A Roadmap for Digital Railways

Digitalisation is one of the top priorities for the rail sector and its future. Representing the railways, CER, CIT, EIM and UIC present this joint *Roadmap for digital railways* highlighting the opportunities and challenges of rail digitalisation. The objective for the rail sector is to offer highly efficient and attractive transport options to their customers and to make the most of the opportunities offered by digital transformation.

In the last decades, IT developments and the increased use of digital technology have transformed the way railways are working today and now have a big influence on our economy and the expectations of our customers. Operating in a competitive environment, railways commit to innovation. It is crucial to adapt quickly to a fast-moving technology environment and to act on new trends in order to foster the rail sector's attractiveness and competitiveness.

At the sector level, railways are exploring all opportunities, and adapting to and integrating in the new digital ecosystem in order to maintain its strong economic position in Europe. This also requires more joined-up work, both within the sector (RU/RU, RU/IM and IM/IM), and together with manufacturers, suppliers, customers, end-users and other third parties. The aim is to build win-win partnerships and to work in a co-creation model developing an innovative mind-set centred on the customer in order to enhance his/her ability to integrate rail travel into his/her experience.

In addition, CER, CIT, EIM and UIC support the Commission's focus on digitalisation as one of its political priorities. Therefore, the sector works together to contribute towards the creation of a European Digital Single Market. With this Roadmap, the sector proposes some further actions calling on EU institutions and especially the European Commission to help to collectively deliver on the objectives of making railways digital:

- **offering connected railways** by providing reliable connectivity for safe, efficient and attractive railways
- **enhancing customer experience** by offering better and added value for customers
- **increasing capacity** by enhancing reliability, efficiency and performance of railways
- **boosting rail competitiveness** by making the most of transport data

Connected railways

Reliable and better connectivity will provide safe, efficient and attractive railways both for customers and staff.

Connectivity is a foundation allowing the full realisation of the European Single Digital Market and digitalisation of railways*. The aim is to increase the access to internet and to provide connectivity across the entire rail network and on all the different railway lines.

Firstly, from the operational perspective, there is a need for highly available, reliable and stable network connectivity, while meeting the technical, operational and functional requirements of the railway system, such as coverage in tunnels and protection of GSM-R and the ERTMS installations, avoiding or mitigating any form of interference and cyber-threats.

Secondly, a certain level of connectivity is also required in order to provide dependable information, such as train schedules, availability of tickets, travel planners, etc. This is a strong customer expectation and a beneficial tool for staff, improving the quality of services and better maintenance.

Therefore, the proper coverage is essential in order to make further digitalisation of railways possible. This relies on a good cooperation between railway undertakings and infrastructure managers on the one hand and between railways and telecommunication players on the other hand.

Also the development of new **5G networks** will offer a great opportunity for railways by enabling, among others, the internet of things and better real-time information. This will make railways more reliable, effective and efficient.

What	Who	When
Connectivity: In the view of the future telecommunication framework, the European Commission, supported by the European Parliament and the Council, should establish a legislative framework <u>providing mandatory coverage and a good speed for data connection on railway lines</u>, as it is already the case in the road sector in some European countries, so as to avoid discriminatory technical and policy regimes.	European Commission supported by European Parliament and Council of the EU	2016-2017
Safe voice communications: Regarding the compatibility with rail-specific communication platforms e.g. GSM-R and its specific spectrum provisions including the interference problems (as referred to in EC decision 2009/766/EC), public authorities, EU institutions, the European Railway Agency (ERA) and standardisation bodies need to meet the <u>rail-specific requirements on connectivity in order to provide safe operations of the rail system.</u> Together with national spectrum authorities, the European Commission needs to play a role in spectrum harmonisation in order to provide interoperability of rail services.	Public authorities, EU institutions, ERA, standardisation bodies	2018-2019

Cyber-Security: After formal adoption by the Council and the European Parliament of the compromise text of the Directive concerning measures to ensure a high level of network and information security across the Union (NIS Directive), the EU institutions should be encouraged to draft <u>harmonised standards on security requirements bearing in mind the rail specificities</u>.	EU institutions, ENISA	2016-2017

French coverage of rail network

In France, a measurement campaign was carried out in order to assess broadband coverage on the network and an improvement plan was set up with the telecommunication operators and regulators in order to have a targeted coverage of 90% of passengers by 2020 and on-board Wi-Fi on high-speed trains (40 TGV equipped in 2016 and 300 in 2017).

