Sub-Activity 2.5: ITS, ERTMS, E-Navigation

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1 Introduction

In this chapter, the digital business developments in the other transport modes are introduced, including the link with the concept of synchromodality .

1.1 Sub-Activity 2.5

In the implementation process of River Information Services (RIS) it became clear in recent years that in areas with mixed maritime and inland traffic, there is a need for a common set of services, information and data. It was also identified that Inland Waterways Transport (IWT) could learn/benefit from the maritime transport domain, specifically from the maritime e-Navigation concept. It is evident that it can be very beneficial for IWT and maritime transport that the information services, systems, applications and technologies are going to be integrated or developed for shared use. The same accounts for the modes road and rail as there is a lot of transhipment to road and rail at inland terminals.

A key aspect in this is to consider analysing the interaction between RIS services with other information services concepts in other transport modes. In addition, it can be of great benefit for the further development of Information Services in IWT to be inspired by services, information, technologies, architecture, etc. that exist in the other domains in general and such as e-Navigation in the maritime transport domain, Intelligent Transport Systems (ITS) in the road sector and the concept of the European Rail Transport Management system (ERTMS) as under development in the rail transport domain.

A pro-active attitude towards the development of multi- or synchromodal transport, as identified in Sub-Activity 2.2, is essential. Development of multi- or synchromodal information services, systems, applications and standards is necessary to make sure synchromodal transport can function in an optimal way. A transition strategy for RIS towards a harmonized multi-modal transport and logistics information services environment is an evident development for the future. The Masterplan on Digitalization of Inland Waterways is a first step in that development.

1.2 Interaction with synchromodality

In the work program, the description of Synchromodality is as follows: "Synchromodality is defined as the optimal, flexible and sustainable use of road transport, rail transport, inland shipping and coastal (maritime) shipping / shortsea in a network under the direction of a logistics service provider with the goal to offer an integrated solution for its (hinterland) transport and to create a better service at acceptable costs. The basis for that is interoperability. Optimal use of inland shipping requires information on the availability of the infrastructure and an efficient planning of the use of the infrastructure."

This description clearly illustrates the importance of the link of Inland Waterway Transport with other transport modes and – by consequence – the developments that are planned or even taking place in those other transport modes. This is the key target for Sub-Activity 2.5.

2 Objectives of SuAc 2.5 ITS, ERTMS, e-Navigation study

The objectives, tasks and expected results for this Sub-Activity are outlined in the following subchapters.

2.1 Objectives

The objective of SuAc 2.5 is to describe the business developments regarding ITS, ERTMS and e-Navigation, with focus on:

- The services, information processes and information requirements related to traffic, transport and logistics that are in a development phase and are relevant to IWT.

- The related consequences for data and information needs

2.2 Tasks

Following tasks were identified in order to meet the objective of SuAc 2.5:

- Make an inventory of and study on ITS, ERTMS and e-Navigation and assess the consequences for the digital transition for IWT in the period 2022-2032.
  The party responsible for this is the SuAc leader DVW.

- Define the integral and harmonized service, information and data requirements related to the digital transition of Inland Waterways for each "development".
  The party responsible for this is the SuAc leader DVW.

- Draft intermediate report (study) on ITS, ERTMS and e-Navigation inventory, study and requirements in relation to the Masterplan Digitalization of Inland Waterways and provide conclusions and recommendations on the (*shared*) use of **services**, systems, applications and technologies in the different modalities.
  The party responsible for this is the SuAc leader DVW.

Remark:

Concerning rail, we'll not only describe the ERTMS (a safety related rail information system) but look more in general towards digitalization initiatives and services in the rail domain, as we will do for Maritime and Road.

2.3 Expected Results

Intermediate report (study) on ITS, ERTMS and e-Navigation inventory, study and requirements.

This report can be used by the other DIWA Activities to derive their scope and even their specific requirements for the next generation of Inland Waterway Transport Services in a synchromodal environment. See 3.3 "Interdependencies with other sub-activities" for more details.

3 Work approach

A work approach was needed to address the different tasks, including a timeline with workshops and clearly identified milestones. Each workshop that has taken place throughout the project is briefly explained, as well as a description of the results of that specific workshops. Also, the two different work approaches are described and an overview of the interdependencies with the other Sub-Activities is elaborated.

3.1 Timeline

	Oct 2021	Nov 2021	Dec 2021	Jan 2022	Feb 2022	Mar 2022
Kick-off	22					
Inventory by each		24				
Inventory review			21-22			
Draft report				27-28		
Feedback loop					24-25	
Finalizing report						14-15

Figure 1: Timeline Sub-Activity 2.5

The Sub-Activity had its first workshop the 22nd of October to make members familiar with the content of SuAc. 2.5. The agenda for this meeting was: an introduction (every member presented him- or herself and explained what triggered them to contribute to this Sub-Activity), a recap of Sub-Activity 2.5, definition of the scope, goals and means, approach and finally creation of a planning for the upcoming months (as can be seen in the table above).

On the 24th of November, the members of the Sub-Activity got together for a second workshop. As a preparation, every member focused on listing a set of features and business developments within their respective transport modalities. This in order to challenge the existing RIS features. Some interesting, in-depth discussions ensued during the workshop, especially for e-Navigation. In order to have an overview of all the features in the different transport modalities, an inventory table was created, based on the PIANC information categories and RIS functions table extended with functions of RIS COMEX.

The following month a 2-day workshop was organised. In this workshop, the members reviewed the table again, finetuning it further by adding new descriptive columns (e.g. type of data, impact of the service, post-on-after trip), discussing every service listed in detail and adding a legenda to give more information to the readers of the table. Furthermore, responsibilities for the drafting of the report were discussed.

In the workshop on the 27th of January, the inventory table was finalized so that all the input had been given by every modality and it only needed to be cleaned up afterwards. Additionally, a first overview of the draft report was created, which had to be worked out further from there on out. The result of the workshop was an action list, this list had to be executed before the next workshop.

The input of all members was put together into one overall draft report that was sent to the members for review. These reviews were handled during the workshop of the 24th of February, which resulted in a new action list for every member.

3.2 Work approach

There were 2 different work approaches :

- The ITS and ERTMS task owners used the existing table as inspiration and completed it with the services and functions they had identified. Afterwards, their findings were reflected in the report in a more detailed manner.

- The e-Navigation task owner started firstly with the desktop research on the different services already available in this transport mode. And hereafter analysed whether the different services could be applicable to RIS or not.

3.3 Interdependencies with other sub-activities

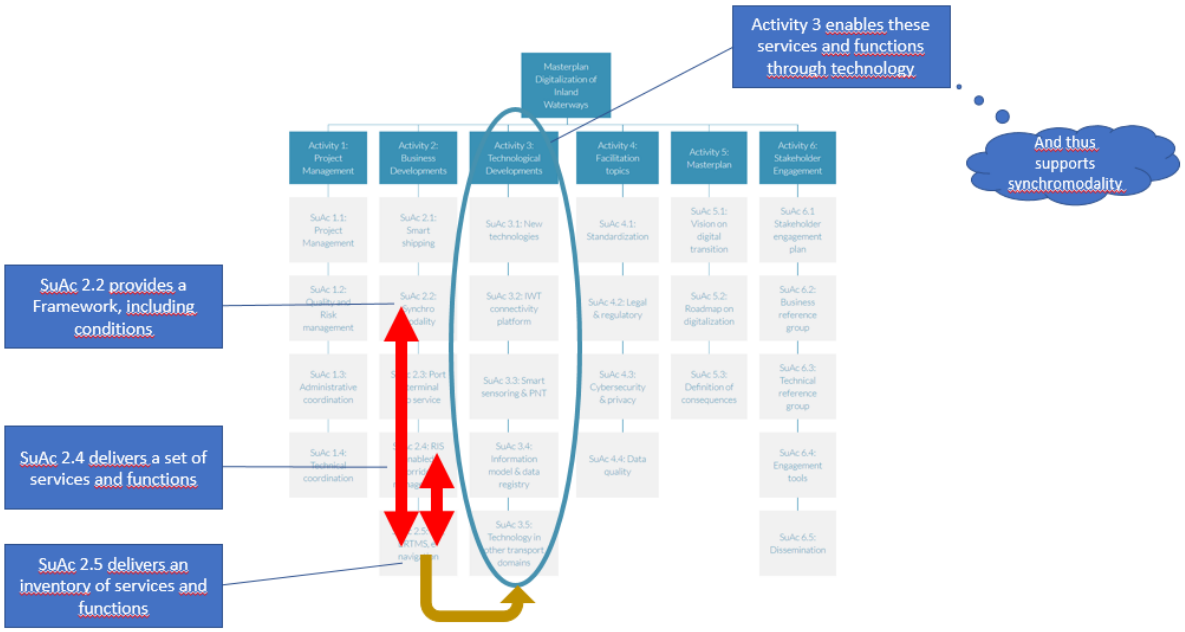


Figure 2: Interdependencies DIWA Sub-Activities

DIWA Sub-Activity 2.5 obviously has some strong interdependencies with the other sub-activities within Activity 2. The main ones being Sub-Activity 2.2 (Synchromodality) and Sub-Activity 2.4 (RIS enabled corridor management) (red arrows). The link with Sub-Activity 2.2 is that both these activities (2.2 and 2.5) are looking for ways how different transport modes are preparing themselves to become synchromodal-ready (cfr supra : description of synchromodality) and how Inland Waterway Transport can benefit from these digitalization initiatives. For Sub-Activity 2.4 there is a tight link in the sense that for the inventory table of SuAc 2.5, the main inspiration was RIS COMEX, which is a considerable part of SuAc 2.4. The EuRIS system is important in order to provide advanced fairway-, infrastructure- and traffic-related services in a single point of access on a pan-European level.

There is also a dependency towards Sub-Activity 3.5 where the output from 2.5 for 3.5 is how business developments in other transport domains (2.5) can be enabled of supported by (new) technologies in those domains (3.5) (and thus inspire IWT).

Furthermore, the interdependencies with all Sub-Activities from Activity 4 are always in one way: Business developments from SuAc 2.5 can potentially impact all SuAcs from Activity 4. The defined services from Activity 2 benefit from standardization, a well elaborated legal framework and need to be designed with respect of data quality, privacy and security (cfr Activity 4).

Finally, the last dependency to mention is the one with Activity 5, where Sub-Activity 2.5 (together with all other sub-activities within the DIWA Masterplan) delivers input to write the overarching report.

The specific descriptions of these interdependencies are elaborated based on the contents of chapter 4 – see chapter 8.2 “Detailed interaction with other sub-activities”.

4 Inventory on RIS, ITS, ERTMS and e-Navigation

During this project, an inventory of the various functions and services was drawn up. First a solid and familiar base for the inventory was installed. Then, for each transport mode, an insight into both the legal framework and the ambitions and principles is provided.

4.1 Table breakdown

The inventory table is based on the PIANC (Permanent International Association of Navigation Congresses) and extended with the RIS COMEX (RIS Corridor Management Execution) inventory tables. The combination of these two tables forms the backbone of the inventory table used for this report. It describes the services and information offered to the users of a transport modality, called functions. In order to make the table clear, it has been divided into first and second level information categories and functions.

An information category offers the possibility to classify all available functions according to these categories. There are 1st level and 2nd level categories, each with related 1st level or 2nd level functions. 2nd level functions contain the most detail and describe the information or services provided by other parties to the user.

The table is divided into 4 different 1st level information categories, further divided into 2nd level information categories:

- Fairway & Infrastructure related Information (1st level)
  - Fairway related Information (2nd level)
  - Land related Information (2nd level)
- Vessel related Information (1st level)
  - Dynamic Vessel Data (2nd level)
  - Hull related Data (2nd level)
  - Convoy Information (2nd level)
- Voyage and Cargo related Information (1st level)
  - Location related Information ((2nd level))
  - Cargo related Data (2nd level)
  - Passenger & Crew Information (2nd level)
- Traffic related Information (1st level)
  - Object related Information (2nd level)
  - Waterway Section related Information (2nd level)

Looking at columns G through J, referring to the inventory table Annex (1), represent each transport mode. The 'X's after the functions mean that the respective modalities offer the before mentioned services/information to their users.

Column L through N show some more characteristics of every function. In column L is mentioned whether an impact is applicable. This is interesting because most services only have a value, with the interpretation being on the receiver's side. In the case of impact, the source already provides a certain interpretation of the data. Therefore, the receiver knows the impact of that service without having to interpret the data. It is also possible to add more information to the impact about price/time/... which is rather important information.

In column M the frequency of update of the data is described (static, slow or fast moving). Filling in this column and thus complementing the inventory provides the opportunity to make a link to Activity 3. Depending on the type of service that has a particular need for data, a technology will be required. The complexity of the technology can then be determined based on this column.

And lastly in column N the P(re)-O(n)-A(fter) trip information is mentioned. This should strengthen the link to Sub-Activity 2.2.

The meaning of the letters used in these columns is explained in the tab "**Legenda**".

4.2 RIS

River information services (RIS) mean the harmonised information services to support traffic and transport management in inland navigation, including, wherever technically feasible, interfaces with other transport modes. RIS do not deal with internal commercial activities between one or more of the involved companies, but are open for interfacing with commercial activities. RIS comprise services such as fairway information, traffic information, traffic management, calamity abatement support, information for transport management, statistics and customs services and waterway charges and port dues.

4.2.1 Ambitions and principles of RIS

An operational service provides and uses information. It supports the user in accomplishing the task at hand.

RIS operational services are:

Fairway Information Services (FIS): contains geographical, hydrological and administrative information regarding the waterway infrastructure and fairways in the RIS area that is required by the RIS users to plan, execute and monitor a voyage. Fairway information is one-way information: shore to ship or shore to stakeholder's office.

Traffic Information Services (TIS) are the provision of information to support the safety and efficiency of traffic and navigation on inland waterways.

- ***Tactical traffic information (TTI)***

  TTI is the operational service affecting the skipper's or the VTS operator's immediate decisions with respect to navigation in the actual traffic situation and the close geographic surroundings. Tactical traffic information contains position and specific vessel information of all targets detected by a radar and presented on an electronic navigational chart, and enhanced by external traffic information, such as the information provided by AIS. TTI may be provided on board of a vessel or on shore, e.g. in a VTS.

- ***Strategic traffic information (STI)***

  Strategic Traffic Information is the operational service affecting the medium- and long-term decisions of RIS stakeholders. Strategic traffic information contributes to the planning decision capabilities regarding a safe and efficient voyage or transport. A strategic traffic image contains all relevant vessels in the RIS area with their characteristics, types of cargo and ship positions, stored in a database and presented in a table or on an electronic map.

Traffic Management Information (TM) is the operational service that supports traffic management processes in inland navigation:

- ***VTS – Vessel Traffic Services***

  Where VTS is a set of services implemented and provided in agreement with the IALA guidelines on Vessel Traffic Services for inland waterways. VTS is implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment.

- ***Lock and Bridge management***

  Lock and bridge management is the process of planning and operating bridges and locks.

- ***Traffic Planning Services***

  The information process for optimising the predictability and efficiency of the traffic flow on inland waterways.

Information to support Calamity Abatement (CAS) is the operational service that facilitates the actions necessary to limit the consequences of a calamity (or accidents and incidents).

Information to support Transport Logistics (ITL) is the operational service that supports transport logistic processes in inland navigation:

- ***Voyage planning***

  Voyage planning is the process of developing a complete detailed description of the journey of a vessel, from start to finish.

- ***Transport management***

  Transport management is the process of planning, organising and executing of the efficient movement of goods from one location to another.

- ***Port and terminal management***

  Port and terminal management is the process of planning, organising and executing the efficient ship and cargo handling in a port and terminal.

- ***Cargo and fleet management***

  Cargo and fleet management is the process of planning, organising and executing the efficient handling of cargo and vessels in a transport company.

Information to support Law Compliance (ILC) is the information that facilitates legal compliance for the waterway users and supports relevant agencies responsible for inland navigation law enforcement.

Statistics Information (ST) is the information on traffic and transport in inland navigation that is required to support statistical processes.

Information for Waterway Charges and Harbour Dues (WCD) is the information needed to facilitate the calculation and collection of waterway charges and harbour dues.

Mainly traffic-related

1. **Fairway information Services (FIS)**
2. **Traffic information Services (TIS)**
   a) Tactical traffic information (TTI)
   b) Strategic traffic information (STI)
3. **Information to support Traffic Management (TM)**
   a) Local traffic management (vessel traffic services - VTS)
   b) Lock and bridge management (LBM)
   c) Traffic Planning (TP)
4. **Information to support Calamity Abatement (CAS)**

Mainly transport-related

5. **Information to support Transport Logistics (ITL)**
   a) Voyage planning (VP)
   b) Transport management (TPM)
   c) Port and terminal management (PTM)
   d) Cargo and fleet management (CFM)
6. **Information to support Law Compliance (ILC)**
7. **Information to support Statistics (ST)**
8. **Information for Waterway Charges and Harbour Dues (CHD)**

Figure 3: RIS Services PIANC Guidelines

4.2.2 Legal Framework of RIS

River Information Services (RIS) is the concept whereby information services in inland navigation **support traffic and transport management** in inland navigation, **including interfaces with other modes of transport.**

Directive 2005/44/EC on harmonized river information services on the EU's inland waterways (hereinafter referred to as the RIS Directive) requires Member States to implement RIS according to certain standards. RIS is expected to improve safety, efficiency and the environmental friendliness of inland navigation. The EU has taken a global approach that encompasses policy development, a legal framework, support for research and development and monitoring of implementation of the legislation.

The RIS Directive refers to the four key technologies, now also known as the technical services: Inland Electronic Chart Display and Information System (Inland ECDIS), Notices to Skippers (NtS), Inland Automatic Identification System (AIS) or Vessel Tracking and Tracing (VTT) and Electronic Reporting International (ERI). These technologies are based on technical and operational standards which were initially defined and are continuously updated by the RIS Expert Groups. The RIS Directive demands Member States to implement RIS according to these standards. A major contribution to the standardization process has been the European Commission's adoption through technical regulations of standards for Inland ECDIS, NtS [1], VTT and ERI.

The RIS Directive was adopted in 2005 by the European Parliament and the Council on 7 September 2005. DG MOVE began an **evaluation** in January 2019 of whether the RIS Directive had achieved its objectives. On the basis of this evaluation, it will decide whether an impact assessment should be carried out with a view to a possible revision of the Directive.

The evaluation concluded that it was impossible to prove a genuine link of benefits with the implementation of the RIS Directive. In addition, the distinction between RIS technology and the RIS Directive was not always possible to maintain in order to conduct the analysis. It was not possible, or did not seem necessary to perform the SCBA (Social Cost Benefit Analysis) for all technologies separately, because from a user's perspective the RIS key technologies are considered to be integrated in one package (sold by companies who provide Inland ECDIS equipment). Furthermore, most Member States were not capable to deliver financial data for every key technology separately. As RIS is being further developed, more benefits will probably emerge.

General objective

To provide an efficient and effective framework for the deployment and use of harmonised river information services in the Union. This framework is to support inland waterway transport, with a view to boost its uptake, enhance safety, efficiency and environmental friendliness, to reduce negative externalities, including through modal shift, and to facilitate interfaces with other transport modes.

Specific objectives of the initiative:

1) To address new policy needs: to ensure
   a) an optimal integration of inland waterway transport into **multimodal logistics**,
   b) **resilience to shocks**, and
   c) to **reduce** negative **externalities** and **minimise** environmental **costs**;
2) To ensure the effective provision of relevant information by Member States to IWT users, enabling the sector to fully benefit from information for voyage planning, as well as efficient and safe navigation;
3) To ensure the efficiency and effectiveness of the processes and organisation design, that lead to the adoption of RIS technical specifications, enabling the sector to take up innovation in a timely way;
4) To minimise cross-border inefficiencies due to differences in Member States' legal reporting obligations;
5) To ensure IWT users' privacy and data protection needs are met by transport- and traffic-related information sharing;

6) To ensure targeted and efficient monitoring, enabling enforcement when needed and evidence-based policymaking

Policy measures

The policy options will be assessed against the baseline scenario (no change to the Directive). The policy options will bundle policy measures addressing the specific objectives. Types of measures considered include:

- Linking to new initiatives, e.g. European Mobility Dataspace and corridor information systems emerging from Digital Transport and Logistics Forum to better integrate IWT into multimodal value chains. (Obj. 1)
- Clarifying RIS Directive provisions on implementation of technical specifications (e.g. on data for navigation and planning) and provision of RIS by Member States. This could include, introduction of metrics (e.g. quality parameters on availability, accuracy) and additional technical specifications. (Obj.2)
- Involving CESNI in governance and processes for adoption of technical specifications; (Obj. 3)
- Clearer provisions on obligations of Member States to receive and forward information of ships in cross border operation.(Obj. 4), take into account the impact of Regulations under elaboration, like eFTI.
- Continue to comply to existing rules on privacy, security and re-use of information, adding new rules if needed. (Obj. 5). The policy options will be completed in the course of the impact assessment and will take into account the results of the stakeholder consultations.

Outcome of the RIS COMEX project

Within the COMEX project a governance has been established by means of an agreement (i.e. ECMA or Eurorpean Corridor Management Agreement) to keep EuRIS operational. The EuRIS system will be the fundamental building block to make IWT synchromodal ready.

The latest legal framework of RIS concerning the technical specifications that define the structure of four messages for electronic ship reporting in inland navigation.

- Commission Implementing Regulation (EU) 2019/1744 of 17 September 2019 on technical specifications for **electronic ship reporting** in inland navigation and repealing Regulation (EU) No 164/2010

- Commission Regulation (EU) No 164/2010 of 25 January 2010 on the technical specifications for **electronic ship reporting** in inland navigation referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

Following legal framework, as mentioned in the regulations below, is about Notices to Skippers (NtS) that use Fairway Information Services (FIS) which contain geographical, hydrological and administrative data that are used by skippers and fleet managers to plan, execute and monitor a trip. FIS provide dynamic information (e.g. water levels, water level predictions etc.) as well as static information (e.g. regular operating times of locks and bridges) regarding the use and status of the inland waterway infrastructure, and thereby **support tactical and strategic navigation decisions**. The ECDIS systems uses these FIS data. The legal work concerning the ECDIS systems is also listed below. VTT systems are also part of this.

