European Green Deal and Sustainable Development Goals' (SDGs) ambitions.

The European rail supply industry fully acknowledges that these digital tools can be powerful enablers of the transition towards an economic and social model based on whole sustainability. This vision has been enshrined in the 'Rail fit for digital age (2020)' paper published by UNIFE. Digital twins are one of the many trends thoroughly examined in the document, as the technology clearly displays how digitalisation is essential to strengthening the sustainability-related assets of rail – energy efficiency, circularity and capacity.

Digital twins are one of the most talked about topics in transport, because it promises to leverage innovation to improve design, visually enhance collaboration and increase both asset reliability and performance. Many other industries have opened their eyes towards this technology – the rail supply industry is no exception. From healthcare to smart city management, digital twins are becoming essential tools for optimising entire manufacturing value chains and innovating new products.

European rail manufactures UNIFE see digital twins as a great enabler of technological advancement for rail transport, interacting as much with big data as with artificial intelligence (AI) and blockchain. One of the true advantages of digital twins technology lies in its ability to anticipate key developments on rail systems and subsystems, deriving insights about the future performance of the physical asset and, eventually, enabling test-driving solutions before taking on the actual applications.

Since digital twins' technology spans the asset's entire lifecycle, one of the major areas of potential is rail infrastructure and rolling stock, especially with regard to predictive maintenance. In fact, the use of digital twins in asset simulation can be very helpful for the prediction and identification of components in tracks and vehicles that pose the risk of failure. This ensures that the lessons learned thanks to these digital solutions contribute to design enhancement in line with operational requirements, and that they are applied to future products and systems.

Furthermore, during the planning and construction of a new railway or rolling stock – as well as upgrade or renewal processes – digital twins can contribute to the prediction of changes occurring in the project execution, as well as the risks brought by non-conformant construction. Therefore, using digital twins can help to drive maximum value from infrastructure and rolling stock investments, avoiding cost increases and delays.

This digital tool can be relevant also from a resource efficiency perspective. By allowing for the tracking of a rail asset's lifecycle, from the design phase through to the recycling stage, it answers the demand for the increased sustainability of process and products. The use of digital twins can, thus, enable rail to further comply with the circular economy requirements set forth by the European Green Deal.

Finally, the strict relationship between digital twins and big data should be looked at carefully. Digital twins tap into real information systems, producing and consuming large volumes of data, bringing in the issue of access to and ownership of that data. UNIFE stresses, once again, the importance of setting a framework for efficient data-sharing in the rail sector – including urban rail – to overcome questions pertaining to data access and ownership. We look forward to the upcoming ‘common mobility data space’ to be set up in the context of the Data Governance Act.

While the railway supply Industry (UNIFE) is quite focused on developing digital twin technology, Infrastructure Managers are focused on finding needs and application ways for this newly coming technologic breakthrough.

All major European IM (e.g. DB, SNCF, FS, NR and ADIF) are adopting this technology in different sectors but mostly with the same aims in mind.

While for the wayside infrastructure the IM are using digital twin technology for better maintaining the network, the Train Operator are recently calling for train supply tenders including among their requirement a full digital representation of the trains to be purchased.

This request aims to be able to better manage the train operations as well as maintenance in order to drastically reduce investments on their fleet assets.

Theme 4	Activities	Outcomes	Main Actors
Digital Twin (AI-based)	<ul style="list-style-type: none"> • Support development of standardized Rolling Stock Digital Twins modeling systems throughout the Industry • Promote and support National Committees to start a standardization project • Support standardization activities at CENELEC and/or IEC as third party 	<ul style="list-style-type: none"> • Railway Operator functional and system requirement specifications • Standard, open, modular and flexible Digital Twins representative solution to the industry (blueprint) • National and/or EU Research projects 	UNIFE UIC NC SDO EU's Rail

Theme 4 - Railway WG Champions:

- TBD
- TBD

2. Planned Theme 5: Passengers' multimodality (AI-based)

The Sustainable and Smart Mobility Strategy confirms the ambition of the European Green Deal to achieve a 90% reduction in transport emissions by 2050. A key element of making transport more sustainable is achieving effective multimodality, where passengers who wish to travel long distances can do so by combining several modes of collective transport, thereby using the most sustainable and efficient mode for each leg of the journey. Protecting passengers along the way, in particular during travel disruptions, is key to enhance the attractiveness of such multimodal travels. Moreover, a failure to provide this protection could itself affect market growth for multimodal travel, with some passengers choosing to travel by car instead of collective transport (judging car travel to be both more convenient and more reliable).

Theme 5	Activities	Outcomes	Main Actors
Passengers' multimodality (AI-based)	<ul style="list-style-type: none"> • Market survey on multimodality • Collect reference use cases • Develop high-level specifications on final apps • Extend the work to freights in a later stage 	<ul style="list-style-type: none"> • White paper / technical report on effects of multimodality on GHG emissions • National and/or EU Research projects 	UIC EU's Rail

Theme 5 - Railway WG Champions:

- TBD
- TBD

4 Organization

- WG co-chairs: L. Benedetti and D. Bozzolo
- WG members: Daniele Bozzolo (DGB Consulting), Lorenzo Benedetti (Eurotube), Paolo Volpato (Huawei), Martin Reed (Essex), Davide Amato (Sadel), Marco Paesani (MPAE)
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