PKP PLK – Dynamic Passenger Information Central System (CSDIP)

PKP PLK developed its own solution - CSDIP. CSDIP presents all the key elements about the railway timetable for passengers at stations/stops administered by PKP PLK. It will be implemented on the railway network, to provide real time information about the railway timetable for passengers, using advanced information technologies. All data necessary to the proper functioning of CSDIP are received from a database which includes planned and online executed railway timetables. The key stakeholders are passengers, operators, IMs.

The main functionality:

- deliver multilingual, high-quality voice announcements at all passenger stations;
- present high-standard, real time visual information for passengers at selected stations;
- handling of external systems and database interfaces (TTS, train sensors, TCS, train schedule etc.);
- fully customisable system e.g. easily configurable voice announcement zones;
- remote maintenance system at all stations and stops from one place;
- monitoring of all connected devices and system availability through the use of the central architecture.

Italian internet access

Internet access is provided across all FSI facilities via LAN and Wi-Fi, giving access to the internet to most of the FSI Group's employees, including customer assistance personnel at stations. This enables instant VoIP (Voice over IP) and video meetings for collaborative problem solving minimising face-to-face meetings. It also enables customer assistance via social networks. Thanks to a collaboration with telecommunication providers, Trenitalia offers a Wi-Fi service free of charge on high-speed trains. In addition, stations managed by RFI are progressively deployed with high-capacity Wi-Fi internet connectivity. The idea is to create a connectivity backbone for 'intelligent stations' equipped with sensors and an enabler for customer experience applications extending to stations.

Digitalisation of railways will enhance customer experience by offering a better and added value and by meeting their expectations.

Digital tools need to address individual requirements by creating **door-to-door solutions** and added value for the customer experience before, during and after travel. They need to be designed in such a way that they are secure, safe, reliable, and 'under customers' control'.

Railways are progressively offering **on-board internet and entertainment services** in order to respond to the increased demand from customers to have the ability to access the internet in order to use their phones, tablets and laptops for leisure and work purposes. This enhances customers' experience, who are satisfied that internet is consistently available throughout the rail networks. Railways will boost access to internet to fulfil customers' wishes and to create an interconnected and 'always-on' digital rail network.

Better collaboration within the sector and beyond will bring added value and offer better solutions for passengers, freight users and their own staff.

What	Who	When
Information for customers: When adopting different specifications (i.e. functional, technical, organisational or service provisions) addressing the <u>compatibility, interoperability and continuity of ITS solutions</u> across the EU under the Intelligent Transport Systems (ITS) Directive (Directive 2010/40/EU), the European Commission needs to ensure the implementation of the ITS Directive in order to <u>provide better information for travellers and a better connection between the different modes of transport.</u>	European Commission supported by railways in an ongoing dialogue	2016

Adif Mobile

'Adif on your mobile' is an application showing real-time traffic information, the timetable of train arrivals and departures and platform information, information and maps of the stations and shopping areas and offering the possibility to subscribe to train and journey alerts.

http://www.adif.es/en_US/adif_movil.shtml

ÖBB multi-media portal platform

ÖBB created a partnership with a provider of wireless connectivity and ICT solutions in order to provide an advanced multi-media enabled portal platform for passengers, giving ÖBB customers direct access to timely journey and service information, on-demand multi-media content and entertainment delivered through the train's on-board platform.