- Commission Implementing Regulation (EU) 2018/2032 of 20 November 2018 amending Commission Regulation (EC) No 416/2007 concerning the technical specifications for **Notices to Skippers**

- Commission Regulation (EC) No 416/2007 of 22 March 2007 concerning the technical specifications for **Notices to Skippers** as referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

- Commission Implementing Regulation (EU) 2018/1973 of 7 December 2018 amending Implementing Regulation (EU) No 909/2013 on the technical specifications for the electronic chart display and information system for inland navigation **(Inland ECDIS)** referred to in Directive 2005/44/EC of the European Parliament and of the Council

- Commission Implementing Regulation (EU) No 909/2013 of 10 September 2013 on the technical specifications for the electronic chart display and information system for inland navigation **(Inland ECDIS)** referred to in Directive 2005/44/EC of the European Parliament and of the Council

- Commission Implementing Regulation (EU) 2019/838 of 20 February 2019 on technical specifications for **vessel tracking and tracing** systems and repealing Regulation (EC) No 415/2007

- Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the technical specifications for **vessel tracking and tracing** systems referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

- Commission Regulation (EC) No 414/2007 of 13 March 2007 concerning the technical guidelines for **the planning, implementation and operational use** of river information services (RIS) referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

4.3 ITS

Intelligent Transport Systems (ITS) are vital to increase safety and tackle Europe's growing emission and congestion problems. They can make transport safer, more efficient and more sustainable by applying various information and communication technologies to all modes of passenger and freight transport on roads. Today we see many applications in the field of ITS also under the more holistic umbrella of Smart Mobility. This includes also modalities such as public transport or bikes.

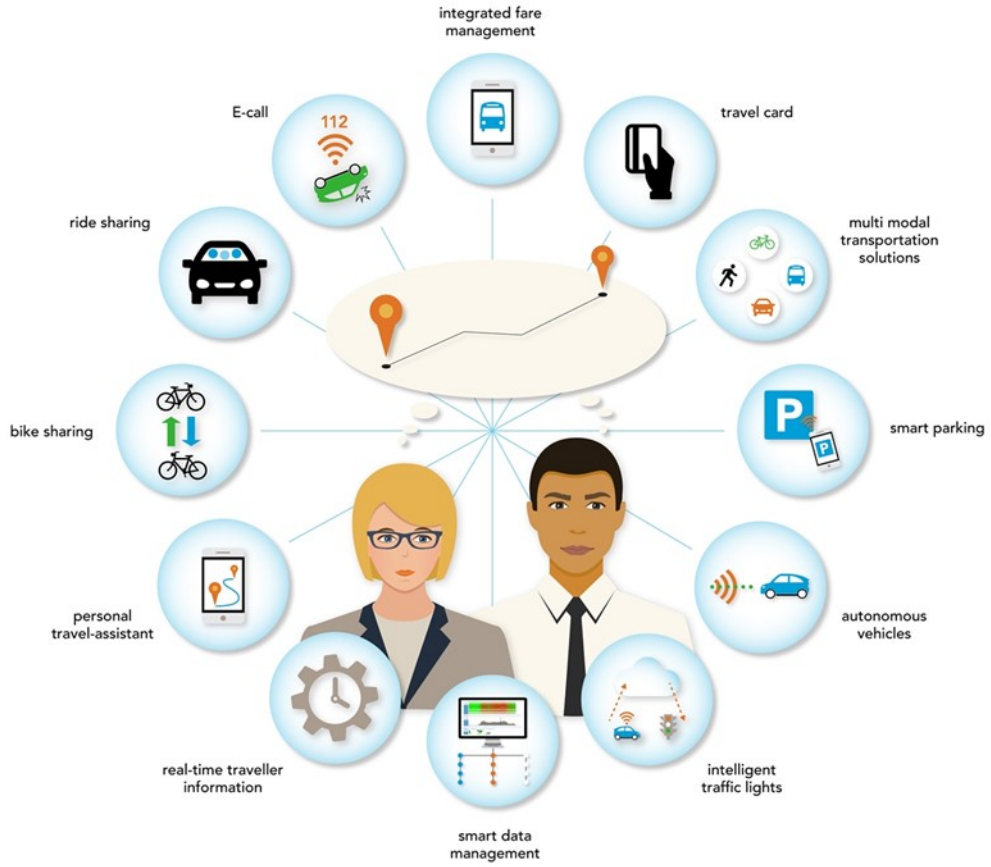


Figure 4: Smart Mobility according to Royal Haskoning (source: Royal Haskoning)

4.3.1 Ambitions and principles of ITS

ITS may be observed from various viewpoints. It can be seen from a technical point of view, from an organisational point of view, from a standardisation point of view or from a legislative point of view and maybe many other viewpoints.

The main goal however is the smooth implementation of use cases to introduce innovations on the road. Therefore, technical developments, standardisation, organisation and legislation play all an important role in achieving a successful introduction of ITS.

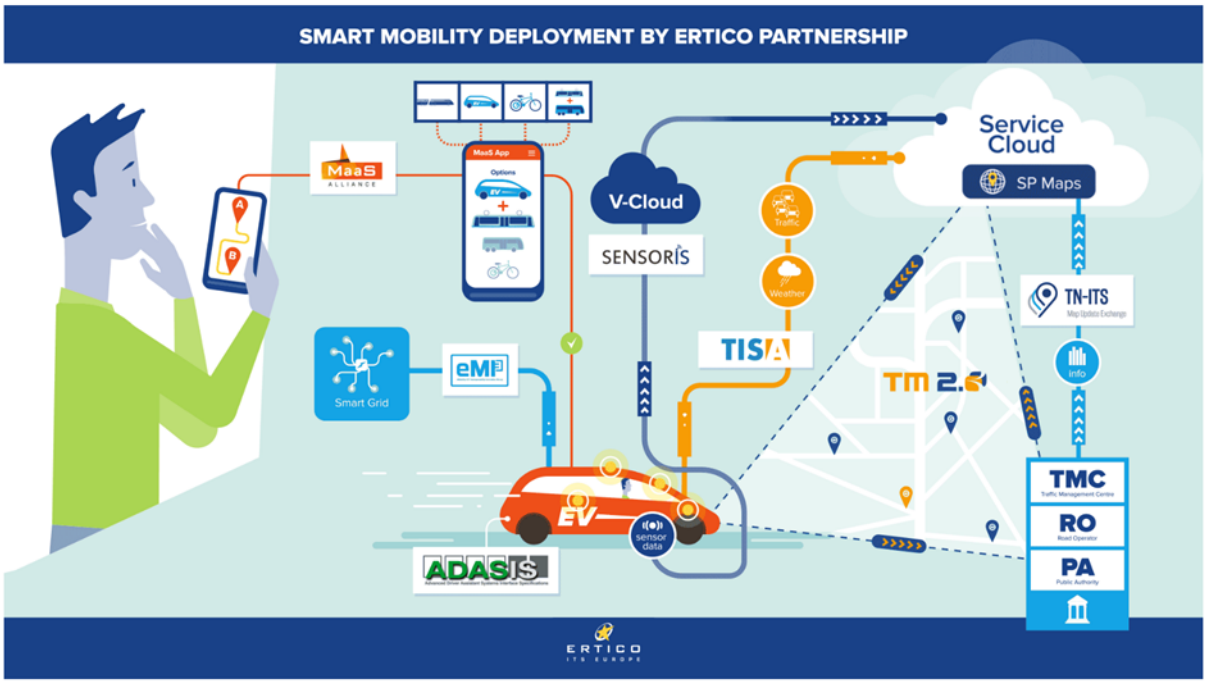


Figure 5: ITS according to Ertico (source: Ertico)

Technically a large number of ITS applications are available or under development. However, many of these applications are in a trial phase. The European Commission introduced safety related use cases which are mandatory in a few years.

Road safety-related traffic data are in the point of view of the European Commission essential for the provision of road safety-related minimum universal traffic information. They are collected and stored by public and/or private operators and service providers. In order for these data to be made easily available for exchange and reuse for the provision of information services, public and/or private road operators and service providers should make them accessible through individual access points or make sure that they are accessible through national access points set up and managed by the Member States. These national access points can take the form of a repository, registry, web portal or similar.

The events or conditions covered by the road safety-related minimum universal traffic information service shall consist of at least one of the following categories:
(a) temporary slippery road;
(b) animal, people, obstacles, debris on the road;
(c) unprotected accident area;
(d) short-term road works;
(e) reduced visibility;
(f) wrong-way driver;
(g) unmanaged blockage of a road;
(h) exceptional weather conditions.

In the first phase, the use cases will be implemented on the major networks. The European Commission indicated to implement the uses cases first on the TEN-T network. Extension to the complete network is only a question of time, since data is mostly available for all roads and communication is only limited to the coverage of the mobile communication networks.

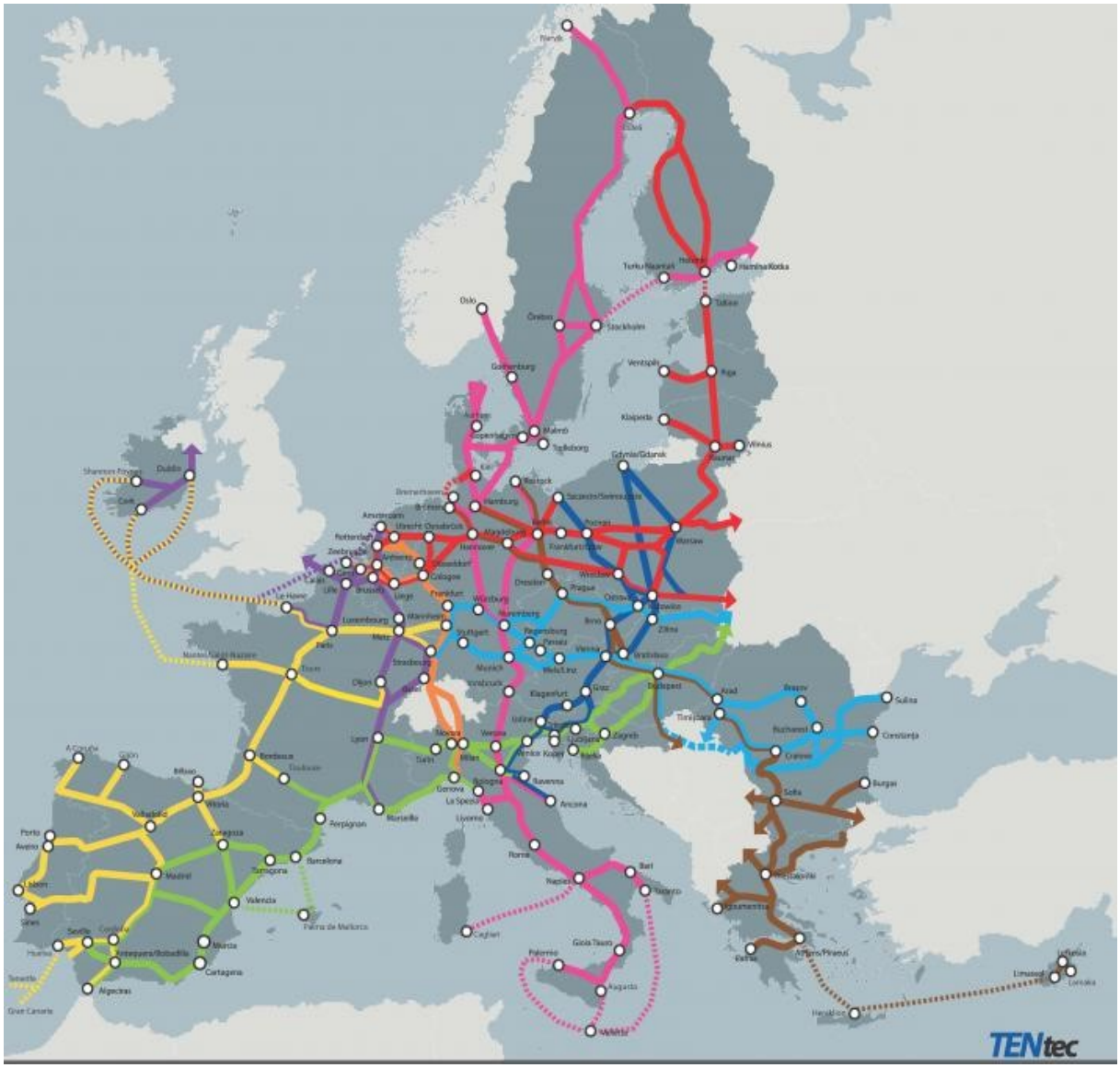


Figure 6: TEN-T network (source: European Commission

4.3.2 Legal Framework of ITS

Speaking of a legal framework, it is mostly referenced to legislation. For ITS this is only part of the governance. Many stakeholders are involved. Talking about legislation in Europe this is limited to the European Commission and national legislation of member states. But it is not only legislation. Also standards are important. Sometimes standards are referred to in legislation but mostly standards are developed independently and are not mandatory but are very practical to implement. Also some legal aspects are found in international agreements from the United Nations.

It is not easy to describe a top-down governance on the legal framework of ITS. There are many interdependencies without a clear and well defined governance. But in practice, all stakeholders are aware of their position and cooperate constructively.

ITS developments are mostly regional. Roughly the world is divided in three sectors: the Americas, Asia and Europe. In Europe, the European Commission is the leading organisation in legislation and in guiding the direction of (technological) developments. Implementation is carried out by member states. Also a part of legislation must be implemented on a country level. The most important legal document in the context of ITS in Europe is the ITS Directive 2010/40/EU. And the Delegated Regulation 886/2013 of 15 May 2013

supplementing Directive 2010/40/EU This directive and delegated regulation aims at the provision of real-time traffic information and emergency services, such as e-call. The content of the directive must be implemented by member states in national legislation.

Only a limited number of regulations are developed worldwide. The United Nations Economic Commission for Europe (UNECE) is one of the most important with regard to vehicle legislation with impact in ITS. The most important agreement dates from March 20, 1958, in short , the agreement on type approval. This legislation states that the driver should always be in command of his car. This regulation is a hindrance in developing self-driving features in a car. An amendment on this legislation is foreseen in the near future.

For the exchange of information the use of standards is promoted. In the field of ITS, the standards are set by organisations such as ISO, CEN, ETSI, IEEE, ITU and others. Many of these standardisation organisations have dedicated ITS programmes. A fee may be required to make use of these standards. Standards are sometimes referred to in legislation but more often open to market uptake.

Also worth to mention is one of the implementation projects, co-funded by the European Commission. The project C-Roads is maybe the most important to mention at this time (C in C-roads stands for connected). Use cases are developed bottom-up, based on the requirements of Road Operators across Europe (see figure below). Only the safety related use cases are based on legislation.

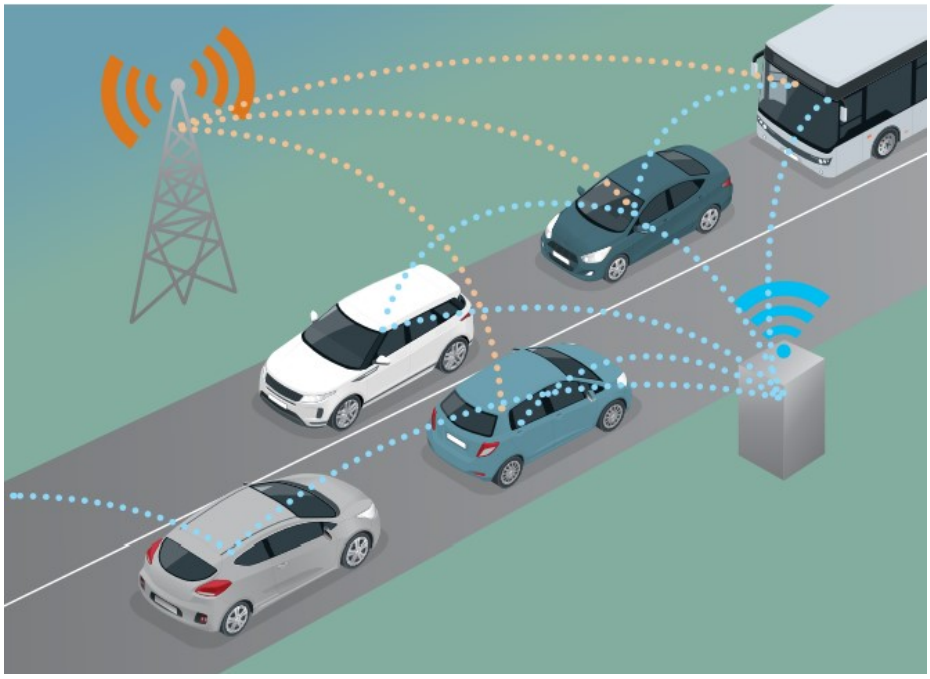


Figure 7: The general principle of C-ITS, according to C-Roads (source: C-Roads)

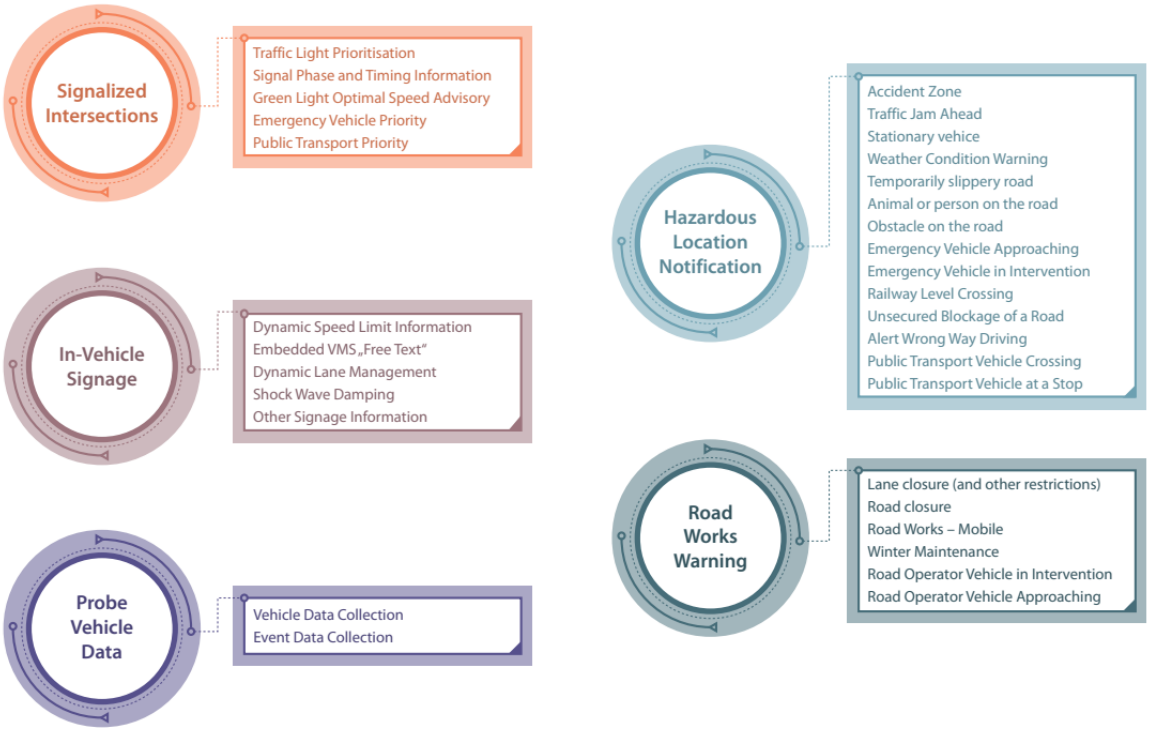


Figure 8: C-Roads Use Cases (source: C-Roads)

4.4 ERTMS

The European Rail Traffic Management System (ERTMS) is a single railway system for European countries. It provides a standardised signalling and speed control system. The ERTMS is essential for the further digitalisation of the rail transport, to overcome fragmentation of the railway systems implied by different national signalling and train management systems.
The two integral technical parts of ERTMS are the European Train Control System (ETCS) and the Global System for Mobile communications for Railways (GSM-R).

The objective of ERTMS is to introduce a single harmonised train control and protection system (Control, Command, Signalling and Communication system) that enables cross-border train traffic without the use of further national systems. It ensures the interoperability of the European railway systems and reduces costs as well as increases the efficiency of the infrastructure and a high level of railway safety in rail transport. Overall, it shall improve the competitive position of the railway sector.

Over the years, ERTMS has already been adopted by many countries on other continents and is increasingly emerging as the global signalling standard. Many large ERTMS contracts already have been awarded in Asia, Middle East, Africa, Australia, Middle and South America.

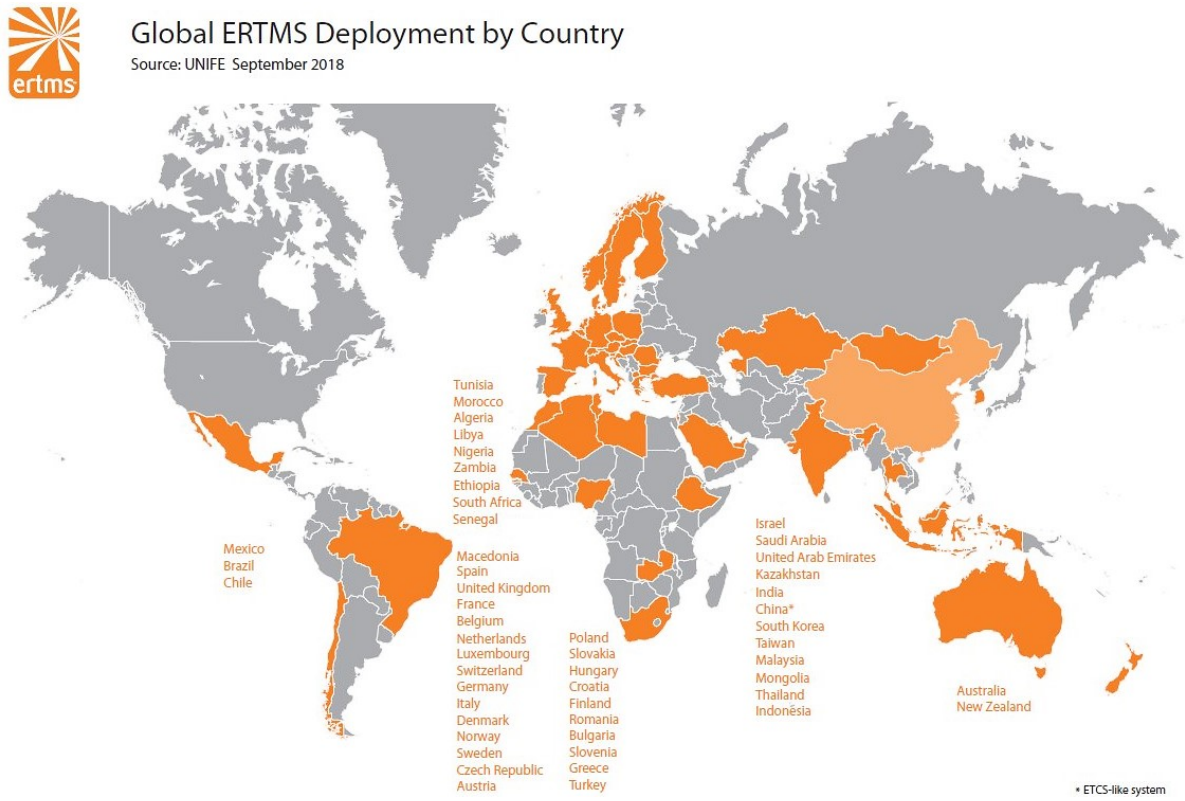


Figure 9: World map of deployment of ERTMS; Source: www.ertms.net (Twitter page)

It is a major asset for the European rail industry in the global railway market. In the year 2018, already more than 100.000 km of ERTMS equipped railway tracks were contracted in 51 countries all over the world as well as more than 16.000 vehicles were equipped with on-board units. The number of tracks put into operation is constantly increasing.

4.4.1 Ambitions and principles of ERTMS

The European Union Agency for Railways (ERA), as the system authority, ensures the synchronous development of the ERTMS within the countries of the European Union and maintains, monitors and manages the requirements of the subsystems.

The ERTMS consists of two technical parts, the ETCS and the GSM-R. ETCS is a train control standard using in-cab equipment to supervise train movements and continuously monitor the train speed. The system can initiate an emergency brake, if the driver does not react according to the traffic rules. GSM-R is the communications standard for railway operations. It provides a communication system for the drivers and signallers. It also provides the data communication for ETCS.
The ERTMS contains different ETCS levels, from 0 to 3. If a train with ETCS equipment is on a route without a train control system or the train is not connected to the ETCS, this is referred to as level 0. The other levels can be described as follows:

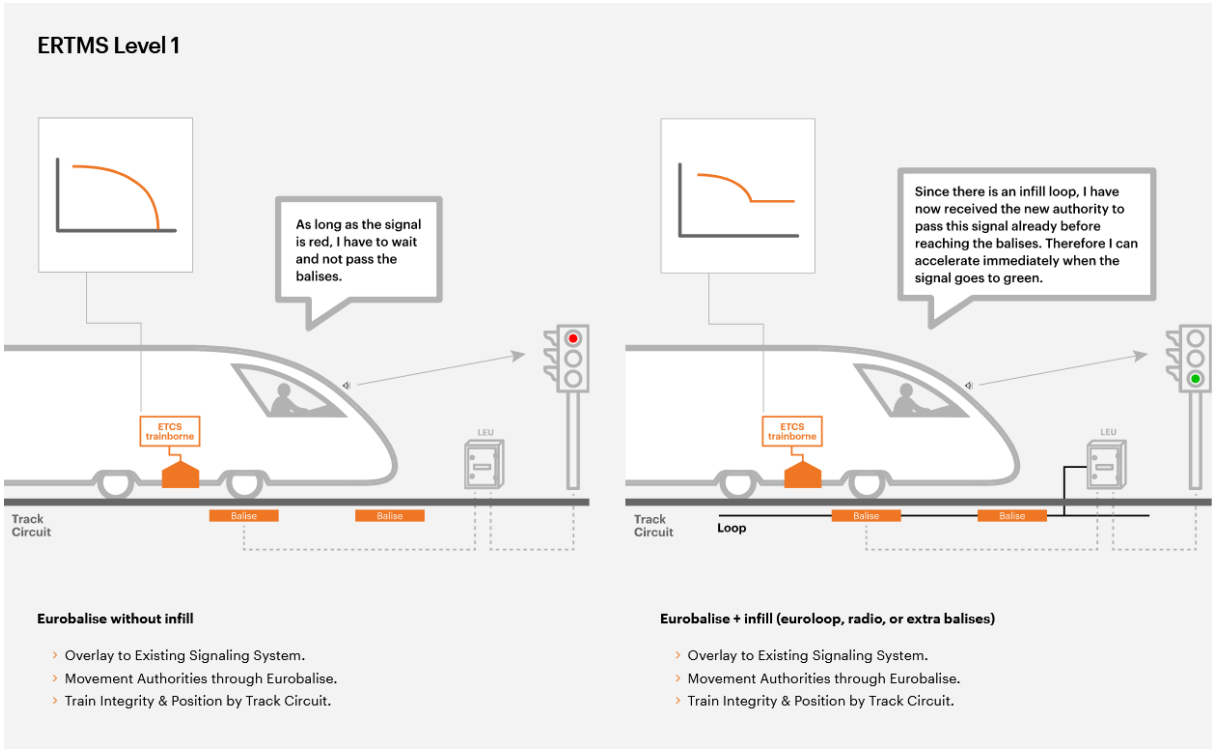


Figure 10: Level 1 of ETCS; Source: https://www.ertms.net/about-ertms/ertms-signaling-levels/

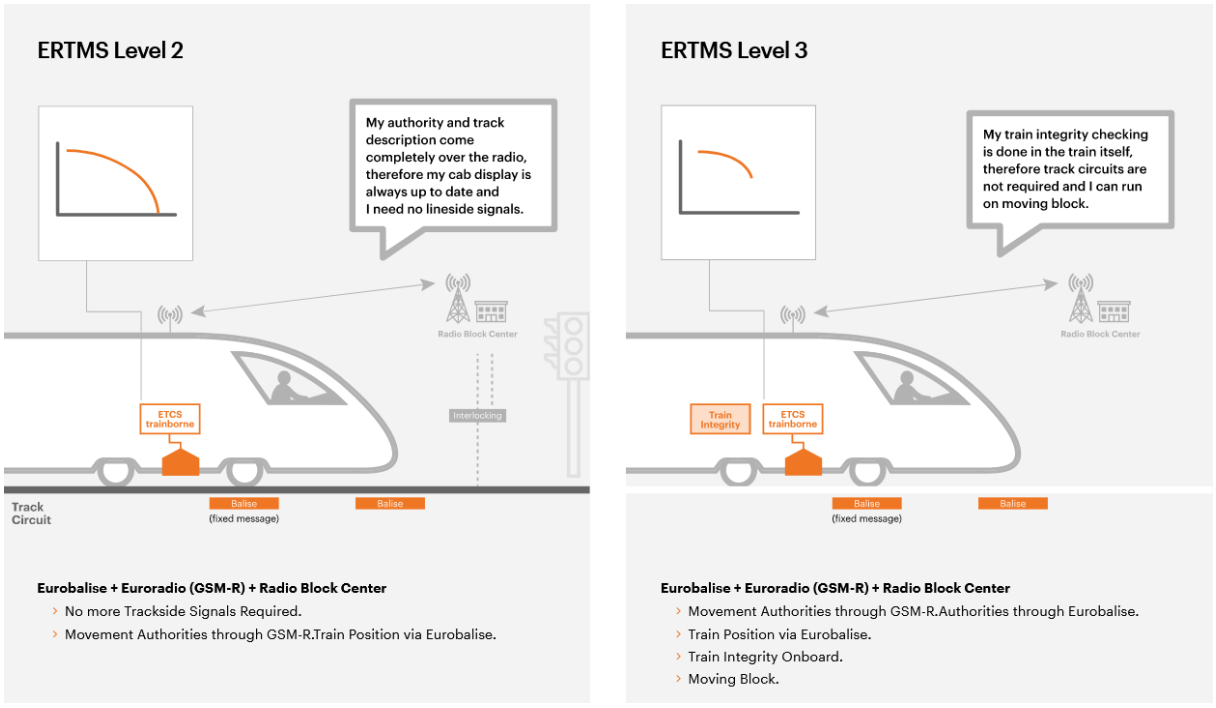


Figure 11: Level 2 and 3 of ETCS; Source: https://www.ertms.net/about-ertms/ertms-signaling-levels/

In accordance to the Directive (EU) 2016/797 (interoperability of the rail system) several Technical Specification for Interoperability (TSI) were created. The specifications provide the requirements to be met. Each subsystem is covered by at least one TSI. Fixed subsystems and vehicles have to comply with the applicable TSI and national rules before they are put into operation. The conformity of fixed subsystems and vehicles is permanently monitored and maintained while they are in use.

As described in the Directive (EU) 2016/797 the railway system is subdivided into following subsystems:

a) Structural areas:
   - Infrastructure
   - Energy
   - Trackside control-command and signalling
   - On-board control-command and signalling
   - Rolling stock

b) Functional areas:
   - Operation and **traffic management**
   - Maintenance
   - **Telematics applications for passenger and freight services**

The subsystems relevant here are the trackside and on-board control-command and signalling as well as the telematics applications.

The Commission Regulation (EU) 2016/919 defines the technical specification for the interoperability of 'control-command and signalling' (CCS TSI). The operation of ETCS needs the implementation of trackside equipment and standardised controlling equipment in the train cab. The trackside information can thus be sent wirelessly to the driver's cab, eliminating the need for trackside signals to be monitored by the driver. This creates the basis for automatic train operation. The exchange of information from the track to the vehicle aims to increase the safety of train traffic.
The GSM-R (Global System for Mobile Communications - Rail) is the digital mobile radio system for the wireless data transmission. For this purpose, the widely used GSM mobile radio standard was adapted for use on the railways. It is the successor system to many incompatible analogue radio systems.
The Directive (EU) 2016/797 covers the 'telematics applications' of the rail system, including applications for passenger and freight services. The Commission Regulation (EU) No 1305/2014 specially defines the technical specification for the interoperability of 'telematics applications for freight subsystems' (TAF TSI). The specification applies for the trans-European rail system network. **This specification sets the technical framework for an efficient interchange of information. It deals with applications for freight services and also the interconnections with other transport modes.**
As described in the Regulation the freight service applications include real-time information of train and freight, marshalling and allocation systems, reservation, payment and invoicing systems, management of connections with other modes of transport and production of electronic accompanying documents.
The minimum requirements ensure the quality of service of the freight services, especially the technical compatibility in the European rail network. The requirements mainly refer to the databases, software and data communication aiming to allow a maximum data interchange between applications and an easy access to information for users.

Trains whose route crosses several national railway systems ideally need a single point to receive all important information. The Regulation (EU) No 913/2010 addresses the development of international rail corridors to improve to competitiveness of the freight transport on the European rail network by defining rules for the organisation and management of freight corridors.
To coordinate and allocate the available infrastructure capacity on the European rail network at time of request, a one-stop shop for the international rail freight is needed.
The association RailNetEurope (RNE), a body for the coordination of the individual infrastructure managers, is acting as this so-called 'one-stop shop' by coordinating, harmonising, developing and offering several services to international railway undertakings. RNE supports their members regarding compliance with EU legal framework and also supports providers of Rail Freight Corridors.

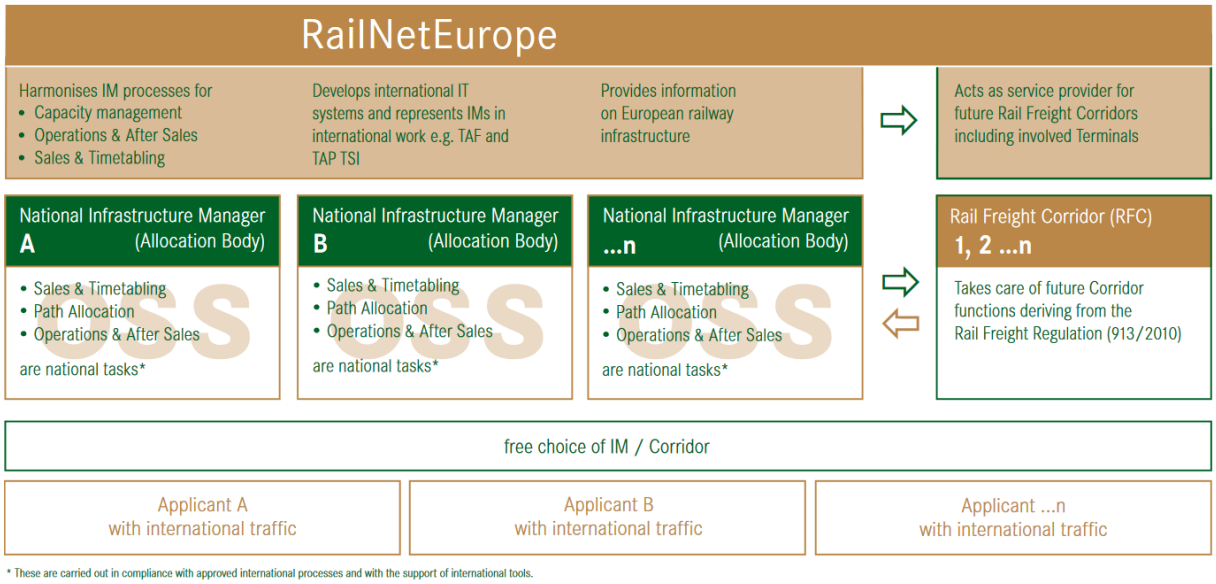
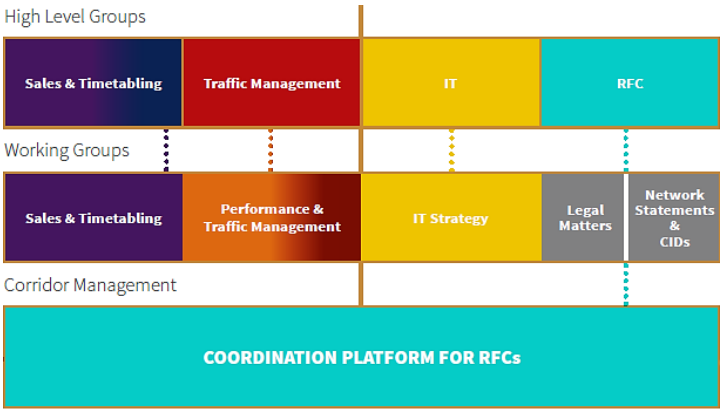


Figure 12: General objective of Rail Net Europe; Source: RNE Annual Report 2011

Currently, the RNE counts over 34 members from 25 different countries. It has their joint office in Vienna, which is also responsible for administration, finances and communication. The association coordinates several international working groups, which are dealing with following business areas:



- Sales & Timetabling
- Traffic & Train Performance Management
- Rail Freight Corridors
- Network Statement & Corridor
- Information Document
- Legal Matters
- Temporary Capacity Restrictions

Figure 13: Segment of RNE Structure; Source: RNE Annual Report 2018

The High Level Groups were set up in the areas of Rail Freight Corridors, IT, Sales& Timetabling and Traffic Management. These groups have to provide input into RNE strategy, give proposals for new projects and induce the implementation of project results.
The RFC coordination platform enables a stronger harmonisation of the implementation approaches of the Rail Freight Corridor organisations and a harmonisation of development of processes and tools. In this way the platform supports the infrastructure managers and allocations bodies, which are part of multiple rail freight corridors.

The offered services of RailNetEurope are described below:

4.4.1.1 Train Information system (TIS)

As a result of the Implementation of Regulation (EU) No 1305/2014 about telematics applications (TAF/TAP TSI), the web-based train information system is used to support the international train management by simplifying the coordination of international railway traffic and logistic chains. The data is directly provided by the infrastructure manager's systems and the information about the trains on the European railway network is shared and displayed in the application in real-time. The data sharing enables the linking of individual nationally ordered trains to an international train.

The system provides further information about the train operation. It uses the gathered data to calculates and displays the **'Estimated time of arrival' (ETA).** In the future this function is using Big Data to make the predictions more accurate.

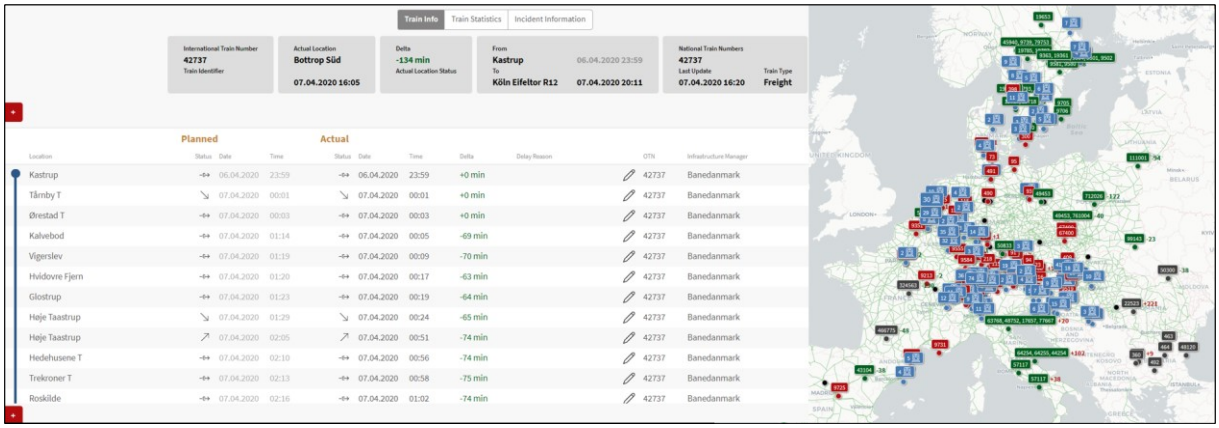


Figure 14: Overview of the web-based Train Information System; Source: tis.rne.eu

The 'Incident management tool' (IMT, formerly 'Park and Run tool') is used to make the dispatching of freight trains easier in case of capacity restrictions between several dispatching centres. The trains, affected by an interruption, automatically gets notified and the information also made visible to all users. It improves the usage of path capacity by minimising the track occupation in bottlenecks, decreases the time for border processes and optimises the allocation of resources (time, financial means, vehicles).
Another tool for rail traffic management, integrated in TIS, is the 'TCCCom'. It was developed to facilitate the communication between dispatching centres, especially in case of incidents and interruptions. It is a messaging tool, which provides the exchange of pre-defined messages and automatic translation of messages to overcome communication problems due to different languages.

In addition, the train composition message (TCM, a subset of the HERMES 30 message) has been introduced in passenger and freight transport to exchange relevant train information between railway companies in Europe. The message has to be sent from the railway company to the next one, describing the composition of the train (locomotive, wagons). It gets exchanged internally between all the parties involved in the train journey. Every change of the train composition has to be updated and reported to the lead railway company, which is organising and managing the journey of the train and distributing this change to the other parties. The message contains elements for identification of the rolling stock, technical data, assessment of compatibility with the infrastructure, assessment of relevant loading characteristics, brake relevant characteristics and maintenance data (e.g. date and time, sender, recipient, operational train number, scheduled time at handover, train type, train weight, train length, brake type, number of vehicles, type of locomotive, wagon position, wagon total load weight, wagon weight empty).
Other messages, exchanged internally between railway companies, are for example the 'Path request message', 'Train ready message', 'Train running forecast message', 'Train running information message', 'Train running interruption message', 'Train delay cause message' and 'Wagon ETI/ETA message' (ETI = Estimated time of interchange; more detailed description in chapter 4.4.1.7.3 Wagon and Intermodal Unit Operational Database).

The information about the cargo in the wagons of a train can be exchanged between freight railway undertakings and infrastructure managers within the 'HERMES 30 message' (or H30 message). The transfer of information happens via the 'Hermes Virtual Private Network (VPN)' of 'Hit Rail'. The messaging and communication protocols of the network provide soft compliance (= is actually not a legal requirement) with the Technical Specifications for Interoperability of Telematics Applications for Freight services (TAF-TSI).
In comparison to the 'Train composition message', the 'HERMES 30 message' provides further additional relevant information, such as consignment data CIM/CUV, wagon load, transport data for intermodal units, load specials (wagon) incl. customs and actual operational wagon data.

With the aim of improving the performance of international operating trains regarding mainly in punctuality, the RNE started a platform for 'Train Performance Management' for cooperation and coordination between the infrastructure managers and the rail freight corridors. The designed 'RFC TPM guidelines' were created in accordance to the Regulation (EU) No 913/2010 for rail freight transport on the European railway network. The guidelines are describing the processes for train performance quality management and help implementing measures and key performance indicators to monitor the train performance on the rail freight corridors. The reports about the performance supports the improvement of punctuality.

4.4.1.2 Customer Information Platform (CIP)

The Customer Information Platform is an interactive multi-corridor information tool, including the rail freight corridors. Some infrastructure managers even wanted to integrate their entire railway network into this platform. The information on railway infrastructure of the corridors in 26 European countries offers precise data on the routing, re-routing options, track properties, terminals, and infrastructure investment projects.

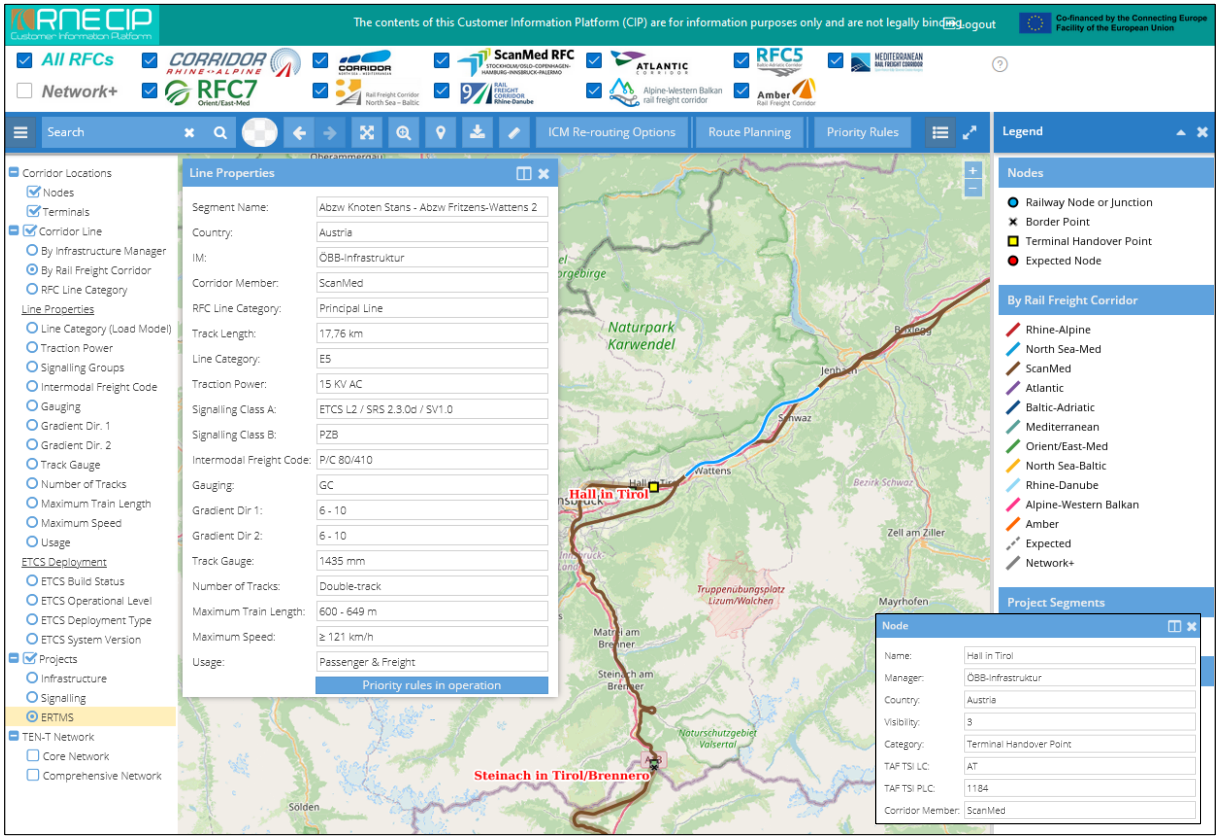


Figure 15: Graphical user interface of the 'Customer Information platform' (CIP) and an example of terminal information (at bottom right) - Source: cip.rne.eu

The Corridor Information Documents (CID) are made available on the CIP. According to the Regulation (EU) No 913/2010, these documents contain all necessary information on the conditions of the use of the corridors, like a description of the corridor, the governing entities of the corridor, information on the rail infrastructure as well as commercial and legal access conditions. The CID got harmonised to provide documents to the users within a common structure, where the same information has the same level of detail and is placed on the same spot in every document. The CID have to be published at least three months before the deadline for requesting timetable capacity.