Interoperable product service interface of the Association of German Transport Companies (VDV)

Almost every public transport organisation (PTO) in Germany – which define time tables and tariffs and pass the public transport contracts - has its own mobile app. As each app requires a separate registration, the VDV eTicket Service developed on behalf of several PTOs the 'interoperable product service interface' (IPSI) to make the mobile ticket customer friendly. It enables the customer to use his known app for ticket purchases in foreign regions. The IPS – the core of IPSI - is in operation since October 2015 and connected with the central systems of (((eTicket Germany. The IPSI-members are currently registering their public transport stations in the IPSI database. The IPSI Service will be available for the largest regions in Germany in 2016-2017.

Xrail project

Xrail is a project bringing together 6 rail partners (CFL cargo, DB Schenker Rail, Green Cargo, Rail Cargo Group, SBB Cargo and B Logistics) committed to significantly enhancing the competiveness of wagonload traffic in Europe. Xrail is targeting a minimum of 90% transport reliability and offers enhanced information before, during and after the transport. Xrail services include international transport schedules, delay alerts and next-day-arrival messages.

http://www.xrail.eu/

Increased capacity

The use of the internet of things as well as the implementation of automatic train operations will increase the capacity, efficiency and performance of railways.

The internet of things, a network of physical objects able to connect with each other and exchange data, will help to increase productivity and effectiveness of operational processes. The challenge will be to implement new sensors on existing equipment, and to create, collect and then make the best use of data in an efficient way while ensuring security and privacy of data. This is a challenge to which the sector is ready to rise.

In addition to sensors, wearables and artificial intelligence will also be increasingly deployed to meet the specific demands of railways, their staff and customers. This area represents a huge opportunity for further transformation of railways. The increased deployment of different tools improves the quality of services and safety and optimises costs and energy consumption. It will also move towards predictive maintenance, real-time and enhanced network supervision and equipment monitoring.

Furthermore, the implementation of **automatic train operations (ATOs)** will contribute to enhance the network capacity, increase punctuality, save energy, lead to financial savings and raise safety. ATO based on a plug and play approach with ERTMS will further drive the development of seamless and interoperable railways in Europe.

What	Who	When
Automatic train operation: Early ATO implementation projects should be used as a pilot to bring a harmonised ATO concept to maturity. EU funds should be made available to support such a project and further ATO research and development beyond the European Shift2Rail programme should become a main priority of EU funding.	Funding under Shift2Rail	2018-2019
ATO: ERA supported by the sector should adopt a harmonised operational concept for ATO over ETCS as part of the next ERTMS baseline. It is important to have an architecture with highly qualitative standards and a favourable life cycle.	ERA supported by railways	Early implementation 2018-2020; final definition / specification 2020-2022
ATO: ERA as the ERTMS authority needs to define under which conditions such a technical concept can be developed. A close cooperation with the sector representative bodies should ensure the availability of a harmonised and formal specification right from the beginning to ensure economies of scale, evolution capability and interoperability based on a plug-and-play approach with ERTMS.	ERA	From 2016

NMBS/SNCB's Optical character recognition (OCR)

A limited number of cameras near the tracks check the composition of the trains. This digital technique automates the formerly manual input of the carriage identification numbers. This information can be used for different purposes: information to the passenger, the maintenance shop, traffic control, train staff, etc. It also detects vandalism/graffiti. Regular checks can help determine where and when carriages were damaged.

CFL Traceability of goods

CFL Cargo uses a traceability software capable of localising freight via GPS. This can be used e.g. to trace dangerous goods. The software also enables to trace the CO_2 impact of the transport service.

http://www.itnovem.com/index.php

DB's DIANA predictive maintenance platform

Sensor technologies collect real-time data that is then transferred and allocated on a diagnosis and analysis (DIANA) platform. The process comprises measuring, collecting, analysing and finally providing structured data. DIANA is the user interface and allows a variety of applications, especially regarding predictive maintenance. DB Netz uses DIANA for instance to control points.

SBB Adaptive steering

Adaptive steering (ADS) is a real-time control of rail services (mobile application for engine drivers) to avoid unscheduled stops. The disposition software calculates the optimum speed for each individual train based on predictions across the entire rail traffic network, thus creating a 'green wave' for rail traffic. Every three seconds, over 5,000 parameters are analysed and predictions about the train's progress are recalculated. A recommended optimum speed is then sent to the engine driver via an iPad in the driver's cab. The system has been introduced nationwide since the start of 2015.