The rail sector of course aims to maintain the continuity of traffic flow at the highest possible level, even if unexpected interruptions or incidents occur. For this purpose, the CIP provides the handbook 'International contingency management' (ICM), which describes the standards for the processes to manage disruptions as well as the processes of communication in the coordination of international traffic. The ICM defines the required international cooperation in case of interruptions and further describes the processes how to recognise and when to declare disruptions. It provides the necessary harmonised rules to operate the 'Incident management tool' (IMT) of the 'Traffic Information System' (TIS) and assures transparency of the status of the traffic flow of international rail traffic.

4.4.1.3 Path Coordination System (PCS)

In the European rail network, railway undertakings must submit a request for the cross-border use of a train path. The Path Coordination System (PCS) is a platform to coordinate and harmonise the path requests and the offers from the involved parties. It allows railway undertakings to make only one request to a system for international operating trains.
The PCS, which is free of charge for users, provides a standardised workflow for all types of path requests, like ad-hoc path request, path request or late path request and also makes the international timetable data available to users. As a consequence, there are decreased dwell times at the borders for trains on international paths.

Figure 16: Scheme of functional structure of PCS

The system is according to the Regulation (EU) No 913/2010 and the TAF-TSI. It is an important step in the creation of an international rail market, specially regrading to freight transport. The PCS acts as a quick and secure communication tool between path applicants, infrastructure managers/allocation bodies and the Corridor-One-Stop-Shop (C-OSS). It helps the C-OSS in performing the capacity allocation tasks on the corridors by providing a path request and path allocation process, which can be evaluated by Regulatory Bodies.

The C-OSS is a joint body established by the Rail Freight Corridor (RFC) organisations where users can get information about infrastructure capacity for international freight trains crossing at least one border along the freight Corridor. The C-OSS publishes 'Pre-arranged paths' (PaPs) and manages path requests and offers for PaPs as well as coordinates Reserve Capacity (RC).
A PaP is defined as a pre-constructed path on rail freight corridors and is in accordance with Regulation (EU) No 913/2010. A PaP can be offered either for an entire corridor or only for a section to form an international path request. PaPs are intended to ensure the best possible use of available capacity and more efficient processing of international path requests. C-OSS uses PaPs to display the capacity offered to freight customers on RFC corridors.
The RCs are jointly determined residual capacities for international freight trains. This reserve is made available in the final timetables of the infrastructure managers in order to allow a quick response to ad hoc capacity requests. Every RC is based on PaPs and is a collection of multiple sections along a corridor. A RC can be provided as a contingent of "capacity slots" per day/section (flexible approach) or as predefined sections in case of remaining capacities.
The C-OSS accepts RC from railway undertakings, shippers, freight forwarders and combines transport operators. All requests have to be submitted via the web application PCS.
In order to provide high-quality path offers, the 'Temporary Capacity Restrictions' (TCRs) have to be considered as well. The maintenance works, for keeping the infrastructure and its equipment in good condition, have to be properly coordinated. The negative capacities caused by the TCRs must be taken into account and shall allow to find other paths if necessary. The PCS enables the coordination of TCRs and the timely publication on the European railway network.

Aiming to reach a satisfactory level of harmonisation of timetabling procedures to facilitate the cooperation at international level, RailNetEurope (RNE) and Forum Train Europe (FTE) agreed to change the timetabling procedure. With the support of the European Rail Freight Association (ERFA) they launched the 'Redesign of the international Timetabling Process' (TTR). The full rollout of TTR shall take place in December 2024.

4.4.1.4 Rail Facilities Portal (RFP)

The Rail Facilities Portal is a common European web portal that provides information on many different rail facilities. It is a platform for facility operators, like freight terminals, marshalling yards, maintenance facilities, fuelling stations, ports, etc. The operators can use it to publish information about their facility. The RFP is also a single source of information for shippers, railway undertakings, combined-transport operators and other logistic service providers providing them available facilities for the planning for their services and logistic chains. On the portal they can get information where to load and unload the freight, a so-called "first and last mile information".

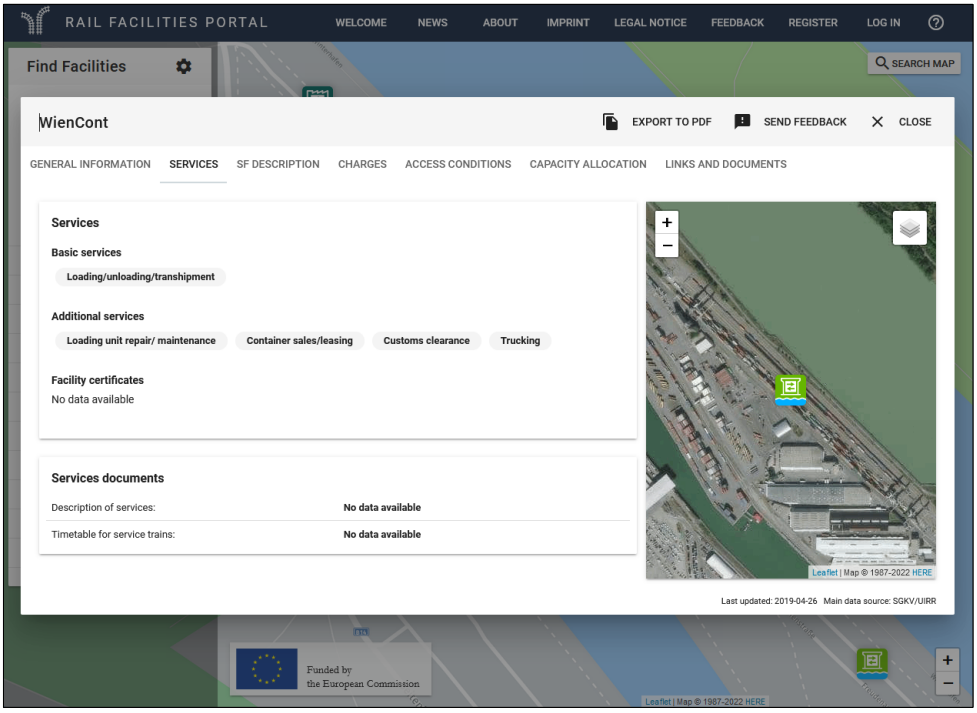


Figure 17: Example of provided information of a rail facility; Source: railfacilitiesportal.eu

Initially the European Commission (DG MOVE) took the initiative to set-up a portal to provide information on many types of facilities. In June 2020, RNE took over the ownership of the RFP from the European Commission. From then on, the RNE and UIRR (International Union for Road-Rail Combined Transport) jointly operate the portal. The RFP is in accordance with the Directive 2012/34/EU and Implementing Regulation (EU) 2017/2177.
Some service facilities can contain 'Operational Points', which technically describe stations, junctions, sidings, etc. These points are stored in the Register of Infrastructure (RINF; see chapter of 'Supporting services'), making the register very important for the facilities portal.

4.4.1.5 Charging Information System (CIS)

The Charging Information System is a web-based application providing information on charges of the train paths. The infrastructure managers, allocation bodies and other parties have the possibility to

calculate the costs for the usage of the European rail network before the start of the international train journey.

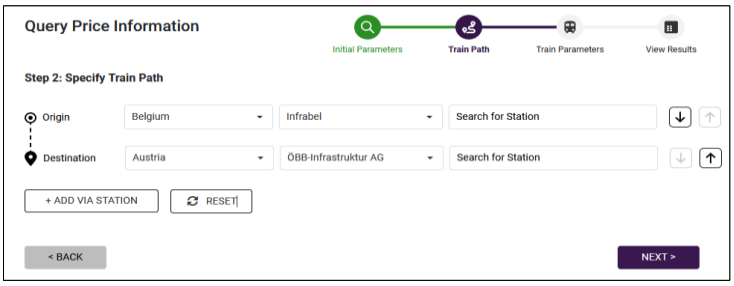


Figure 18: Calculation procedure of charge estimate; Source: cis-online.rne.eu/cis

The system gets data from 26 infrastructure managers. The CIS also allows the calculation of charge estimates for shunting and the station use and prices in the next timetable period.

4.4.1.6 Network and Corridor Information Portal (NCI)

The portal provides access to latest published information about 'Network Statements' and 'Corridor Information Documents' (CID). The NCI is a single point for all available infrastructure data. It offers a search function for the various contents. This data gets regularly updated by the infrastructure managers/ allocation body's and the organisations of the RFCs.

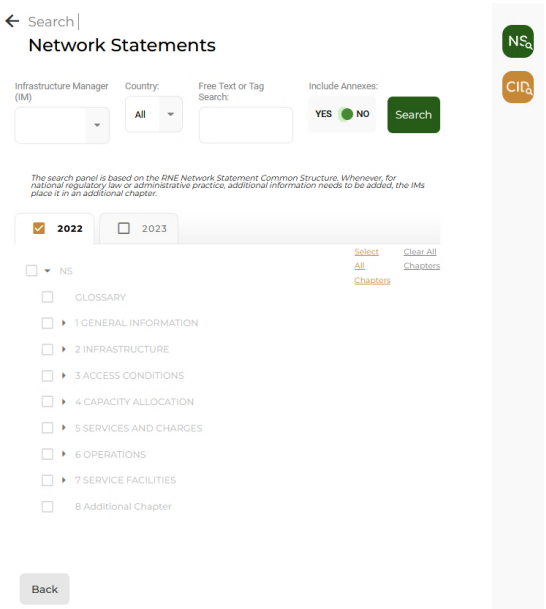


Figure 19: Search for Network Statements in the NCI; Source: nci-online.rne.eu

According to the Directive 2012/34/EU the infrastructure managers have to publish the 'Network statements'. These statements are the key to the market access and describe all the requirements the users have to know in order to make requests for infrastructure capacity, in particular the commercial, technical and legal access conditions. The harmonisation of the statements was driven by RNE and allows users to find the same information in the same place in each document. The CID are also accessible on the 'Customer Information Platform' and are available here again with the additional functions of the portal.
The working group at RNE responsible for this data has harmonised terms and the wordings used in the 'Network statements' and CIDs.

4.4.1.7 Supporting services

4.4.1.7.1 European Vehicle Register (EVR)

The keepers of rail vehicles have to register their rolling stock and subsequently continue to keep the data up to date. The register enables traceability of vehicles and the history. The EVR is a web-based tool for the keepers to register the vehicles at a single point. It also manages the allocation of vehicle numbers. The harmonised registration procedure is administered at national level.
The EVR is available since November 2021 and can be used by all relevant stakeholders. It is in accordance with Directive (EU) 2016/797 and the specifications in Commission Implementing Decision (EU) 2018/1614. The respective member states retain responsibility for fees and charges for the registration as well as for the ensuring of quality and integrity of the vehicle data.

4.4.1.7.2 Rolling Stock Reference Database (RSRD)

The operation of freight trains on the European rail network is heavily dependent on infrastructure data ('Network Statements', restriction notices) and rolling stock data. The data of infrastructure together with the data of the rolling stock allow an assessment of the compatibility of the vehicles with the infrastructure. The information of the rolling stocks is stored in the 'Rolling Stock Reference Databases' (RSRD) and in the 'Wagon and Intermodal Unit Operational Database' (WIMO).
The keeper of a rolling stock is responsible for the entry of the data in the database. The following items are saved in the RSRD:

- Identification of rolling stock
- Assessment of the compatibility with the infrastructure
- Assessment of relevant loading characteristics
- Brake relevant characteristics
- Maintenance data
- Environmental characteristics
- Administrative data (registration in home countries and in others, EC certification, safety certifications not complying with Rolling stock TSI)

4.4.1.7.3 Wagon and Intermodal Unit Operational Database (WIMO)

The WIMO provides the information needed for operational purposes and for tracking of wagons and intermodal units on the trans-European rail system network and other parts of the network. The TAF TSI (Technical Specification for Interoperability relating to Telematics Applications for Freight Services) required the implementation of the WIMO for the freight transport on the European rail network.
The data in the database has to be updated at every relevant event in real-time, to enable the tracking and tracing of the wagons or the movements of intermodal loading units (ILU).
In the database is data stored like movement of a wagon and of an ILU from departure to final delivery at customers sidings. It further contains the 'Estimated times of interchange' (ETIs) and actual times at different locations, the final delivery time (ETA) and the different status of the rolling stock. The status information of the rolling stock can be as follows:

- Loading of the rolling stock
- Loaded wagon on journey
- Empty wagon on journey
- Unloading of rolling stock
- Temporary wagon speed restrictions

The keepers, railway undertakings, fleet managers, etc need these data for their operation. However, the WIMO does not store the train movement.

The ETA (Estimated time of arrival) is calculated to know when a train will arrive at a certain point. This helps railway undertakings to better plan the trip and possibly adjust it on the way. Nevertheless, not all wagons have necessarily the same journey as the train. Therefore, in some cases they may

need a different planning. The ETAs of a train can have a relevance for some wagons or ILUs at certain stops on the journey. For the wagons or ILUs which are leaving the train before the end station the **ETI** (Estimated time of interchange) has to be calculated. The wagons of a train may have different interchange points and therefore sometimes need their own ETI calculations. This information is important for the railway undertaking leading the trip to monitor the physical transport of a consignment and to check it against the commitment to the customer. The currently transporting RU has to provide the ETI for the wagons and/or intermodal units for the interchange points or other defined reporting points to the next RU in the transport chain by use of 'Wagon ETI/ETA message'. The RU receiving the ETA/ETI information processes this information, stores it as a wagon movement in the WIMO and sends it to the LRU. The last RU in the transport chain has to update the ETA of the wagons at the final destination and sends it to the LRU. The information on ETA/ETI is provided by the responsible infrastructure manager, who submits within the 'Train Running Forecast message' the ETA for the defined reporting points on the contracted path.
The reporting of interchange describes the transfer of responsibility for a wagon or ILU between two RUs, which occurs at interchange points. The information of these messages gets stored in the WIMO.

4.4.1.7.4 Wagon Trip Plan Databases

The trains can be composed of wagons from different customers. The responsible company of the train (LRU, lead railway undertaking) has to create and update a trip plan for each wagon. The trip plan has to be compliant with the train path at train level. Any service interruption may need the usage of different paths, which lead to revised trip plans for specific wagons. The trip plan is created upon receipt of the consignment note form the customer. The 'Wagon Trip Plans' have to be stored in a corresponding database of the LRU. The database is accessible via a common interface.

4.4.1.7.5 Register for Infrastructure (RINF)

The RINF is essential for describing the static rail network characteristics and capabilities and provides information about all the possible routes across the network to the railway undertakings.

The register consists of a centralised database maintained by the ERA and saves:
- 'Operational Points' (OP)
- 'Section of Lines' (SoL)

The OP can represent stations, junctions, sidings, etc., whereas the SoL are linking these points and describe the characteristics of tracks. Finally, these items allow to model the whole European rail network. The railway undertakings need to know all possible routes across the network to find the best route and to check the 'Route Compatibility'.
The infrastructure managers have built their railway lines and fully know the characteristics of them. Therefore, they regularly and directly submit and update the data describing their infrastructure to the RINF application since 2021.

The RINF is using information of the 'Central Reference File Database' (CRD). The CRD is also a centralised database which stores 'Location Codes' and 'Company Codes'. It provides the unique identifiers for the facilities where a train can operate. There are unique identifiers for stations / terminal / shunting yards etc. and any other predefined place that a train can use regularly. This database is providing following information:
- List of Countries
- Location Reference File, which uniquely identifies physical rail points (Location Code for e.g. stations, customer sidings, loading places)
- Partner Reference File, which uniquely identifies all rail actors who exchange information (Company Codes)

4.4.1.7.6 Infrastructure Restriction Notice Database (IRNDB)

The infrastructure managers have to store and update all restrictions or temporary restrictions on its network in the IRNDB. Each infrastructure manager of the European railway network has its own database. It helps to provide this real-time information to railway undertakings immediately. The knowledge and awareness of restriction is very relevant for the operation of trains on the contracted paths.

4.4.2 Legal Framework of ERTMS

The European Rail Traffic Management System (ERTMS) enables a single railway area with a harmonised railway system and also standardised information exchange. It provides a European control and protection system and allows user-friendly international train traffic.
In the year 2005, the European Commission and representatives of the railway sector agreed to the development and implementation of ERTMS on important routes of the European rail network, especially on the freight corridors.
The establishment of the Single European railway area is defined in the Directive 2012/34/EU. This Directive provides rules for the management of railway infrastructure and for rail transport activities, issuing an amendment of licenses by the Member states as well as principles and procedures of railway infrastructure charges and allocation of infrastructure capacity.
The deployment of a European rail network creates a new international rail market, especially for freight transport. This requires common rules for the organisation of the international rail corridors. The rules for the selection, organisation, management and indicative investment planning of freight corridors are defined in the Regulation No 913/2010 and shall apply to the management and use of railway infrastructure included in freight corridors.
The Regulation 1315/2013 provides guidelines for the development of the trans-European transport network. The trans-European transport network contains transport infrastructure, measures promoting the efficient management and use of such infrastructure, telematic application as well as measures permitting the establishment and operation of sustainable and efficient transport services. The infrastructure of the trans-European transport network consists of the infrastructure for railway transport, inland waterway transport, road transport, maritime transport, air transport and multimodal transport. The Regulation also identifies projects of common interest and sets the requirements which have to be complied for the operation of the network. Moreover, it provides measures for the implementation and further development of the trans-European transport network.

- DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area
- REGULATION (EU) No 913/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 concerning a European rail network for competitive freight
- Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU

The European Union Agency for Railways (ERA, prior: European Railway Agency) was established to promote the creation of a single European railway area. The Agency Regulation 2016/796 defines the role and tasks of the ERA and the tasks of the Member States to support the establishment of a European railway system. The ERA ensures an interoperable European Rail Traffic Management System as well as maintains and manages the specifications and helps implementing the system. The Agency is also allowed to issue single safety certificates and vehicle (type) authorisations.

- REGULATION (EU) 2016/796 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the European Union Agency for Railways and repealing Regulation (EC) No 881/2004

The Commission Implementing Regulation (EU) 2017/6 describes the timetable for the deployment of ERTMS in the Member states and the core network corridors (see Annex 1 of the Regulation). A vehicle equipped with ERTMS gets gradually access to an increasing number of lines, ports, terminals and marshalling yards. In specific, the core network corridors need to be equipped. A coordinated cross-border deployment is important for the railway companies' business cases as well. Therefore, the

infrastructure managers signed an agreement to ensure a synchronised deployment with harmonised technical solutions.
The Directive (EU) 2016/797 on the interoperability of the rail system within the European Union defines the conditions of the national rail system to be met to achieve interoperability within the Union rail system. The technical harmonisation includes the conditions concerning the construction, upgrading, operation and maintenance of the system as well as the qualification and safety conditions applying to the employees who are responsible for these activities.
The Directive (EU) 2016/798 on railway safety provides and ensures the uniform development and improvement of the safety level of the European Union rail system. It harmonises the regulations in the Member states and defines responsibilities between the users and aims to remove the need of national rules. In order to do this, common safety targets and methods are applied. In line with this goal, there is also a need for a certification of train drivers within the EU rail system (see Directive 2007/59/EC).

- COMMISSION IMPLEMENTING REGULATION (EU) 2017/6 of 5 January 2017 on the European Rail Traffic Management System European deployment plan
- DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the European Union
- DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety

The EU Agency for Railways the ERA cooperates, among others, with RailNetEurope (RNE), a European association of rail infrastructure companies and authorities. RNE was established in the year 2004 to harmonise conditions in European railway transport. RNE provides assistance in complying with the European regulatory framework. Their main goals are to support the railway transport, facilitate the access to the railway network, improve the quality of international railway services and improve the efficiency of operational processes. Most of RNE's work is done in permanent working groups and project teams. RNE is cooperating with other European bodies to build consensus on issues of common interest. Especially in the field of TAF/TAP TSIs (Technical Specification for Interoperability relating to Telematics Applications for Freight/Passenger Services) is a close collaboration with the ERA. The TAF/TAP TSIs define the common data exchange and business processes between individual infrastructure managers or infrastructure managers and railway undertakings.

In further regulation the technical specifications are defined in more detail. The Regulation 2016/919 addresses the interoperability regarding the control-command and signalling subsystems of the rail systems. It shall apply to all new, upgraded or renewed systems and excludes the already existing systems. The Regulation 1299/2014 addresses the interoperability of the infrastructure subsystems (e.g. tracks, switches, crossings. platforms, safety and environment, fixed installations for servicing trains, etc.) of the European rail network. It shall apply to new railway lines since 2015 and upgraded or renewed infrastructure. It does not apply to infrastructures already in place before 2015.
The Regulation 1305/2014 deals with the interoperability related to telematics applications for railway freight subsystems. These subsystems comprise the applications for freight subsystems like real-time information systems of trains and freight, marshalling and allocation systems, management of connections with other modes of transport, etc. (defined in Directive 2016/797, Annex II 2.6b).

- COMMISSION REGULATION (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union
- COMMISSION REGULATION (EU) No 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union
- COMMISSION REGULATION (EU) No 1305/2014 of 11 December 2014 on the technical specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union and repealing the Regulation (EC) No 62/2006

The ERTMS is as well a safety management system on the European railway network and helps to achieve the common safety targets. This safety management system includes, among others, staff training programmes and concepts to ensure that staff competence is maintained. The Directive

2016/798 specify the need for railway undertakings of safety certificate in order to gain access to the railway infrastructure and the European railway network for international rail freight services.
The Directive 2007/59 describes the certification of train drivers on the international railway network. It lays down the conditions and procedures for the certification and specifies the tasks for which the competent authorities of the Member States, train drivers and other stakeholders in the sector, in particular railway undertakings, infrastructure managers and training centres, are responsible. The Directive applies to train drivers and railway undertakings who require a safety certificate as well as infrastructure managers who require a safety authorisation.
There are also procedures and criteria to be followed to be allowed to use the services at the facilities. These are described in the Regulation 2017/2177 (services are listed in Directive 2012/34, Annex II).
Each member state has to report statistics regarding rail transport on its national territory. In the Regulation 2018/643 are common rules for the production of statistics at Union level. A railway undertaking shall provide data separately for each country in which it operates to enable national statistics to be compiled.

- DIRECTIVE 2007/59/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the certification of train drivers operating locomotives and trains on the railway system in the Community
- COMMISSION IMPLEMENTING REGULATION (EU) 2017/2177 of 22 November 2017 on access to service facilities and rail-related services
- REGULATION (EU) 2018/643 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 April 2018 on rail transport statistics

On 29 November 2021 the ERA and UIC, the worldwide railway organisation, have signed a coordination framework. The International Union of Railways (French: Union internationale des chemins de fer, UIC) is an international federation of railway undertakings. Members are divided into active, associate and affiliate members according to size and activity. The association was founded on 17 October 1922 in Paris. It had 51 founding members from 29 countries, including China and Japan. The aim is to improve the conditions of construction and operation of railways for international traffic through standardisation.

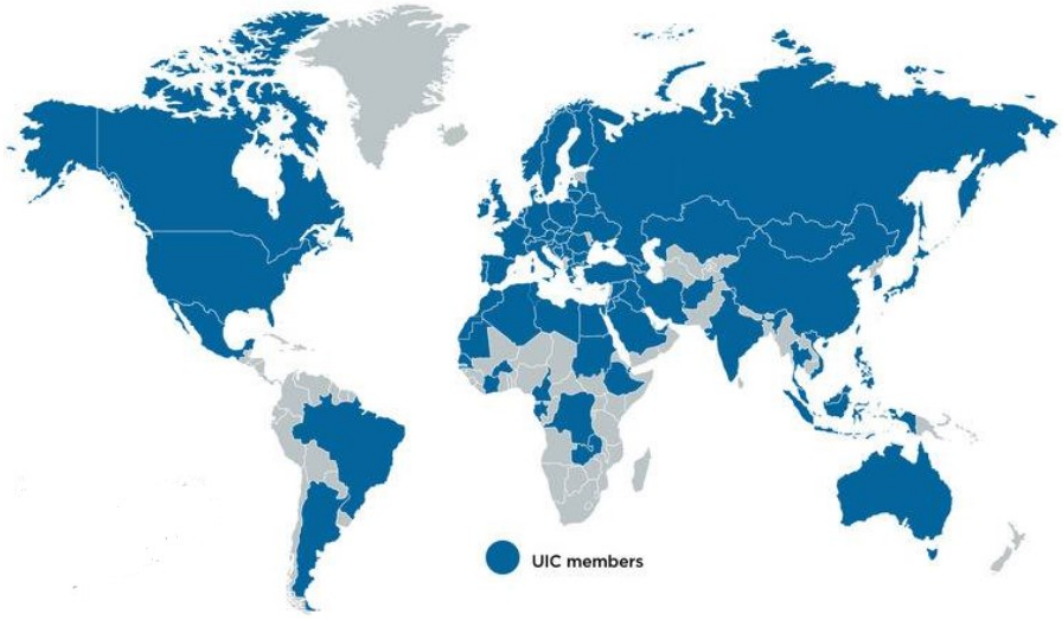


Figure 20: Members of UIC

The coordination framework will be used as an umbrella for topics of common interest, like annexes to Technical Specifications for Interoperability (TSIs) such as GSM-R, FRMCS (Future Railway Mobile Communication System), safety and operations, human and organisational factors, etc. The cooperation also on a global level is crucial for the rail sector and a great help to create an attractive offer for rail customers.

On April 2019 the ERA and the German Federal Railway Authority (EBA) have signed a cooperation agreement. Since June 2019, the ERA is the single railway authority in Europe being responsible for issuing authorisations for the placing on the market of railway vehicles and vehicle types, for issuing single safety certificates for railway undertakings in the European Union and for granting ERTMS trackside approval. The authorities concluded how they will cooperate in issuing single safety certificates, vehicle and vehicle type authorisations. With the implementation of the 4th Railway Package (the "technical pillar" includes the Regulation 2016/796, Directive 2016/797 and Directive 2016/798) these tasks have been assigned differently. Now EBA assists the agency in carrying out the new task. The Agency signed more cooperation agreements with the other National Safety Authorities of the Single European Railway Area prior to taking up its new responsibilities.

The UIRR (French: Union internationale pour le transport combiné Rail-Route; English: International Union for Road-Rail combined transport) is a partner organisation of the UIC. It is participating in various project regarding rail market liberalisation, modal shift, emissions reduction and environmental issues. The organisation was founded in Munich by 8 intermodal transport companies in the year 1970 and has now 19 members. The liaison office is based in Brussels. Today, the UIRR already consists of 41 member companies in 17 European countries (CT operators and CT terminals).
UIRR is

- the officially recognised Representative Body of rail freight customers at the European Railway Agency
- the Administrator of the ILU-Code

The objective of the UIRR is to promote combined (freight) transport, especially the combination of road and rail. By now, more than 50% of the tonne-kilometres in rail freight transport can be ascribed to combined transport.
The road sector has a large share of the freight transport market, but it also struggles with congestion, accidents, environmental damage, etc. The combined transport rapidly come to be perceived as the best alternative given that its advantages to a great extent combat the disadvantages attributable to road transport.
As a support to CT, the EU policy can include direct or indirect support measures (e.g. liberalisation of rail transport). As a consequence, the liberalisation can contribute to an increase in the market shares of both rail and road-rail CT, enabling the various players to offer their customers the best quality services at a more competitive price.

4.5 e-Navigation

On a very high level, e-Navigation is about improving safety and efficiency of shipping by changing from conventional transmission methods to contemporary digital technologies. This entails setting up new globally harmonized services and technologies for shore-to-ship, ship-to-ship, ship-to-shore and shore-to-shore information exchange.

4.5.1 Ambitions and principles of e-Navigation

e-Navigation is currently working hard on fleshing out the Maritime Services (which correspond to the IWT Operational services).

The initial descriptions of Maritime Services in the context of e-Navigation (IMO MS.1/Circ.1610) defines 16 Maritime Services:

- MS 1. Vessel Traffic Services – Information Services
- MS 2. VTS - Navigational Assistance Services
- MS 3. VTS - Traffic Organization Services
- MS 4. Port Support Service
- MS 5. Maritime Safety Information Service
- MS 6. Pilotage Service
- MS 7. Tug Service
- MS 8. Vessel Shore Reporting Service
- MS 9. Telemedical Assistance Service
- MS 10. Maritime Assistance Service
- MS 11. Nautical Chart Service
- MS 12. Nautical Publications Service
- MS 13. Ice Navigation Service
- MS 14. Meteorological Information Service
- MS 15. Real-time Hydrographic and Environmental Information Service
- MS 16. Search and Rescue Service

It should be noted that this list is still subject to change, in particular in the light of the publication of IMO A.1158 'Guidelines on Vessel Traffic Services' and the initiatives of IALA concerning the Maritime Services.

Contrary to the IWT approach in Europe where one of the tasks of CESNI is currently taking up all the standardization work in ES-RIS, for e-Navigation the standardization work is taken up by different bodies like IMO, IHO, IALA, and IEC, each focusing on a specific subset of the technical services. IMO does, however, maintain responsibility for the governance of e-Navigation.

When considering the current status of the Maritime Services, the Maritime Services, MS5 – Maritime Safety Information is by far the most mature service, with all exchanged information already digitized. MS8 - Vessel Shore Reporting Service (and specifically the technical service on Route Information Exchange) also seems quite mature, with S-421 recently published.
The VTS services MS1-3 are currently the focal point of the community with a lot of changes going on, and in particular the replacement of the old Resolution A.857(20), Guidelines Vessel Traffic Services (1997) by the new Resolution A.1158(32), Guidelines for Vessel Traffic Services (2021).

Fout! Verwijzingsbron niet gevonden. Figure 21 below shows the overarching e-Navigation architecture. It gives a clear overview of the on-vessel and on-shore interaction with Operational services, and how the required data is transmitted via Technical Services.

If we compare this overarching e-Navigation architecture to the overarching architecture for RIS (in the same format) from **Fout! Verwijzingsbron niet gevonden.** 22, we can see that there are many similarities. The overall structure is the same, but there are some differences. For RIS, only a limited number of Shore-based authorities have full access to the Common technical shore-based RIS system (top right). Many parties, like hydrographical offices and some inland port authorities, have to use the

interfaces for the different shore based stakeholders (bottom right). Additionally, in RIS many of the Services are also available via websites (like EuRIS, vaarweginformatie, Danube Portal, VisuRIS, … but also BICS, CEERIS), which can complement the on-board equipment. In X the usage of these websites via a laptop, desktop, smartphone, … falls under the Human-Machine-Interfaces of the Shipboard technical equipment supporting RIS. This is also the reason why the Data Structure is not limited to ES-RIS but also contains Open APIs.

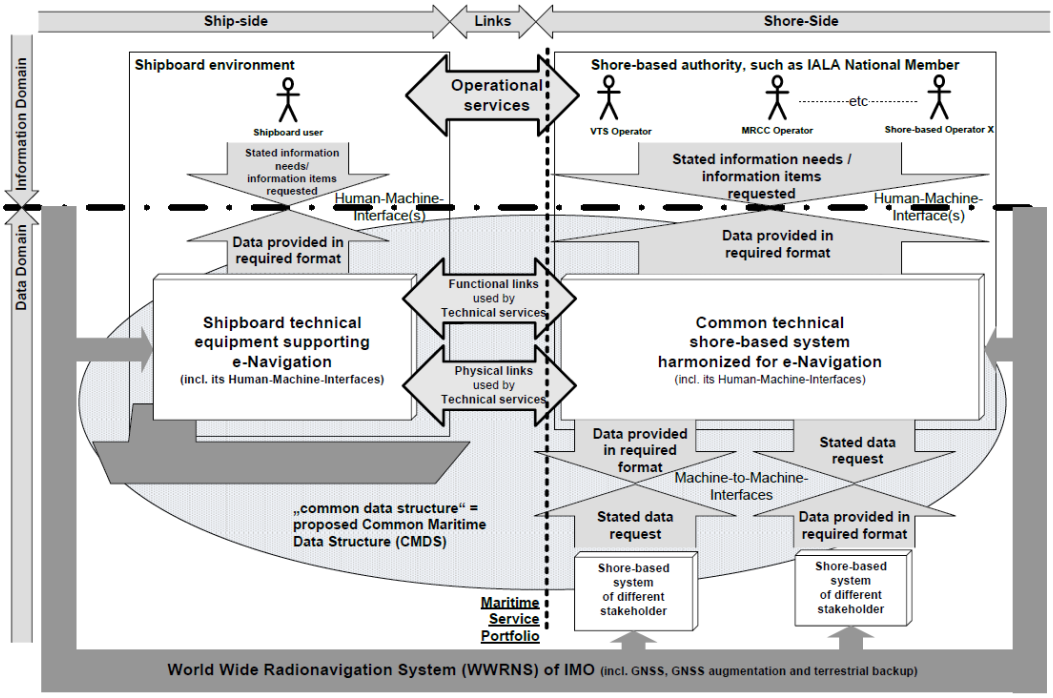


Figure 21: Overarching e-Navigation architecture (IMO MSC.1/Circ. 1595)

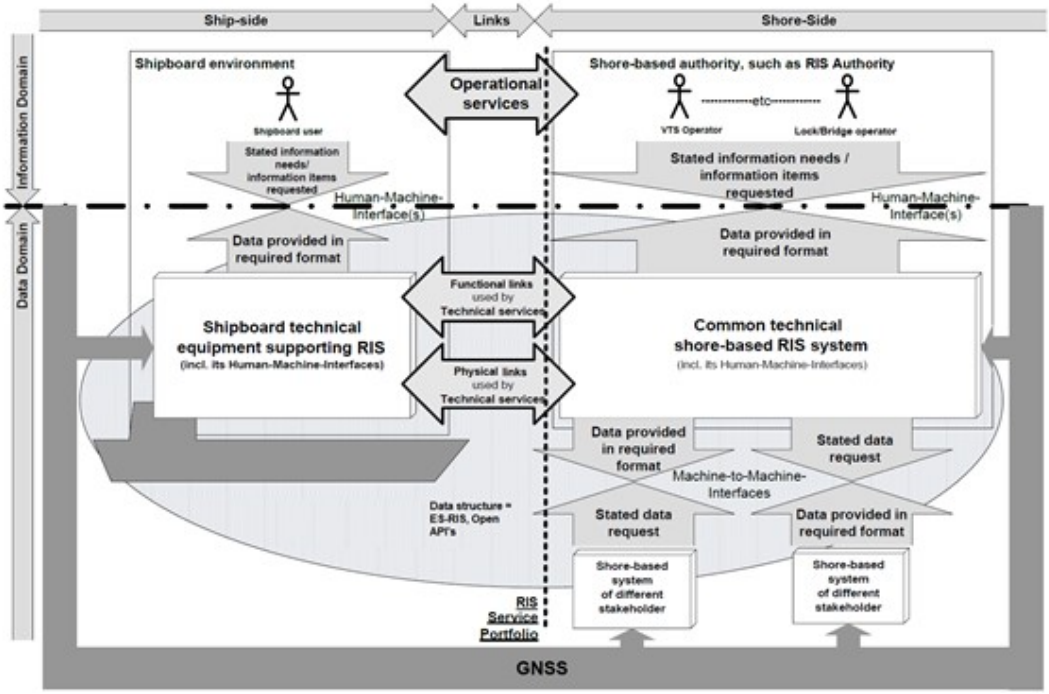


Figure 22: Overarching RIS architecture

There is a great deal of standardization work being done, specifically relating to the **S-100** world with the **Common Maritime Data Structure**, which is **a main pillar of e-Navigation**.

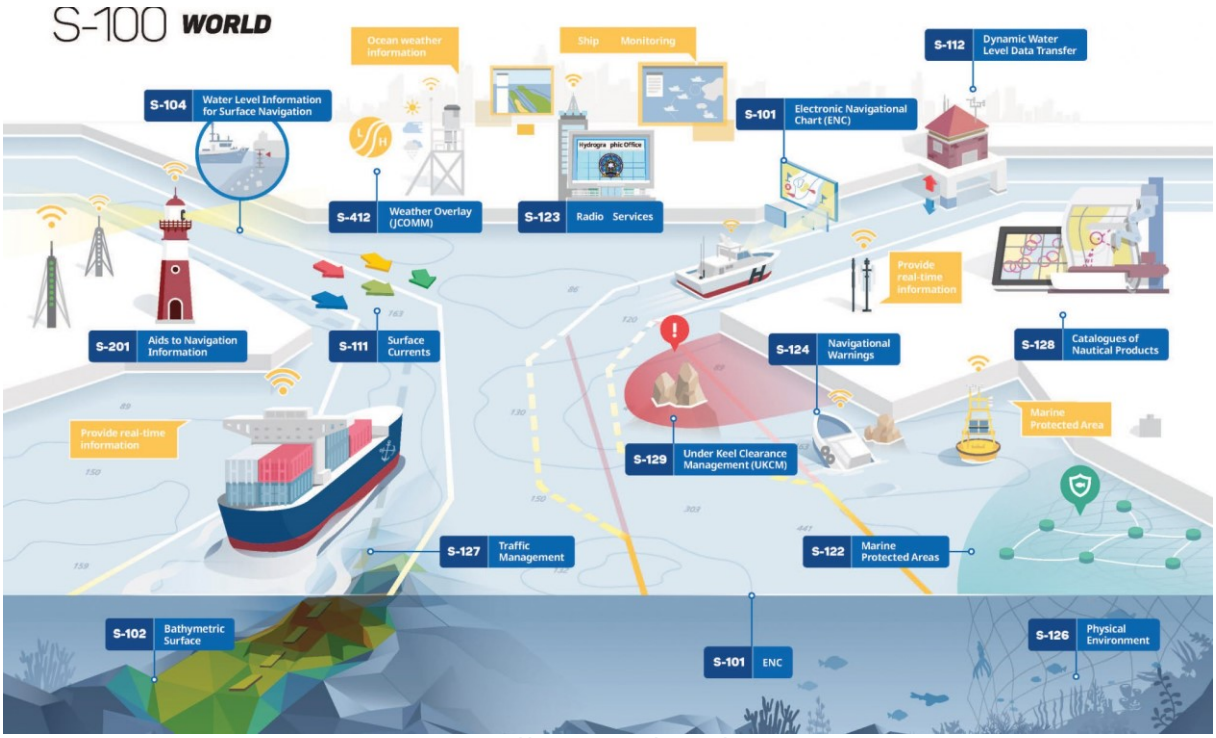


Figure 23: S-100 world; Source: http://s100.iho.int/home/s100-introduction

This Figure does not show all S-100 domain documents under development. Specifically, S-421 on vessel routes is not mentioned.

A second important aspect of e-Navigation is the standardization and harmonization of the bridge layout and human-machine-interfaces on the bridge. The integration of navigational and other systems on the bridge increases the complexity, calling for reliable and resilient bridge systems. The many different types of potential alarms ask for an integrated alarm system to avoid distraction of the bridge team by redundant and/or superfluous alarms. And of course the bridge team should always be able to easily operate the navigational equipment and all presented information, which can be made much easier if standard modes/default display configurations are available for all important equipment, reducing the time needed to get familiar with (new) bridge equipment.

The present project's starting point was the IMO led strategic initiative called 'e-Navigation'. The development of an e-Navigation strategy was first suggested to IMO's Maritime Safety Committee in 2005 (MSC81/23/10,19 Dec 2005). Hence, the state of the developments at 'maritime' as it is represented in this report as of 2022 has taken already almost 20 years in the making. As a definition which was developed in the process, e-Navigation is 'the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment' (IMO MSC.1/Circ.1595).

This strategic initiative carried out initially mostly by IMO, IALA, and IHO solely and which started as a study exercise, in fact, was the trigger for a comprehensive and global harmonisation process of existing and emerging new electronic and digital means and methods involved in the voyage of a vessel from berth to berth, in particular concerning the voyage's nautical aspects proper.

In the process of the progressing development of the e-Navigation initiative, there was developed a globally harmonised implementation strategy, the so-called E-Navigation Strategy Implementation Plan (SIP), which was first released by IMO in (2009) (MSC85/26/Add.1, Annex 20) and updated in 2018 (MSC.1/Circ.1595).

Thus, e-Navigation can be construed as a strategy for the eventual digitalisation of the maritime domain regarding all aspects of a vessel's voyage from berth to berth and thus renders a role model for the present masterplan for the digitalisation of inland waterways (DIWA).

Already during the work on the e-Navigation Strategy Implementation Plan, several participants took parallel initiatives, depending on their respective individual areas of interest, to develop building blocks of the overarching picture of e-Navigation into considerable more detail and brought them to the attention of relevant international organisations with to goal to have them endorsed, eventually. Some of these respective individual areas of interest were also received a fast tracking priority in the e-Navigation Strategy Implementation Plan.

All of these initiatives were inspired and informed and thereby inherently coordinated from the outset

- on one hand by a fundamental common systemic understanding, namely by the 'overarching architecture' for the implementation of e-Navigation (compare MSC.1/Circ.1595, Figure 1).

- on the other hand by IMO's early fundamental decision to base the globally harmonised voyage of a vessel and/or its digital twin, including any and all relevant entities and incidents to be potentially encountered during that voyage, on the IHO developed data modelling framework called by them Universal Hydrographic Data Model (S-100); in turn, IHO agreed to open the UHDM/S-100 framework up for other relevant domains that are not hydrographic in the strict sense of the word, thus effectively providing the data modelling framework for all aspects of a vessel's digital voyage. Several international organisations joined the "S-100 world" by starting work on their 'data products', including for example IALA, IEC and JCOMM.

In the meantime, it may appear that the term 'e-Navigation' has been pushed to the background internationally, or that the interest in its tenets and aspirations may have ceased to exist; as an indication for that impression it may serve, that the longstanding and ground-breaking series of e-Navigation Underway Conferences, both internationally as well as with North American and Far East Asian regional spin offs, has expired. Contrary to that impression, the spirit of e-Navigation is operative still, although not made explicit any more, in several different working fora, i.e. the very success of the e-navigation paradigm has led to replacing the general and generic term 'e-Navigation' by several more specific terms designating concrete working fields instead.

Examples for the building blocks which have been developed and endorsed since or which are gaining maturity now are given as follows, and it should be noted beforehand, that this list is not meant to be exhaustive:

- Updating shipborne navigation and communication equipment, which is a fundamental pre-requisite for any digital solution (compare e.g. IMO-MSC.1/Circ.1389; 2010);
- Software quality assessment and human centric design (compare e.g. IMO-MSC.1/Circ.1512; 2015);
- Shipborne equipment for resilient PNT, namely the definition of multi-system shipborne radionavigation receivers (compare e.g. IMO-MSC-Resolutions 401(95), 2015, and 432(98), 2017);
- Common shore-based system architecture for in particular but not limited to AtoN/VTS ad-ministrations (compare e.g. IALA Rec. e-Nav 140, Ed.2, IALA Guideline 1113, and IALA Guideline 1114, all 2015);
- Automated Ship Reporting within Ship Reporting System (compare e.g. IMO-MSC-Resolution 432(98), paragraph 2.2.2.1, 2017, and the ongoing work of the IMO FAL Committee in this regard);
- Shipborne Integrated Navigation Systems, capable of processing AIS-ASM and AIS-AtoN message (compare e.g. IMO-MSC-Resolution 452(99), 2018) in conjunction with the standardisation of user interfaces for shipborne navigation equipment, namely at INS, EC-DIS, Radar and other systems (compare e.g. IMO-MSC.1/Circ.1389, 2019);
- Maritime Services (compare e.g. IMO-MSC-Resolution MSC.467(101), 2019, and associated work at different international organisations such as IALA Guideline 1155, 2020f);
- Ongoing work of the development of the Universal Hydrographic Data Model aka 'S-100-World' with contributions by several international organisations (compare e.g. IHO web page; IALA's ongoing work on S-201 regarding AtoN; S-421 on route management of vessels (IEC 63173-1), 2021)
- Port Collaborative Decision Making (PortCDM) and Sea Traffic Management (ongoing).

These working fields related to the voyage of a vessel and/or its digital twin within the digital domain are carried forward by dedicated groups of experts, each. To summarise in a picture: The e-Navigation strategy was a 'firework', the 'sparks' of which ignited individual 'fires' (i.e. above individual building blocks) of that in turn are in the process to render a 'bush fire' now (i.e. the notion that there is no way in the future without taking onboard the e-Navigation introduced principles).