The exploitation of transport data will boost the competitiveness of digital railways.

The development of new IT technologies has facilitated the collection and exploitation of transport data. Maximising the use of data will lead to economic growth, innovation and significant benefits for the rail sector, their customers and the European economy, creating and developing interoperable and interconnected services. The different aspects of opening up data and data sharing need to be better explored in order to create clear added-value for the rail sector and the society.

The first step is to ensure **interoperability of data** formats in order for the actors to work together. Therefore, joint interfaces need to be developed in order to enable data exchange between different systems. To ensure safety and interoperability of these technical solutions, open standards need to be developed taking into consideration the rail-specific requirements.

Sharing transport data should enable the emergence of innovative solutions generated through co-creation. It would provide opportunities for third parties (such as start-ups, app developers and technology providers) to deliver new solutions for users, increasing railway attractiveness and competitiveness.

A proper big data analysis will provide information about trends and demands that could help to redesign transportation with more personalisation and flexibility and help cities to be more efficient (e.g. reduce traffic congestion and emissions, predict weather changes etc.).

What	Who	When
Free flow of data: The forthcoming proposal for a European <u>free flow of data</u>, planned from the Commission for November 2016, should take into account the needs of the rail sector.	European Commission, European Parliament and Council	2016

RailTopoModel

Considering the growing needs for data exchange in railway projects (e.g. ETCS projects), a few IMs have been working since 2012 to define a standard object model, RailTopoModel, to become a standard for all data exchanges in the domain of railway infrastructure.

Version 1 of RailTopoModel will be published by UIC as an International Railway Standard (IRS) in April 2016. This first release is the foundation of a universal language designed to support digital continuity in railways all along the whole life cycle and operation of a railway network.

The enhancement of this foundation is on the way. Version 2 which includes signalling and interlocking should come in early 2017. All further developments, deployment, communication, governance of such a sectorial standard require resources and investment.

A first application of RailTopoModel is the standard format for data exchange railML version 3 provided by railML.org in compliance with RailTopoModel IRS. This first version for infrastructure will be enriched in early 2017 with a theme dedicated to Interlocking.

Building Information Modelling

Building Information Modelling (BIM) is the process of generating, building and managing data through the life of the project by using model-based technologies linked to a database of project information. BIM incorporates data – physical, environmental, commercial – on every element.[1] HS2, a second high-speed undertaking in Britain, have used BIM technology from the start, e.g. to show the physical effects of the line construction.

Swedish Trafiklab

ASTOC/SJ is involved in Trafiklab, which is a community for open traffic. It is a place where developers can share data and APIs (application programming interfaces) for public transport in Sweden and easily get the information they need to develop sharp services.

https://www.trafiklab.se/

ATOC's open data

ATOC supports the principle of transparency and how this contributes to the wider industry agenda by making data openly available in the public domain and has over the past two years invested in making more of its data open for developer and third party use including information feeds from its national passenger information systems Darwin, Stations Knowledge Base and the Online Journey Planner. National Rail Enquiries have a selection of APIs and XML feeds that are available for use by third party developers to create their own applications.

http://www.nationalrail.co.uk/46391.aspx

Open data platforms

There are various highly complex problems with which the railways have to deal with. In order to solve these issues, a number of railway companies have created open data platforms, where they can collaborate with start-ups. The developers joining these platforms are invited to develop ideas and apps based on the company's data.

DB: data.deutschebahn.com
SBB: www.sbb.ch/opendata
SNCF: data.sncf.com

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[1] Crossrail cited in: http://eurailmag.com/the-importance-of-building-information-modelling/

At European level, it is essential to complement the initiatives outlined in this paper by creating the necessary policy framework to foster innovation and develop digital railways, taking into consideration the existing regulatory environment.