It is obvious, that the plurality of the thus emerging results can no longer be described here comprehensively because they now affect the digital part of the maritime domain throughout. It is to be hoped, that the globally harmonised e-Navigation principles in conjunction with the governance of the process, asserted and executed by IMO, will be strong enough, to render the anticipated result in due course.

Applied to the inland waterways the role model of 'e-Navigation' would mean:

- In analogy to the IMO, one organization recognised in the inland waterway domain must assert and execute the control or governance of the different strands of development with the goal to harmonise them. Depending on how comprehensive the scope of this harmonisation is intended to become, this organisation may be a global organisation for global harmonisation of digitalisation in the inland waterway domain (e.g. PIANC, IEHG or IALA) or for a regional harmonisation of digitalisation, such as Europe-wide harmonisation, a regional body (such as in Europe e.g. UNECE, CESNI, an EU agency or a river commission).
- Since the maritime domain and the inland waterway domain are both 'wet', they share a certain proximity. This has led in the past to the adoption-with-amendments of major developments of the maritime domain in the inland waterway domain, both in operational and technical terms, such as AIS becoming Inland-AIS and ECDIS becoming Inland-ECDIS. For the future, which is the topic of the present DIWA project, this successful habit should be systematically employed for any and all relevant aspects of the maritime offspring of e-Navigation.

Since the term e-Navigation doesn't appear much with all these maritime off-springs any more, the term e-Navigation should be construed as and replaced by 'maritime' in the DIWA masterplan throughout.

4.5.2 Legal Framework of e-Navigation

In the maritime domain, there are several entities which are setting up the legal and regulatory framework for shipping. The most fundamental entity is an international **convention** that is agreed upon and consequently signed by a sufficient number of signatory states, henceforth called member states (to that convention). Each international convention addresses a specific topic, such as the Law of the Sea (UNCLOS), the Safety of Life at Sea (SOLAS), the Prevention of Pollution from Ships (MARPOL), the Facilitation of International Maritime Traffic (FAL), or the setting up of international **organizations**, such as the International Maritime Organization (Convention on the International Maritime Organization), to execute certain tasks within their remit. These international conventions may include specific binding stipulations such as – as relevant for the topic at hand in the case of SOLAS –rules for deploying Aids-to-Navigation (AtoN) from ashore, including but not limited to setting up Vessel Traffic Services (VTS), or certain mandatory carriage requirements of certain pieces of equipment for vessels, such as an Electronic Chart and Display System (ECDIS) and an AIS device.

The most important international organization for the topic at hand is the above IMO which belongs to the United Nations system of organizations. There are other relevant international organizations, too, such as the International Hydrographic Organization (IHO), the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the International Electrotechnical Commission (IEC), and the International Standards Organization (ISO) to name only those which have a bearing on operational aspects.

The relevant legal and regulatory framework for the operation of shipping is created by IMO on the basis of the relevant international conventions, some of which are mentioned above. To that end, IMO has several instruments, i.e. documents that contain relevant stipulations, namely for example a **resolution** by a competent IMO organ (such as the IMO Assembly or an IMO Committee), hence called IMO Assembly Resolution, MSC Resolution (of IMO's Maritime Safety Committee), FAL Resolution (of

IMO's Facilitation Committee), or MEPC Resolution (of IMO's Marine Environment Protection Committee). Assembly resolutions are superior to committee resolutions, but IMO Assembly has delegated its authority to IMO Committees frequently in recent years. Resolutions have the power to amend international conventions to a certain degree.

Regarding the legal and regulatory framework of maritime services, which is the generic term for the topic under consideration here, there are several relevant resolutions:

- Recently, the IMO Assembly replaced their long-standing resolution on Vessel Traffic Services ("Guidelines on Vessel Traffic Services", A.857(20) of 1997) by the assembly resolution **A.1158** of 2021 on the same topic, and delegated their authority to further deal with A.1158 in the future to MSC;
- Resolution MSC.467(101) of 2019 on "Guidance on the Definition and Harmonization of the Format and Structure of Maritime Services in the Context of e-Navigation", which sets up the generic, conceptional framework for operational and technical services as well as for the stipulated employment of IHO's S-100 framework for data model development;
- Resolution MEPC.304(72) of 2018 being the "Initial IMO Strategy on Reduction of GHG Emissions from Ships";
- Resolution MEPC.323(74) of 2019 being an "Invitation to Member States to Encourage Voluntary Cooperation between Ports and Shipping Sectors to Contribute to Reducing GHG Emissions from Ships";

It is important to note, that all these relevant resolutions to any topic at hand must be considered concurrently to gain the full picture, regardless of what IMO organ concluded them. Hence, the above list, by means of example, shows such a list of relevant resolutions from different IMO organs, but it may not even be complete for the topic of maritime services. So, for considering the potential transfer of operational concepts from the maritime to the IWT domain, the above resolutions form a good starting point, also in the order given.

It is also important to note, that legal and/or regulatory progress expresses itself by the fact, that younger resolutions may amend older resolutions in terms of their meaning (or even revoke an older one, in which case the older one ceases to exist as a valid instrument). Regarding maritime services, the recent IMO Assembly resolution on VTS doesn't specify any of the maritime services contained in the service portfolio called Vessel Traffic Services any more, as the predecessor assembly resolution A.857 has done by specifying, among many other details, the Information Service (INS), the Navigational Assistance Service (NAS), or the Traffic Organization Service (TOS). This doesn't mean that these services don't exist anymore conceptionally at IMO – it simply only means that there is no IMO resolution in place now, that specifies INS, NAS, or TOS. As a consequence, if so desired, the international community may define these services in different instruments, that may have lesser legal and/or regulatory strength from a formal point of view, but may exhibit different benefits in turn.

A category of IMO instruments with a lesser legal and/or regulatory strength than resolutions are IMO **circulars**. These are regularly issued by IMO Committees, and they specify their topic in much more detail and may be even very specific. Examples of such circulars for the topic at hand are

- Circular MSC.1/Circ.1595 of 2018 entitled "e-navigation Strategy Implementation Plan, Update 1";
- Circular MSC.1/Circ.1610 of 2019 entitled "Initial Descriptions of Maritime Services in the Context of e-navigation";
- a whole branch of circulars on "guidelines on ship-port interface" issued by the FAL Committee (FAL.6/Circ-series).

It is important to note, that IMO circulars are generally considered dealing often with relatively short lived aspects compared with resolutions and even conventions: A "strategy" or an "implementation plan", by very definition have certain durations albeit the precise dates of which may not be specified. The very title "initial list" of MSC.1/Circ.1610 implies, that amendment is pending or even programmed. Hence, there are sometimes several revisions implemented for a certain circular if degree of amendment can be dealt with by a revision; otherwise, a new circular is agreed upon replacing the old one. In regard to maritime services it is thus almost a sure event, that both above circulars will be further developed or replaced by improved versions in the foreseeable future (up to 2032), which will

most likely not happen to the above resolutions. As a conclusion, IMO circulars are a solid basis to plan on, but significant progress in detail should always be anticipated.

Last but not least, there are developments taking place beyond IMO the results of which are relevant for the work of IMO, such as the United Nations overarching efforts to re-duce GHG emissions. The results of these developments, stemming e.g. from the UN endorsed GEF-UNDP-IMO Global Maritime Energy Efficiency Partnerships Project (GloMEEP), are sometime also endorsed by IMO, but are not re-issued as IMO resolutions or circulars but e.g. in the format of IMO Secretariat notes. Relevant examples for the topic at hand here are:

- MEPC.74/INF.34 of 2019 – "Reduction of GHG Emissions from ships – Just-In-Time Arrival of Ships";
- MEPC.75/INF.22 of 2020 – "Reduction of GHG Emissions from ships – Just-in-Time Arrival Guide – Barriers and Solutions."

While IMO certainly has the role to set up the framework of maritime shipping in general and of maritime services specifically, i.e. to stipulate the What, it is often up to other international organizations to deal with more details within their respective domain of interest, i.e. dealing with the How. For example, IALA deals with any kind of details related to Aids-to-Navigation and VTS within the framework set up by IMO as given above; IHO deals with any aspect of hydrography and electronic charts for maritime use in the international domain as stipulated by IMO (or even SOLAS convention for that matter in both cases); and so forth. Therefore, it is required to consider their relevant documentation, too, to determine the 'state of the art' in their specific domains of interest each. It would be a flawed approach to not adhere to their specific regulations as long as there is a need for international harmonization, which holds true for the IWT in Europe, too.

5 Results and conclusions

This chapter provides a description of the gap analysis with useful recommendations towards the other Sub-Activities and a number of conclusions. Finally a short cross check is made with all the predetermined goals and tasks to see if they have been fulfilled.

5.1 Results of GAP analysis (incl. Synchromodality)

As mentioned in section 3.2, two different work approaches were applied. In the first part of this gap analysis, the inventory was taken as the initial starting point. For the second part of this section, desk research and a description of the services will be taken as the entry point to find possible gaps.

5.1.1 Gap Analysis through table review

First of all, a distinction is made between possible GAP's in the inventory.

The first GAP that is identified is the one between two sources. The starting point of this inventory was the input from PIANC (guidelines of 2019), which we can describe as the 'baseline' in this project, extended with the results of RIS COMEX. RIS COMEX was a European research project where 13 countries participated in completing an inventory of services, for which the most part is already implemented.

Therefore, the work done in RIS COMEX is highlighted by listing the GAP's between PIANC and RIS COMEX. A service that is listed below is a service that is not present within PIANC but is part of RIS COMEX and thus already implemented. In the inventory itself (annex 1) , these services are marked in Italic. This is already an important analysis as it allows us to identify the added value of RIS COMEX.

Network and infrastructure:
The services listed in this category all describe the network characteristics and the network infrastructure of the given transport modalities. They handle actual and predicted updates on the network (such as weather and ice updates) as well as the status of the infrastructure of the network (such as opening hours of locks and bridges).

- Provide predicted weather information
- Provide information on expected restrictions caused by predicted ice situation
- Provide information on ice breaking measures
- Depth profile of the fairway
- Shallow sections/critical sections
- Provide information on water level info (or correction data) for critical stretches
- Provide information on restrictions caused by high water conditions
- Permanently moored vessels/parked vehicles or facility in the fairway/on the route
- Provide information on malfunctions of aids to navigation
- Provide information on short term changes of aids to navigation
- Digital (fairway/route) network based on the RIS Indices
- The (fairway/route) network at different scales
- Provide information on opening hours of harbours
- Provide information on opening hours of terminals
- Provide information on short term changes of lock operating hours
- Provide information on regular lock operating times
- Provide information on short term changes of bridge operating hours
- Provide information on regular bridge operating times
- Provide information on predicted vertical bridge clearance
- Actual Passage Time (timestamp) at a specific waypoint of a stretch (e.g. river km)

Voyage and cargo:
The services listed in the voyage and cargo category mainly provide information on the position of a vehicle on its voyage as well as information on the cargo of the vehicle that is undertaking the voyage, including the certificates it has to transport its cargo.

- Actual passage duration (hh.mm.ss) required for navigating through a specific stretch or section (e.g. between two locks) considering the actual traffic situation (density)
- Provide information on free loading space (tonnage, type of cargo, containers, etc.)

Traffic:
In the traffic category all traffic related information services are listed. This goes from predicted passage time to the network density, which can give an overview of an ETA.

- Timeframe of reservation
- Available berth space/infrastructure/services within the defined timeframe
- Vessel/convoy dimensions, respectively occupied berth space
- RTA from the lock master to the skipper
- Assigned position of the own vessel from lock master to skipper
- Assigned positions of all vessels in the lock chamber
- Actual positions of all vessels in the lock chamber
- Requested sequence of entering the lock chamber from lock master to skippers
- Provide information on incident type, severeness, location, expected duration including influence on infrastructure passage durations incl. waiting times
- Provide information on influence on fairway stretch passage durations including waiting times
- Actual lock entry duration
- Actual lock leaving duration
- Predicted positions of the vessels (anonymized)
- Provide information on sailing/travel time over a certain stretch for certain vessel classes per sailing direction
- Predicted Passage Time (timestamp) at a specific (way)point of a stretch (e.g. river km) considering the predicted traffic situation (density)

Secondly, a gap was identified by the other transport modes (ITS, ERTMS and e-Navigation). If a service is encountered that is present in one of the other modes and is not present in RIS at the moment, one speaks of a GAP. This GAP could then be studied and the question can be asked whether this is of interest for IWT and how this service could be provided.

Below, the gaps are listed for each information category.

Network and Infrastructure > Network Characteristics & Network Infrastructure
Traffic related > Object related information

- GAP 1: Easy feedback on discrepancies between provided data and real-life situation

A system for this feedback is not yet really embedded in RIS. At the moment, there are small-scale local initiatives, but they have not yet been developed on a European scale. The aim is to create a service that ensures the low-threshold involvement/contribution of the community. There may be a possibility to make this generic. In this way, the synchromodal aspect can also be included.

Voyage and cargo > Voyage related information

- GAP 2: Provide path offer & path request
- GAP 3: Provide Re-routing (pre-arranged paths and reserve capacity in case of temporary capacity restrictions)

GAP 2 is partially covered in RIS under the Voyage Planning, and implemented in, for example, the voyage computation modules of EuRIS. Here a skipper can get suggested route & timing information based on provided vessel, cargo and departure time information, and optional via-points. There is even a structural exchange of this information with some reporting software (CEERIS, BICS) which effectively closes the GAP 2 for the geographical area's covered by CEERIS. GAP 2 could be closed completely by formalizing/standardizing/embedding this exchange in the RIS functions.

GAP 3 is covered in VisuRIS, IVS Next and EuRIS, where all active voyages that could be affected by a NtS update (new/modified/retracted) are automatically recomputed when the NtS update is published. One aspect that is not covered is the notification of the skipper when the system concludes that his/her voyage is rerouted in the system. This would be an interesting service to investigate because it has many implications/scenario's. It would be interesting for the skipper to know that the foreseen itinerary

was changed, and even more interesting if the skipper could confirm the re-routing decision, or inform the system that he/she choose a different reaction (e.g. stay on the original route, take a different alternative path, …)

Traffic > Provide information on incident focused on traffic situation

- GAP 4: Provide pro-active alerts
- GAP 5: Provide overview of affected vehicles
- GAP 6 : Communication with affected vehicles[1]
- GAP 7: Easy feedback on discrepancies between provided data traffic information and the real-life updates or even initiate the abnormal state.

Pro-active alerts provide active alerts, i.e. in case of near misses between two vessels, by means of traffic simulation based on the current traffic including the expected traffic. At the moment, no such proactive alerts are sent within the context of RIS. What is currently offered is, sending out reactive alerts by means of NtS. This concerns alerts that come after an event or incident. These alerts relate to the traffic situation. We conclude here that there is a gap between RIS and other transport modes. The pro-active aspect of the service is therefore the next level which would offer added value if provided.

GAP 7, i.e. community involvement, can also be applied within the context of traffic information.

[1] This is operational in some countries (IVS next)

5.1.2 Comparison of ERTMS Services and RIS Operational Services through documentation.

There are a few key differences between ERTMS and RIS:

- The ERTMS is not directly an information service, but a control system for rail traffic, which generates important data for traffic management.
- Like RIS, the main goals are the improvement of safety, efficiency and interoperability in the European area, which should result in a reduction in costs.
- In general, the traffic on the railway is the most regulated and prescriptive transport mode. The railway traffic is strongly coordinated. The railway undertakings of the trains have to request the use of a path of the railway network. There is no train voyage without previous approval by the infrastructure operator.
- Over the years, rail transport has developed into an extremely safe transport system. The operator of the railway path gives direct instructions and commands towards the train driver. The train driver has to confirm the proper receipt of commands (e.g. confirm that a red light was seen passing a distant signal). Also, the train driver frequently has to confirm that he/she is in the drivers cab and responsive ('dead man's switch') otherwise safety measures will be taken (e.g. train will stop automatically).
- The ERTMS comprises several control system levels for the use of differently equipped traction units to maintain the safety of traffic on the railways by automatic train protection systems. Depending on the level of ETCS locomotives either communicate with the infrastructure through balises, or in higher ETCS levels using GSM-R.
- Within ERTMS it is required to know the exact position of all carriages, e.g. axels are counted at several locations to monitor completeness/integrity of a train according to the specification provided in the train composition message.
- To establish a single European railway network a central authority, the European Agency for Railways, was founded to ensure synchronous development and to monitor requirements.
- The single European railway area includes rules for the management of railway infrastructure and rail transport activities.
- The task of developing and providing harmonised services has been handed over to the association RailNetEurope. The association is supporting the members regarding compliance with EU legal framework.
- Provision of information:
    - The RailNetEurope (RNE) offers several services to international railway undertakings. In rail transport, the timetable is an extremely important information. The timetable coordinates the use of the rail paths and optimises the use of the infrastructure. Together with the real-time information it ensures the predictability of train traffic. The performance of the trains is permanently monitored. The key indicators within the regular report support the improvement of punctuality of following journeys. Punctuality is a benchmark parameter in rail traffic and efforts are being made to avoid any deviations. Each train journey is provided with sufficient information about the track, rail facilities and the entire corridor, as well as national regulations. In case of temporary capacity restrictions, the affected trains get notified to enable to re-route the voyage and use other pre-arranged paths. The train facilities are available via a common portal operated by RNE. The facility operators can provide information and updates for their facilities to make them known to a broader public.
    - Some important information for the operation of trains as well as for the management of the logistic chain is only exchanged internally between railway undertakings involved in the train trip. The train composition message describes the formation of the train regarding the trains and numbers of wagons as well as additional information. The HERMES 30 message contains the full set of train information including cargo information. This message is used as a preadvice on international freight trains between railway undertakings. It contains the information about the destinations of the individual wagons of a train, which may well be different. Due to the changes in train composition, the 'Estimated time for interchange' are calculated for affected wagons as it is done for the train for specific locations.
    - In RIS the provision of charts for the navigation on the waterway is very important. In contrast, such charts are not so important for rail transport. The trains are railbound

and don't need detailed information about the surroundings for the voyage. Instead, precise information about the track characteristics are very important.

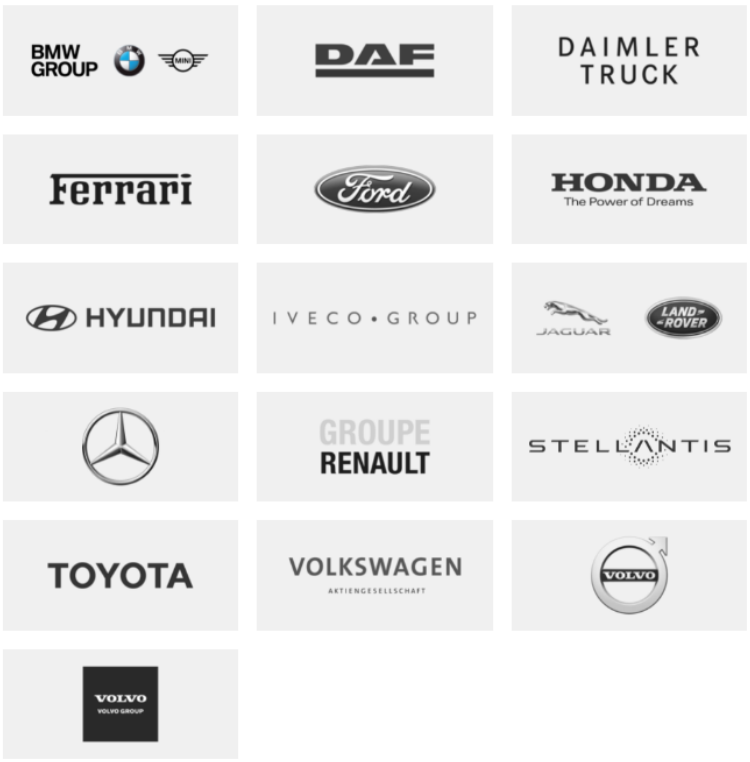
- On the rail network, passenger transport is also very important and must accordingly be considered just as much as freight transport. On the other hand, there is no recreational traffic on the railway, so this part does not need attention and own appropriate services.

5.1.3 Comparison of ITS Services and RIS Operational Services through documentation.

There are a few key differences between ITS for road transport and ITS for waterways.

- The market for ITS is huge. The potential market is hundreds of millions of cars. That maybe the most important difference between ITS for road transport and ITS for waterways. This means many stakeholders, a huge potential and potential conflicting interest.
- ITS for road is focussed on all road users, both professional and non-professional. There is no major difference in the approach towards trucks or passenger cars. This differs from shipping, where services are mainly focussed on commercial shipping.
- ITS for road transport is mostly use case driven. Given the use case, what is required to reach that goal. A good example is e-Call for safety and assistance after an incident. Services may vary between regions. In Scandinavia for example, you will find more use cases related to severe winter weather conditions.
- ITS for road is mainly driven by private organisations. Tech industries such as Google, Apple, TomTom and HERE are major drivers for new developments. Also OEM's (Original Equipment Manufacturer) (car manufacturers and supply industry) are an important driver for new developments. And finally MNO's (Mobile Network Operators) are key in the provision of information towards the road users.

The European Automobile Manufacturers' Association (ACEA) represents the 16 major Europe-based automobile manufacturers.



- ITS for road transport is a worldwide development with regional accents. All private organisations involved have a worldwide presence in worldwide markets.
- ITS is increasingly dependent upon wireless connections between vehicles (V2V) and between vehicles and roadside units (V2R). A distinction is made between short range communication (up to several hundred meters) and long range (from several hundred meters). A variety of

public and private organisations are exploring their position on the various ways of communications. Mobile Network Operators (MNO's) are investigating the ITS opportunities for their 4G and 5G networks.

5.1.4 Comparison of Maritime Services and RIS Operational Services through documentation.

Although a lot has happened in e-Navigation in the last five years, the base has not changed significantly since the publication of the PIANC WG156 Report from 2017: 'E-Navigation for Inland Waterways'. As this report contains a comprehensive comparison of the Maritime Services and RIS Operation Services, it was used as the starting point for this section.

5.1.4.1 MS1-3: Vessel Traffic Services

The recent IMO Assembly Resolution A.1158 has replaced the old IMO VTS Resolution A.857(20). While this resolution entails a significant update of the Guidelines for Vessel Traffic Services, the impact on the Maritime Services seems limited.
The new Resolution defines three categories/types for/of VTS which link nicely to the MS1-3:

1. Providing timely and relevant information (corresponding to MS1 – Information Services)
2. Monitoring and managing ship traffic (corresponding to MS3 – Traffic Organization Services)
3. Responding to developing unsafe situations (corresponding to MS2 – Navigational Assistance Services)

MS1 – VTS Information Services (INS) is about providing timely and relevant information on factors that may influence ship movements and assist onboard decision-making. This may include

- Position, identity, intention and movement of ships
- Maritime Safety Information (see MS5)
- Any potential hindrances that may impose restrictions on the navigation of ships (e.g. ships with reduced manoeuvrability)
- Information on reporting formalities, ISPS details, …
- Support for and cooperation with allied services (e.g. pilotage, tugs, linemen)

The related RIS services are of course the VTS services. There are many similarities. A notable difference is that meteorological and hydrological information is much more important and complex for the Maritime side.

MS2 – VTS Navigational Assistance (NAS) is about responding to developing unsafe situation by assisting on board navigational decision-making and monitoring its effects. Use cases include

- A ship unsure of its route or position, deviating from the route, or requiring guidance to an anchoring position
- A ship that has defects or deficiencies such as navigation or manoeuvring equipment failure
- A ship at risk of grounding or collision
- Severe meteorological conditions
- Emergency response or support for emergency services

There is no RIS Operational service that offers remote navigational assistance and it is not envisioned that such a service would become relevant in the foreseeable future.

MS3 – VTS Traffic Organization (TOS) covers the monitoring and management of ship traffic to ensure the safety and efficiency of ship movements. This may include:

- Planning ship movements in advance
- Organizing ships under way
- Organizing space allocation
- Establishing a system of traffic clearances
- Establishing a system of voyage or passage plans

- Providing route advice
- Ensuring compliance with and enforcement of regulatory provisions

The related RIS services are the VTS services, and to some extent the Traffic Planning services. There are many similarities. No gaps were detected where RIS Operational services could be extended based on MS3.

5.1.4.2 MS4: Port Support Service (PSS), formerly Local Port Service (LPS)

This Maritime Service is applicable for ports where setting up VTS is considered excessive or inappropriate. PSS does not interact with traffic, nor is it required to be able to respond to developing traffic situations. It can provide information about berthing, port services, shipping schedules, hydrological data, meteorological data, …
Two Technical Services for PSS on the ship-to-shore have already been elaborated:

- S-211 for exchanging timestamps and related data associated with a port call
- S-421 for exchange of voyage related information, including waypoints and timestamps

Overall this Maritime Service seems to be in a rather conceptual state, with the exception of the ship-to-shore Technical Services.

The shore-to-ship part of this MS links to the **Information for Transport Logistics (ITL) services like T1** in RIS. But there is also some overlap with **Fairway Information Services (FIS) F7 and F8**. (See PIANC RSI Guidelines 2019 for more details on the specific services Tx, Fx, …).
An example is the information on berths and berth reservation schedules that are available and implemented in EuRIS. However, the ports and port terminals could be further involved here to increase the number of berths covered.
The ship-to-shore part of this MS is linked to the **ERI technical service in RIS**. It would be interesting to review both S-211 and S-421 to see if there is (potential) overlap, search for best practices and lessons learned. It should however be pointed out that the possibilities for harmonization seem limited due to the maturity of ERI in IWT, and the current roadmap for the ERI updates till at least 2025.

5.1.4.3 MS5: Maritime Safety Information (MSI) service

This Maritime Service is about the provision of navigational and meteorological warnings, meteorological forecasts and other urgent safety-related messages as broadcasts to ships. The Maritime Safety Information service is the internationally and nationally coordinated network of broadcasts containing urgent information, which is necessary for safe navigation, received in ships by equipment which automatically monitors the appropriate transmissions, displays information which is relevant to the ship and provides a print capability.
The services that constitute this Maritime Service are already provided in a fully electronic format.

The related technical services are NAVTEX and Enhanced Group Call Services (EGC) like SafetyNET.
S-124, S-411 and S-412 standards will be used to display MSI information in ECDIS.

The related RIS are under the Fairway Information Services. Notice to Skipper messages can also be used to provide the information. For very urgent information VHF radio or Inland AIS should be used. So the communication in IWT is not (yet) fully digitized.

The recent evolutions for display of the MSI on ECDIS could be an interesting topic, and as such S-124, S-411 and S-412 could be interesting to investigate. It could also be interesting to see if these standards are compatible with S-401 (Inland ENC).

With regards to the Aids to Navigation, there is a clear harmonization between the Inland and Maritime sector. For Inland AIS AtoNs, the same message (ITU-R M.1371 Msg. 21) is used in both domains. The main difference is that all Inland AIS AtoNs types are encoded as maritime AtoNs of the 'default' type (ensuring a generic display on Maritime systems), while the additional Inland information is encoded in the AtoN status parameter (ensuring a correct display on Inland systems).

5.1.4.4 MS6: Pilotage Service

This Maritime Service provides easy access to information about provided pilotage services in a port or specific area. This includes information about regulations, contact, notices, means of boarding, boarding point, limitations, booking procedure, … The Maritime Service does not provide piloting information, as this is a service physically performed on board ships by duly qualified and certificated/licensed maritime pilots.
The information could be displayed as a layer on the ECDIS.
This Maritime Service is still in a very conceptual phase.

There are no matching River Information Services.

The relevance of pilotage could however increase in light of Smart Shipping. For example to provide assistance at locks/berths that are not yet fully compatible with fully autonomous vessels. If deemed relevant, a new Fairway Information Service could be drafted to cover the information needs, or this could be an extension on the existing FIS F8 and F9. Notice that MS7 could also be relevant.

5.1.4.5 MS7: Tug Service

This Maritime Service aims to provide information about the availability of tug services, including regulations, contact, notices, … but also the properties and availability of the tugs. Its target 'audience' ranges from small vessels with limited capacity and service in ports and rivers to ocean-going vessels built for complex operations and salvage.
By facilitating electronic access to all necessary tug-related information, transit times can be optimized, and efficient movement of goods and persons can be promoted.
This Maritime Service is still in a very conceptual phase.

There are no matching River Information Services.

The relevance of tugs could however increase in light of Smart Shipping. For example to provide assistance at locks/berths that are not yet fully compatible with fully autonomous vessels. This would however require a standardized physical interface between the tugs and the autonomous vessels. If deemed relevant, a new Fairway Information Service could be drafted to cover the information needs. This would have to be done in close cooperation with the development and standardization of the physical tug-autonomous vessel interface.
Information about the tugs could possibly be communicated to the autonomous vessel via an extended LockAccess message.

5.1.4.6 MS8: Vessel Shore Reporting

This Maritime Service provides information from shore to ship about two different reporting regimes:

1. Vessel Shore Reporting
2. Automated Ship Reporting

The Vessel Shore Reporting regime can cover information and guidelines related to reporting formalities and instructions for reporting to a specific port. It can be extended to the full exchange of information required in a single window ship reporting system.
In the Automated Ship Reporting regime, reports are automatically generated from onboard systems. This allows a significant reduction of the mariner's workload regarding the preparation and submission of reports to shore-based authorities. This regime is possible in areas where a Ship Reporting Service (SRS) is established. Although the minimum data set is very limited, the regulation allows supplementary information to be requested if justified to ensure the effective operation of the ship. Normally an on-shore representative (or agency) is involved, acting on behalf of the master or owner of the ship.

With S-127 and S-421 there are already standardized product specifications available for this Maritime Service. Their specifications are a point of interest and should be further investigated.

Regarding to RIS, there is an obvious link with Electronic Reporting, which is an area where big steps have been taken in IWT over the last few years. There is the COMEX Project which lead to the setup of the EuRIS platform where the electronic reports submitted in 13 different European countries are combined to enable a seamless information flow and voyage monitoring for the Skippers and Logistics Partners. In the COMEX Project an Arrangement was created to enable better international exchange of Electronic Reporting information, with a solid legal foundation. Several single window reporting applications have also been brought into operation (in addition to already existing ones e.g. BICS): CEERIS is a single window reporting platform covering the Danube from Austria to the Black Sea, eRIBa enables single window reporting in Belgium, with extensions to The Netherlands in the pipeline.

Harmonising the Inland and Maritime messages seems infeasible given the many differences in reporting requirements and information needs. A 'translation service' between Inland and Maritime reporting systems could be of interest for maritime ports as it could enable automated exchange of ETD/RTA information:

- The earliest possible departure time from a terminal for inland barges, based on the ETA of the maritime vessel carrying the cargo
- A required time of arrival for the inland barge based on the scheduled departure time of the maritime vessel that will transport the cargo in the next leg of its voyage

If there is sufficient interest in this type of service, an effort could be made to create the necessary standards to cover the information needs.
Given that this type of service would require a lot of internal information from the Terminals where the cargo is (un)loaded to/from the barges to maritime vessels and vice-versa, this would be a service operated by the Terminals themselves (and perhaps some already have).

There are several interesting aspects of S-421 that could be considered for IWT:

- It contains a system for recommending/requesting changes in route/timing from shore to ship
- Vessels can request a recommended route/timing from the shore for their (planned) voyage
    - For planned voyages, these recommended routes can have a limited time validity
- Geofence lines can be set up, so that the bridge receives an automatic notification when approaching a shallow area, VTS zone, reporting location, … i.e. when some specific action from the bridge is required.
- Vessels are able to update the status of their voyage (i.e. Route Termination Message) which can greatly ease the efforts required on shore for tracking active voyages

All in all, this stresses the importance of **digitising the route information exchange** in the form of shore to ship recommendations, updates, suggested voyage plans, receipt notifications, … compared to the current unidirectional route information provision from ship to shore.

Given the many recent changes on both the Maritime and the Inland communities, it seems that an exchange of ideas and lessons learned could be beneficial for all parties involved.

5.1.4.7 MS9: Telemedical Assistance (TMAS)

A Telemedical Assistance Service provider should be able to provide medical advice for seafarers 24/7. TMAS should be permanently staffed by physicians qualified in conducting remote consultation, and who are well-versed in the particular nature of treatment on board a ship.
The level of service that can be provided depends on the type of transmission technique and the available bandwidth. However, a shift towards standardized digital information exchange should lead to an increased quality of remote diagnostics and even treatment compared to the current voice communication over VHF, MF and short wave radio and e-mail.

This service is still in a very conceptual phase and is not relevant for RIS.

5.1.4.8 MS10: Maritime Assistance (MAS)

The primary mission of this Maritime Service is to handle communication between the ship's officers, the coastal State and other maritime players when a ship is in need of assistance. The circumstances of a ship's operation that involve a MAS are not those requiring the rescue of persons. When the

situation changes and the persons on board find themselves in distress, the MRCC gets priority over MAS.
The Marine Radio Service data products (S-123) contain contact details for MRCCs, which preferably also provide MAS.

The corresponding RIS are the Calamity Abatement Services (CAS), and the Inland AIS technical service.
Both the Maritime and the Inland services are an organized way of handling calamities. There is however a big difference because the RIS Centres just deliver the necessary data about the incident to the emergency services without delay. They do not take on a coordinating role.

In recent years a lot of improvements have been made in IWT regarding CAS, specifically with respect to the automated exchange of voyage and vessel related information (including dangerous goods information) with the increase in digital reporting (ERINOT-VES), and the cross-border exchange of the reported information (ERINOT-PAS).

5.1.4.9 MS11: Nautical Chart Service

This Maritime Service provides geospatial information to support safe maritime navigation. The nautical charts (in digital and/or printed format) depict the configuration of the shoreline and sea floor, water depths, locations of dangers to navigation, aids to navigation, anchorages, …. The data model is based on IHO S-100.
While no technical services or specific standards are currently mentioned for MS11 in MSC.1/Circt.1610, it can be assumed that S-101 will play a major role here.
It is important to know that IHO does not provide any technical services for MS11. This is a task for the Value Added Resellers. IHO has, however, established sophisticated secure quality proof transmissions, to ensure that the data will not be corrupted during transfer.
It is mentioned that the service should include both hard media and online delivery mechanisms, with provisions for data authentication and encryption.

Regarding to RIS, the matching services are inland ECDIS and services for distributing iENC. As iENC is compatible with ENC (and vice versa), and this compatibility is ensured for the future thanks to the work of the Inland ENC Harmonization Group (IEHG).
Although there is no formal standard yet for distributing the iENC, all RIS authorities (in Europe?) are already providing access to the latest maps through website subscriptions. With the launch of EuRIS, the charts for almost all inland waterways in Europe will be available via a single website, and the related updates via a single subscription.

It seems noteworthy that at the time of writing, S-101 and S-401 have not yet superseded S-57.
S-101 version 1.0.0 was published in 2018 for implementation and testing purposes. S-401 (the IWT counterpart/extension) was published in 2019, also for implementation and testing purposes.

In practice Belgium, the Netherlands and Germany produce ENC's with high detailed depth information for the maritime pilots for a safe approach of sea ports. These ENC comply with international standards and RIS standards (S57 and Inland ECDIS) as these maps cover both maritime and inland waters.

5.1.4.10 MS12: Nautical Publications Service

This Maritime Service delivers a set of nautical information available for a particular marine area with the aim of supporting the navigation process. The information complements nautical charts (MS11) with information on ports and sea areas like contact information of authorities and specific services, but also regulations, restrictions, recommendations, and other nautical information.
MS12 includes

- Sailing directions, list of lights, notices to marines, tide tables, …
- A discovery service for local services
- An ordering service for the local services

- A delivery service for the local services

MSC.1/Circ.1610 specifically states that *"Users should be enabled to report discrepancies between the real word and the information provided by the Nautical publications service with no or minimal human interference."*
It is important to know that IHO does not provide any technical services for MS12. This is a task for the Value Added Resellers.

Regarding to RIS, there is a strong similarity with the Fairway Information Services. And while platforms like EuRIS, VisuRIS, Danube Portal, … are not directly integrated into the iENC software, they do seem to have a good match with MS12. However, these platforms do not always support 'push notifications' when relevant information is updated.

Within the IRIS Europe 3 project (ending in 2014) an iENC Update Service was implemented in close cooperation with the three main iECDIS manufacturers Periskal, Tresco and innovative navigation. The participating waterway administrations in the D4D Portal provide their latest iENC via RSS feed to the central access point at D4D. Whenever updates are available the manufacturers are notified, they perform quality checks and finally release the maps for their users. The iECDIS applications on board automatically get notified on those updates and enable downloading and installing with the precondition of an active internet connection. The iENC data exchange of that update service is based on a harmonised Web Service specified and pilot implemented in the project.
To our knowledge this service is operational for the three mentioned manufacturers and their waterway users.

It would be interesting to see if extending the iENC Update Service would be interesting. This extension could go in two directions:

1. Include the iENC data of more waterway administrations. For example by migrating the service to the EuRIS Platform, which covers a larger set of waterway administrations then D4D.
2. Connect other iECDIS manufacturers to the iENC Update Service to cover a wider range of skippers.

It would also be interesting to consider the possibilities for setting up a system where easy feedback from users to provider about discrepancies between real world and provided information is made possible.

5.1.4.11 MS13: Ice Navigation Service

The purpose of this Maritime Service is to provide ice navigation information to ships in and in the vicinity of possible ice infested regions. It is critical to safeguard the ship navigation in these regions, given how quickly the ice maps become outdated in the rapid changing conditions of the ice-covered navigational regions.
WMO/IOC has taken up the task of drafting the necessary standards to back this Maritime Service.

The situation for RIS is far less complex, and the information needs much smaller. The information needs are covered by the F2 Fairway Information Services, and specifically the NtS ICEM.

5.1.4.12 MS14: Meteorological Information Service

The purpose of this Maritime Service is to provide forecasts and warnings for the high seas, coastal, offshore and local areas (WMO No.558). This also includes warnings about severe weather (gales, storms, tropical cyclones) and information about weather, waves and ice (SOLAS V/5). Ice accretion and extremely low air temperatures are also considered (Polar Code)
This information is currently provided via the Worldwide Met-Ocean Information and Warning Services (WWMIWS) through marine communication systems like SafetyNet and NAVTEX. The minimum characteristics for a weather service (and thus MS14) are defined in SOLALS V/34 resolution A.893(21).
The met-ocean services shall be issues by the National meteorological service, which implies that WMO and its members should oversee weather routing services and standards.
The standards for the portrayal of met-ocean conditions on ENC systems are documented in S-421.

Here also, the situation for RIS is far less complex and the information needs are much smaller.
The information needs are covered by the F2 Fairway Information Services, and specifically the NtS WERM.

5.1.4.13 MS15: Real-time hydrographic & environmental information services

The Maritime Service is split into two parts:

1. Water level information for navigation
2. Surface water currents for navigation

The water level information is essential for determination of the under-keel clearance required for safe navigation. Real-time water level information and forecasts are important for applications such as route planning, port entry and tidal projections. The service supports both observed and forecasted time series and/or gridded water levels/hydroid surfaces.

The surface water currents information provides digital information on surface current speed and direction to ECDIS. The service supports time series at fixed and moving stations, as wel as gridded forecasts for regions.

The information is encoded using XML and HDF5 data files. IHO Standards like S-104 (Water levels) and S-111 (Surface Water Currents) is used to provide all information.

- Water levels (S-104)
- Surface Water Currents (S-111)

When considering RIS, we can see that the Maritime environment is much more complex. Using the Notice to Skippers Water Related Message (NtS WRM) information about water levels can be sent. These messages are actively used in the EuRIS platform to provide both actual and predicted water levels (also enabling actual and predicted bridge clearance information).
There is also a partial overlap with Fairway Information Services, specifically the water level information.

5.1.4.14 MS16: Search and Rescue (SAR)

The SAR service is about assisting and coordinating search & rescue operations at sea. Following the SAR Convention (1979), SAR plans have been put in place for the thirteen search & rescue area's that together cover all oceans. In each area the concerned countries have SAR regions for which they are responsible. Collaboration between neighbouring countries is encouraged.
Maritime Rescue Coordination Centres (MRCCs) form the heart of the SAR regions and are the primary contact in a SAR incident and responsible incident management and decision making.

Digital exchange and sharing of information could significantly reduce the human errors in SAR case prosecution and also result in huge time savings by allowing MRCCs more timely access to accurate and relevant information.

The exact information to be provided and corresponding technical services have not been elaborated yet.

When considering RIS, we see that SAR corresponds to the Calamity Abatement Services (CAS).
There is however a major difference: While the RIS Centres deliver the necessary data about the incident to the emergency services without delay, the actual search & rescue operations are executed by the emergency services. The role of the RIS Centre and RIS Authority is purely informative.

5.2 Interactions towards other Sub-Activities

This section describes all interactions towards other Activities/Sub-Activities in the DIWA project. These interactions have been drawn up after performing the research on the other transport modes in contrast to section 3.3.

On the one hand there can be interactions that are specifically aimed at a Sub-Activity in the DIWA project. On the other hand, there will also be interactions towards a whole Activity. These should be included in each of the Sub-Activities for this Activity. These interactions are also described again in the form of recommendations in section 5.4.

For Activity 2

- "A Service catalogue is needed to fulfil all the requirements that have been defined. This has to be done on Activity 2 level based on the input from all the different Activity 2 Sub-Activities." (cfr. 7.1 Next steps IWT)

For SuAc 2.1 – Smart Shipping :

- The objective of ERTMS is to introduce a single harmonised train control and protection system (Control, Command, Signalling and Communication system) that enables cross-border train traffic without the use of further national systems. It ensures the interoperability of the European railway systems and reduces costs as well as increases the efficiency of the infrastructure and a high level of railway safety in rail transport. Overall, it shall improve the competitive position of the railway sector. (cfr introduction to chapter 4.4 ERTMS)

  This is an objective that can also be important for Smart Shipping to reduce costs as well as to increase the efficiency of the infrastructure and a high level of safety in Inland Waterway Transport.

- "The Commission Regulation (EU) 2016/919 defines the technical specification for the interoperability of 'control-command and signalling' (CCS TSI). The operation of ETCS needs the implementation of trackside equipment and standardised controlling equipment in the train cab." (cfr 4.4.1 Ambitions and principles of ERTMS)

  A (partial) standardisation of the central equipment could facilitate the international operation of smart shipping or the linking of different smart shipping concepts. It would also reduce the cost of developing the systems.

For SuAc 2.2 – Synchromodality :

- To know how logistic service providers handle their synchromodal transport, these questions are provided to Sub-Activity 2.2.
  - Can you give an insight into the decision-making process of a synchromodal transport choice?
    - Which parameters are used: cost, time, ecological, … ?
  - What services are helping them to make a choice?
  - What services are still missing to make a choice?
  - Do they work in stages, being:
    - Pre-trip info: for decision / justification of transport choice
    - On or During trip info: for adjustment
    - After or Post trip info: for evaluation purposes
  - Do they use M2M interfaces or do they still do a lot of manual work?
    - Can M2M interfaces make life easier?
    - Are they open to this?

- River Information Services (RIS) is the concept whereby information services in inland navigation support traffic and transport management in inland navigation, including interfaces with other modes of transport (cfr chapter 4.2.2 Legal Framework of RIS).

  As SuAc 2.2 is focussing on synchromodal service providers, we assume these service providers and by consequence SuAc 2.2 also elaborate on the interfaces between the different modes of transport. We think about integration or at least interoperability. The latter can be reached by using semantic modelling, an important and state-of-the-art concept that is also explored by the EU DTLF (www.dtlf.eu) project and one of its spin-off projects, FEDeRATED (www.federatedplatforms.eu). Interoperability requirements for B2B as well as for B2G and G2B are needed in this context.

- "The Customer Information Platform is an interactive multi-corridor information tool, including the rail freight corridors. Some infrastructure managers even wanted to integrate their entire railway network into this platform." (cfr 4.4.1.2 Customer Information Platform (CIP))

  This is a shared feeling with EuRIS. Why limit to specific corridors, this only gives troubles for the pre- or post-corridor part of the voyage. Synchromodal transport expects transparency on the whole network and not only on a corridor.

- "The information about the cargo in the wagons of a train can be exchanged between freight railway undertakings and infrastructure managers within the 'HERMES 30 message' (or H30 message)". (cfr 4.4.1 Ambitions and principles of ERTMS)

  Extensive information about the transported goods and loading unit may be essential for synchromodal transport. HERMES30 message could be a template for the harmonised exchange of cargo information.

- The 'Estimated time of interchange' (ETI) gets calculated for wagons or intermodal loading units (ILU) of a train. It is like the ETA for the train. Wagons or ILUs can leave the train at any intermediate stops on the voyage before the end station. The ETI allows to make trip plans for the individual wagon or the ILU (or several wagons or ILUs with the same voyage). (cfr 4.4.1 Ambitions and principles of ERTMS)

  The ETI information makes it possible to transport the freight (in containers) individually synchromodal.

- "The Rail Facilities Portal (RFP) is a common European web portal that provides information on many different rail facilities. It is a platform for facility operators, like freight terminals, marshalling yards, maintenance facilities, fuelling stations, ports, etc. The operators can use it to publish information about their facility. The RFP is also a single source of information for shippers, railway undertakings, combined-transport operators and other logistic service providers providing them available facilities for the planning for their services and logistic chains. On the portal they can get information where to load and unload the freight, a so-called "first and last mile information"." (cfr 4.4.1.4 Rail Facility Portal of ERTMS)

  A synchromodal transport relies on good information about terminals and other transhipment points, especially about their equipment. Harmonised information on these facilities between each transport mode should be attempted. Certain data should also be machine-readable.