Digitalisation and the development of new technologies may not fit within the current legal system. The rail sector representatives will identify the main obstacles for rail digitalisation when they arise and then to look into the potential solutions to overcome those barriers. These activities should be supported by the European institutions, mainly the European Commission and ERA.

In order to achieve seamless and digital railways, the newly developed technologies need to also meet the highest requirements in terms of safety, security and sustainability but also in terms of availability and affordability as well as adaptability to the old set-up of the railways.

The coverage of the railway network (including lines, stations, and sidings) should become a priority for European institutions, telecommunication providers but also for the national authorities that manage and monitor the spectrum allocation schemes. Close cooperation between railways and the telecommunications sector is therefore absolutely crucial for strong connectivity of railways.

In addition and in order to reduce the imbalances between different European territories, financial assistance, e.g. through dedicated budgetary resources or public service obligation (PSO), should also be provided to contribute to increase connectivity. The less developed regions should benefit from dedicated European funding in order to be able to offer similar innovative services.

Furthermore, the use of financial instruments, such as, European Structural and Investment Funds (ESI Funds), the European Fund for Strategic Investments (EFSI), Horizon 2020 and other EU programmes in the areas of research and innovation, in particular the Connecting Europe Facility and Shift2Rail, should be encouraged and increased. The financial instruments should support and stimulate public and private investment in innovative digital initiatives of railways and provide funding to relevant projects for research and development in areas identified by the sector.

The railway sector in cooperation with other parties is committed to fully engaging in the digital revolution and to contributing to the creation of a true Digital Single Market for Europe.

CER, the Community of European Railway and Infrastructure Companies, brings together more than 70 railway undertakings, their national associations as well as infrastructure managers and vehicle leasing companies. The membership is made up of long-established bodies, new entrants and both private and public enterprises, representing 73% of the rail network length, 80% of the rail freight business and about 96% of rail passenger operations in EU, EFTA and EU accession countries. CER represents the interests of its members towards EU policy makers and transport stakeholders, advocating rail as the backbone of a competitive and sustainable transport system in Europe. For more information, visit www.cer.be or follow us via Twitter at @CER_railways

CIT is an association of railway undertakings and shipping companies that operate international passenger and/or freight transport services. 136 companies are full members of the CIT and more than 80 undertakings are indirectly affiliated via 6 associate organizations. The CIT is an association under Swiss law, with its headquarters in Bern and has the task to provide all necessary juridical documents and instruments for international traffic at railway level. The CIT support legally the railway undertakings, implement international and European rail transport law, standardises the contractual relationships between the various players (customers, carriers, infrastructure managers, wagon keepers, customs authorities) and represents the interests of the carriers vis-à-vis legislators and other national and/or international authorities. In addition, it provides regular briefings for its members and provides members with training courses and legal advice.

EIM, the association of European Rail Infrastructure Managers, was established in 2002 to promote the interests and views of the infrastructure managers in Europe, following liberalisation of the railway market. It also provides technical expertise to the appropriate European bodies such as the European Railway Agency. EIM's primary goal is promoting growth of rail traffic and the development of an open sustainable, efficient, customer orientated rail network in Europe.

UIC is the worldwide organisation for the promotion of rail transport at a global level and collaborative development of the railway system. It brings together some 240 members on all 5 continents, among them rail operators, infrastructure managers, railway service providers, etc. UIC maintains close cooperation links with all actors in the rail transport domain right around the world, including manufacturers and suppliers of goods and services, railway associations, public authorities and stakeholders in other domains and sectors whose experiences may be beneficial to rail development. The UIC's main tasks include understanding the business needs of the rail community, developing programmes of innovation to meet those needs and preparing and publishing professional railway standards that facilitate the implementation of the innovative solutions. The train and education of the people called upon to use these innovative solutions is vital and the organisation of training schemes is a core component in ensuring the competency of tomorrow's generation of rail personnel. Representing rail with a wide range of international organisations such as the UN and cooperating with all organisations specialising in rail matters and transport issues right around the world is one of the prime raisons d'être of the UIC.