- The Network and Corridor Information Portal provides information about the requirements to be met in order to be allowed to use this part of the infrastructure. The information comprises commercial, technical and legal access conditions. (cfr 4.4.1.6 Network and Corridor Information Portal of ERTMS)

  As long as the transport network is not fully harmonised, information on the different conditions of infrastructure use is very relevant for users. The creation of multimodal corridors can significantly simplify the organisation of synchromodal transport. The

documents or the information including information and rules for the use of these corridors should be made available in a portal or a one-stop shop.

For SuAc 2.3 – Port and terminal information services :

- The 'Estimated time of interchange' (ETI) gets calculated for wagons or intermodal loading units (ILU) of a train. It is like the ETA for the train. Wagons or ILUs can leave the train at any intermediate stops on the voyage before the end station. The ETI allows to make trip plans for the individual wagon or the ILU (or several wagons or ILUs with the same voyage). (cfr 4.4.1 Ambitions and principles of ERTMS)

  The ETI could be calculate for barges or loaded containers. This variable could be a key information displayed at these nodes in order to plan the cargo transhipments and the further ship voyages.

For SuAc 2.4 – RIS enabled corridor management :

- "The designed 'RFC TPM guidelines' were created in accordance to the Regulation (EU) No 913/2010 for rail freight transport on the European railway network. The guidelines are describing the processes for train performance quality management and help implementing measures and key performance indicators to monitor the train performance on the rail freight corridors. The reports about the performance supports the improvement of punctuality." (cfr 4.4.1.1 Train Information System of ERTMS)

  A concept for punctuality management should also be established for shipping in order to increase the accuracy of the calculated times of the voyages. On the other hand, punctuality together with KPIs should increase the reliability of announced arrivals.

- "The Rail Facilities Portal is a common European web portal that provides information on many different rail facilities. It is a platform for facility operators, like freight terminals, marshalling yards, maintenance facilities, fuelling stations, ports, etc. The operators can use it to publish information about their facility." (cfr 4.4.1.4 Rail Facility Portal of ERTMS)

  Good information about terminals and other transhipment points, especially about their equipment, is very essential on the shipping side. Certain data should also be machine-readable. If information on facilities is not harmonised on a synchro- or multimodal level, the extent and accessibility of this information should be improved in the RIS. The composition of the information provided should be brought in line with other transport modes in the sense of a possible multi- or intermodal transport.

- "The trains can be composed of wagons from different customers. The responsible company of the train (LRU, lead railway undertaking) has to create and update a trip plan for each wagon. The trip plan has to be compliant with the train path at train level." (cfr 4.4.1.7.4 Wagon trip plan database of ERTMS)

  Corresponding to the wagon trip plans in rail transport, such travel plans could also be used in inland navigation. By means of an (improved) voyage planner of the RIS portal, the skipper should be able to plan his voyage accurately, including his intended intermediate stops. The planning is reported to the RIS/waterway administration. Conversely, the RIS (maybe using an AI) or the waterway administration optimises this voyage planning with recommendations (e.g. estimated lock times, bridge openings, etc.). By exchanging the information about the intended voyage, both parties are better coordinated. The skipper can (partially) change or update his planned voyage during the voyage, which also leads to a new optimisation process.

For Activity 3:

- "ITS for road is focused on all road users, both professional and non-professional. There is no major difference in the approach towards trucks or passenger cars. This differs from shipping, where services are mainly focussed on commercial shipping." (cfr chapter 4.3.1 Ambitions and Principles of ITS)

  As the non-professional users are actively tacking part in the traffic on the waterways and the locks, they should be encouraged or even obliged to take an active role in the data sharing concerning traffic management. We can be inspired by ITS, where this is taken into account from the start.

- "The Commission Regulation (EU) No 1305/2014 specially defines the technical specification for the interoperability of 'telematics applications for freight subsystems' (TAF TSI). The specification applies for the trans-European rail system network. This specification sets the technical framework for an efficient interchange of information. It deals with applications for freight services and also the interconnections with other transport modes ." (cfr 4.4.1 Key Insights of ERTMS).

  So this Regulation seems very interesting, because it addresses interconnection with other transport modes specifically.

- Figure 15: 'Overarching RIS Architecture' (cfr 4.5.1 Ambitions and principles of e-Navigation)

  For Sub-Activity 3 throughout, this architecture may be helpful for defining the context of the different IWT related technologies.

- "The plan for a fall-back scenario is something that should be further discussed and elaborated within Activity 3. These activities will be able to discuss in further detail the precise technicalities of a fall-back scenario. " (cfr. 7.3 Fall-back scenario)

- There appears to be a "blind spot" regarding the important (global) role of the International Telecommunication Union (ITU) regarding all radio links for mobile applications (in particular regarding ITS and Rail).

  This "blind spot" can be investigated as far as applicable within Sub-Activity 3.5.

- Use the column 'S/SM/FM' in the service catalogue (Annex 1) to make a proper distinction in the possible technologies.

- The Maritime environment relies heavily on the S-100 standard to provide digital services. Within Activity 3 it might be interesting to investigate the differences and similarities between this S-100 standard and the ERI messages. (cfr 5.1.2 Comparison of Maritime Services and RIS Operational Services through documentation)

For Activity 4:

- "The ERA is mainly responsible for the overall coordination at European Union level to avoid individual development of the ERTMS and to ensure the compliance of the ERTMS equipment with the specifications." (cfr Chapter 4.4.1.7.6)

  Within Activity 4 a placeholder should be foreseen for 'Governance'. And this part could be an inspiration for this topic.

- "In addition, the train composition message (TCM, a subset of the HERMES 30 message) has been introduced in passenger and freight transport to exchange relevant train information between railway companies in Europe. The message has to be sent from the railway company to the next one, describing the composition of the train (locomotive, wagons)." (cfr 4.4.1 Key Insights of ERTMS)

  Within Sub-Activity 4.1 it might be interesting to investigate the differences and similarities between this HERMES 30 Message and the ERI messages.

- The Maritime environment relies heavily on the S-100 standard to provide digital services. Within Sub-Activity 4.1 it might be interesting to investigate the differences and similarities between this S-100 standard and the ERI messages. (cfr 5.1.2 Comparison of Maritime Services and RIS Operational Services through documentation)

- The different transport modes are applying different terms for voyage, trip, path, route, etc. Within Sub-Activity 4.1, clear and unambiguous definitions should be elaborated.

For Activity 5

- "Description of the business value for the stakeholders (Business & Government) when growing from 'Digitised' to 'Connected' and ultimately 'Intelligent'." (cfr. 6.3.1 Business value for stakeholders)

  Make suggestions how to reach the criteria to grow from one level to the other. And incorporate this in the roadmap for IWT.

For Activity 6

- "Description of the business value for the stakeholders (Business & Government) when growing from 'Digitised' to 'Connected' and ultimately 'Intelligent'." (cfr. 6.3.1 Business value for stakeholders)

  Proposed business values can be elaborated in Activity 6. Activity 6 needs to motivate the shift from 'Digitised' to 'Connected' and later on to 'Intelligent' with the business models.

5.3 Conclusions

- Principles and ambitions

A first conclusion that can be drawn concerns the ambitions and principles for the different modes of transport. These ambitions and principles are quite similar to each other. They all relate to safety and efficiency that also reduces costs. But there is a difference with ERTMS, here it is not specified that there is an ambition to work more environmentally friendly or sustainable. Something that is clearly mentioned for RIS, ITS and e-Navigation.

This means the services deployed under these digitalisation initiatives can be easily applied across the different modes.

- Common operation of European Services

For European railways, dedicated organisations and associations have been established in order to harmonize and standardize rail services already early in the 20th century. These organisations grew in terms of members (on a global scale) and competences. The European Union contributed to the harmonization by means of several directives and regulations on organisational and technical level.

Initially the European Commission (DG MOVE) took the initiative to set-up a portal to provide information on many types of facilities (Rail Facilities Portal (RFP)). In June 2020, RNE (Rail Net Europe) took over the ownership of the RFP from the European Commission. From then on, the RNE and UIRR (International Union for Road-Rail Combined Transport) jointly operate the portal. The RFP is in accordance with the Directive 2012/34/EU and Implementing Regulation (EU) 2017/2177.

European Services for Inland Waterways such as the European Reference Data Management System (ERDMS), the European Hull Database (EHDB), the European Crew Database (ECDB) have been / are being implemented by DG MOVE. In a view of efficient and sustainable operation it could be investigated how this process worked in the rail sector in order to learn from it for the IWT domain.

- Making services mode agnostic

An important approach taken in this report is to make the inventory as generic as possible. An attempt has always been made to make the terms used for both the information categories and if possible for the functions as generic as possible. Overall, this has been successful for the majority of services (all categories + some functions). By means of a generic description of the services, an additional attempt has been made to fill in the 'Generic' column. The services that qualify for this are generic across different transport modes. The approach for doing this is to try to get into the synchromodal narrative as quickly as possible, something which is discussed several times in this report.

- Service data types

For each service, the exercise was done to fill in the column 'S/SM/FM' (Static, Slow Moving and Fast Moving data). Based on this column, important distinctions can be made in Activity 3. For example, fast moving data requires higher technology solutions than static data. Fast moving data is very dynamic and can change at any given moment and will have to be available at high frequent intervals. Depending on the data type, each service can require specific technologies (cfr. Act. 3), update intervals and quality parameters.

- Trip state: pre / on / after

Based on the information of synchromodal service providers the services have been given a state whether they relate to Pre- On- or After-trip information. These services are important to feed logistic services providers. There is also a strong link between the different states. One will start to explore the possibilities of different transport modes during the pre-trip state. Once the most optimized path defined and confirmed, the involved stakeholders of the transport will try to stay as close as possible

to the path and timing as “agreed” during the pre-trip exploration. Finally an evaluation of the “on” state during the “post” state will reflect on how effective the pre state was and can make proposals to adjust “pre” services to be more accurate.

- Overall conclusion

Overall, it is possible to conclude that, apart from the gaps found in the gap analysis (chapter 5.1), the current inventory is extended with services and concepts inspired by other transport mode, synchro modality and finally by the implementation of EuRIS within the RIS COMEX project. The research has been carried out and a lot of useful work has been achieved.

5.4 Recommendations

This section lists all the recommendations that have emerged throughout the study. For each recommendation, a reference is also given to the section in this report to find more clarification on these recommendations. The recommendations are divided into 3 types. Firstly, there are the recommendations for the DIWA project. These are recommendations that should be included in this project. Secondly, there are the recommendations for the waterway authorities. And finally, the recommendations for the stakeholders. For each recommendation, information on the complexity and priority of this recommendation is provided at the end of this chapter.

5.4.1 Recommendations for the DIWA project

Rec 1: Take the operational services in PIANC extended with the services of RIS COMEX as the baseline for a service catalogue. (cfr. 5.1.1)

Rec 2: Define communication profiles for the different operational and technical services. (cfr 5.1.3)

Rec 3: Elaborate on the standardization and harmonization of the bridge layout and human-machine-interfaces on the bridge. (cfr 4.5.1)

Rec 4: Investigate the potential of the digital twin of a vessel as explained in the Universal Hydrographic Data Model (S-100) opened by the IHO. (cfr 4.5.1)

Rec 5: Look for similarities (or inspiration) between S-211 and S-421 standard with the ERI technical service in RIS. (cfr 5.1.4.2)

Rec 6: Look for similarities (or inspiration) between S-124, S-411 and S-412 and ECDIS. (cfr 5.1.4.3)

Rec 7: Elaborate on a translation service between Inland and Maritime reporting systems e.g. automated exchange of ETD/RTA information. (cfr. 5.1.4.6)

Rec 8: Start the testing and development phase for S-401 (the IWT counterpart/extension of S-101). (cfr. 5.1.4.9)

Rec 9: Develop a service catalogue on Activity 2 level to fulfil the requirements, defined within the different Sub-Activities, to cover all the business developments in IWT. (cfr. 7.1)

Rec 10: Investigate the Commission Regulation (EU) No 1305/2014 which specially defines the technical specification for the interoperability of 'telematics applications for freight subsystems' (TAF TSI). (cfr 4.4.1)

Rec 11: Investigate the principles and governance of the S-100 world as a baseline within the overarching architecture of RIS. (cfr 4.5.1)

Rec 12: Investigate digital fall-back scenario's on a technical level. (cfr. 7.3)

Rec 13: Investigate the role of the International Telecommunication Union (ITU) regarding all radio links for mobile applications (in particular regarding ITS and Rail).

Rec 14: Investigate the differences and similarities between this HERMES 30 Message and the ERI messages. (cfr 4.4.1)

Rec 15: Define the criteria to grow from 'Digitised' to 'Connected ' and ultimately 'Intelligent' in the DIWA Digital Maturity Model. (cfr 6.3.1)

Rec 16: Approve the proposal by Sub-Activity 2.5 to make the new service catalogue mode agnostic. (cfr Annex 1)

Rec 17: Use the column 'S/SM/FM' in the service catalogue (Annex 1) to make a proper distinction in the possible technologies. (cfr. 5.3)

Rec 18 Check the physical transport composition (length, depth, cargo, convoy,…) whether this corresponds with the digital transport composition. (cfr. 5.1.2)

Rec 19 The different transport modes are applying different terms for voyage, trip, path, route, etc. Within Sub-Activity 4.1, clear and unambiguous definitions should be elaborated.

5.4.2 Recommendations for waterway authorities

Rec 20: Process automatic alerts in case of incident or man over board. (cfr 5.1.3)

Rec 21: Keep supporting the worldwide approach of River Information Services within the global official organisations. (cfr 5.1.3)

Rec 22: Install a governance body to guard harmonisation and developments in the field of automated vessels i.a. the hard infrastructure. (cfr 4.4, 5.1.2)

Rec 23: Keep supporting DTLF with insights from IWT in the framework of synchromodal transport. (cfr 4.2.2)

Rec 24: Extend the geographical coverage of EuRIS with all waterways suitable for commercial IWT i.e. beyond corridors. (cfr 4.4.1.2)

Rec 25: Install a system authority or equal governance at EU level to guard harmonisation and developments in the field of operational services and systems e.g. ERA in ERTMS, IMO in e-Navigation. In case of legal obligations proper enforcement is necessary. (cfr. 4.4.1.7.6, 4.5.1, 5.1.2)

5.4.3 Recommendations for stakeholders

Rec 26: For network and infrastructure information, extend the current information catalogue with a service to give easy feedback on discrepancies between provided data and real-life situation. (cfr. 5.1.1)

Rec 27: For voyage and cargo information, extend current information catalogue with a service to provide path offer & path request. (cfr. 5.1.1, 5.1.2)

Rec 28: For voyage and cargo related information, extend current information catalogue with a service to provide re-routing (pre-arranged paths and reserve capacity in case of temporary capacity restrictions). (cfr. 5.1.1)

Rec 29: For traffic related information, extend current information catalogue with a service to provide pro-active alerts. (cfr. 5.1.1)

Rec 30: For traffic related information, extend current information catalogue with a service to provide overview of affected vehicles. (cfr. 5.1.1)

Rec 31: For traffic related information, extend current information catalogue with a service to communicate with affected vehicles. (cfr. 5.1.1 & Annex 1)

Rec 32: For traffic related information, extend current information catalogue with a service to provide easy feedback on discrepancies between provided data traffic information and the real-life updates or even initiate the abnormal state. (cfr. 5.1.1)

Rec 33: Take into account the non-professional users for a smooth traffic management. (cfr 5.1.3)

Rec 34: Facilitate developments from innovative companies (with a level playing field) which create value for IWT. (cfr 5.1.3)

Rec 3: Elaborate on the standardization and harmonization of the bridge layout and human-machine-interfaces on the bridge. (cfr 4.5.1)

Rec 35: Involve the ports and port terminals to increase the number of berths covered in operational systems. (cfr 5.1.4.2)

Rec 36: Introduce pilotage services for autonomous vessels. For instance, to provide assistance at locks/berths that are not yet fully compatible with fully autonomous vessels. (cfr 5.1.4.4)

Rec 37: Introduce tug services for autonomous vessels e.g. through an extended LockAcces message.. For instance, to provide assistance at locks/berths that are not yet fully compatible with fully autonomous vessels. This would however require a standardized physical interface between the tugs and the autonomous vessels. (cfr 5.1.4.5)

Rec 38: Provide a service to make tidal projections available that are based on astronomical tide. (cfr. 5.1.4.13)

Rec 39: Challenge the elaborated service catalogue with operational services (from 'Digitised' to 'Intelligent') and associated business values with the involved stakeholders. (cfr. 6.3.1)

In this table, all the recommendations are listed again. For each recommendation a degree of complexity and priority has been specified (H: High, M: Medium, L:Low). In so doing, it is possible to better comprehend the recommendations.

Recommendations	Level of complexity	Priority
1	L	H
2	M	H
3	H	H
4	L	H
5	M	M
6	M	M
7	M	H
8	L	M
9	L	H
10	L	L
11	M	H
12	L	H
13	L	H
14	M	L
15	M	H
16	L	H
17	L	L
18	H	H
19	L	H
20	M	H
21	H	L
22	H	M
23	L	H
24	L	L
25	H	M
26	M	M
27	M	M
28	M	M
29	M	M
30	M	M
31	M	M
32	M	M
33	Technical: L, Organisational: H	M
34	L	H
35	L	M
36	H	L
37	H	L
38	L	H
39	L	H

Remark: some of the recommendations are only applicable towards other Sub-Activities in DIWA. The real complexity will be known after the results of the investigations are available.

5.5 Cross check with objectives and tasks

5.5.1 Objectives

The objective of this Sub-Activity is to describe the business developments regarding ITS, ERTMS, e-Nav, with focus on:

- The services, information processes and information requirements related to traffic, transport and logistics that are in a development phase and are relevant to IWT.
- Consequences for data and information needs

The desk research based on the legal framework and the experience from previous realised and ongoing projects provided a better understanding of the different business developments of each transport mode, i.e. their principles, ambitions and key insights, reflected in chapter 4.

The information requirements related to traffic, transport and logistics are reflected in the inventory table (Annex 1) by means of the different categories and more specific the different 1st and 2nd level functions. The consequences for information needs are reflected within the gap analysis in chapter 4.7.

The consequences for data needs will be defined and investigated within the different Sub-Activities of Activity 3 and 4.

5.5.2 Tasks

1) Make an inventory and study on ITS, ERTMS and e-Navigation and assess the consequences for the digital transition for IWT in the period 2022-2032.

2) Define the integral and harmonised service, information and data requirements related to the digital transition of Inland Waterways for each "development".

3) Draft intermediate report (study) on ITS, ERTMS and e-Navigation inventory, study and requirements in relation to the Masterplan Digitalisation of Inland Waterways and provide conclusions and recommendations on the (shared) use of services, systems, applications and technologies in the different modalities.

The results of the above mentioned tasks are considered in the report for this Sub-Activity and included in the inventory (Annex 1).

6 Annexes

6.1 Inventory

Inventory in Excel

6.2 Bibliography

- References to other sources (see Samenwerkruimten, PIANC, COMEX, IHO, IMO, …)
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1744&qid=1643210761572

6.2.1 Bibliography RIS

- CESNI-TI RIS | HOMEPAGE
- https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13135-River-information-services-revision-of-EU-rules_en
- Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information, OJ L 249, 31.7.2020, p. 33–48 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020R1056&from=en

All following legal framework can be found on:

- Commission Implementing Regulation (EU) 2019/1744 of 17 September 2019 on technical specifications for electronic ship reporting in inland navigation and repealing Regulation (EU) No 164/2010
- Commission Regulation (EU) No 164/2010 of 25 January 2010 on the technical specifications for electronic ship reporting in inland navigation referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community
- Commission Implementing Regulation (EU) 2018/2032 of 20 November 2018 amending Commission Regulation (EC) No 416/2007 concerning the technical specifications for Notices to Skippers
- Commission Regulation (EC) No 416/2007 of 22 March 2007 concerning the technical specifications for Notices to Skippers as referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community
- Commission Implementing Regulation (EU) 2018/1973 of 7 December 2018 amending Implementing Regulation (EU) No 909/2013 on the technical specifications for the electronic chart display and information system for inland navigation (Inland ECDIS) referred to in Directive 2005/44/EC of the European Parliament and of the Council
- Commission Implementing Regulation (EU) No 909/2013 of 10 September 2013 on the technical specifications for the electronic chart display and information system for inland navigation (Inland ECDIS) referred to in Directive 2005/44/EC of the European Parliament and of the Council
- Commission Implementing Regulation (EU) 2019/838 of 20 February 2019 on technical specifications for vessel tracking and tracing systems and repealing Regulation (EC) No 415/2007
- Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the technical specifications for vessel tracking and tracing systems referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

- Commission Regulation (EC) No 414/2007 of 13 March 2007 concerning the technical guidelines for the planning, implementation and operational use of river information services (RIS) referred to in Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on harmonised river information services (RIS) on inland waterways in the Community

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- COMMISSION DELEGATED REGULATION (EU) No 886/2013 of 15 May 2013 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users
- DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles
- UNECE Agreement concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations.
- Homepage » ERTICO
- A better future transformed by intelligent mobility. - ITS America
- https://ec.europa.eu/transport/themes/its_en
- Homepage | UNECE
- ETSI - Welcome to the World of Standards!
- ISO - International Organization for Standardization
- CEN-CENELEC - CEN-CENELEC (cencenelec.eu)
- ITU: Committed to connecting the world
- https://www.c-roads.eu/platform.html

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- https://www.era.europa.eu/activities/european-rail-traffic-management-system-ertms_en
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- REGULATION (EU) 2016/796 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the European Union Agency for Railways and repealing Regulation (EC) No 881/2004
- DIRECTIVE 2012/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 November 2012 establishing a single European railway area
- COMMISSION IMPLEMENTING REGULATION (EU) 2017/6 of 5 January 2017 on the European Rail Traffic Management System European deployment plan
- DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the European Union
- DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety
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- COMMISSION REGULATION (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the 'control-command and signalling' subsystems of the rail system in the European Union

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- Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU
- COMMISSION REGULATION (EU) No 1305/2014 of 11 December 2014 on the technical specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union and repealing the Regulation (EC) No 62/2006
- COMMISSION IMPLEMENTING REGULATION (EU) 2017/2177 of 22 November 2017 on access to service facilities and rail-related services
- REGULATION (EU) No 913/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 concerning a European rail network for competitive freight
- DIRECTIVE 2007/59/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the certification of train drivers operating locomotives and trains on the railway system in the Community
- REGULATION (EU) 2018/643 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 April 2018 on rail transport statistics

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6.3 Table of figures