DIWA Report

Sub-Activity 3.2: IWT Connectivity Platform

Version: v1.0 final version, October 2023

Main author: Project team Masterplan DIWA

Contributing: Generaldirektion Wasserstraßen und Schifffahrt, De Vlaamse Waterweg, viadonau – Österreichische Wasserstraßen-Gesellschaft mbH, Voies navigables de France, Rijkswaterstaat

Co-financed by the European Union
Connecting Europe Facility

Main author: Jannes Verstichel, De Vlaamse Waterweg/Alsic

Contributing: Christoph Plasil, viadonau
Mario Kaufmann, viadonau
Robert Schwarz, viadonau
Thomas Zwicklhuber, viadonau
Martijn van Hengstum, Rijkswaterstaat
Peter Oudenes, Rijkswaterstaat
Therry van der Burgt, Rijkswaterstaat
Jef Bauwens, De Vlaamse Waterweg
Eric Duchesne, De Vlaamse Waterweg/BDO

Co-funded by
the European Union

Table of content

List of figures

List of tables

1 Executive Summary

This report considers the technological developments on information management in inland waterway transport on European corridors to simplify data sharing between different stakeholders to create an optimal use of IWT and the other transport modalities. Linking data sources to one another via a Connectivity Platform, thus creating a one-stop-shop for information is investigated, also from a rail point-of-view, as well as new and upcoming initiatives and technologies like eFTI, FEDeRATED, FENIX, Linked Data and (European) Data Spaces. Some Port Community Systems are also examined and evaluated

Given the many current (and often early stage) developments related to this SuAcs topic, the study focusses on high level information, identifying trends and interesting avenues (possible scenario's) rather than investigating and clarifying technical implementations or detailed architectures of initiatives that may not reach the required maturity or level of adoption that is required to make them an actual candidate for implementation in IWT.

1.1 Connectivity Platform initiatives and technologies

At the start of the Masterplan DIWA project conception in 2018 the **Maritime Connectivity Platform** (MCP) was envisioned to be developed to support the electronic exchange of information for e-Navigation services. It would be beneficial to coastal states of the EU if there was synergy between such a platform and separate development for maritime and IWT could be prevented.
The Maritime Connectivity Platform[1] is an architecture with a set of standards covering ship – shore data exchange, enabling seagoing vessels to consume the same services all over the world via MCP implementations, regardless of the underlying (legacy) implementation of the local shore system(s).

Data Spaces (like the **European Data Spaces**) have a similar goal of enabling data-sharing and providing services for transparent data pooling and processing, while adhering to all relevant legislation. The Common European Data Spaces have an even bigger goal, as their aim is to also overcome existing legal barriers to data sharing.
Although this goal could be reached by setting up brand new (eco)systems, the EU acknowledges that some sectors (e.g. the mobility and transport sector) already have important frameworks and initiatives for sharing relevant data B2B, B2G, G2B and G2G. Moreover, they are aware of the fact that several initiatives (by both governmental and private actors) aim to further improve/extend on these frameworks and provide data governance, technical infrastructure and economic models to create a data economy in the mobility sector. Given this state of affairs, a (European) mobility data space should not be construed as a (single) operational (technological) instance where data consumers can plug in and extract mobility data from plugged in data providers, but rather as an alliance of parties that can assist with some or all aspects of mobility data exchange via both existing and new systems.

EuRIS is a single web portal that seamlessly combines River Information Services of 13 European partners[2]. As one of the results of the EU funded RIS COMEX project[3], it is an operational platform backed by a solid governance model, including financing agreements allowing sustainable operation. As it discloses a treasure of high quality IWT information on many levels and over a huge geographical area, it is **set to become an important, if not the, access point for information on inland waterways and inland waterway transportation**.

eFTI, FEDeRATED and FENIX are interesting initiatives concerning (decentralized) data sharing and information exchange are the result of the **Digital Transport and Logistics Forum** (DTLF) which is a consultative platform of the European Commission for the coordination and cooperation between stakeholders from a cross-modal and cross-sectorial perspective to support the European Commission in promoting the digital transformation of the transport and logistics sector.

[1] https://maritimeconnectivity.net/
[2] https://www.eurisportal.eu/
[3] https://www.riscomex.eu/

The **Regulation on electronic freight transport information (eFTI)**[4] aims to encourage the digitalization of freight transport and logistics to reduce administrative costs, improve enforcement capabilities of competent authorities, and enhance the efficiency and sustainability of transport. The eFTI Regulation establishes the legal framework for electronic exchange of information that is required by the EU and national legislation to prove compliance with EU and national rules on the movement of goods by rail, road, inland waterways and air between the economic operators and the Member States authorities on the movement of cargo in the European Union. The three main aspects of eFTI are the common data set, the platforms and the certification process. This report focusses on the eFTI platforms, which are an approved software that can be accessed by a national authority to retrieve information made available by an economic operator. eFTI platforms need to comply with certain functional requirements to ensure, among others, data authenticity, integrity and cybersecurity. The related service providers must also meet a set of requirements (keep data for a certain period of time, provide access to authorities, secure data) and receive certification. While each economic operator can use any certified eFTI platform for providing their data in an electronic way, they are not obliged to do so and can keep reporting their information on paper (unless national legislation states otherwise). The relevant authorities, on the other hand, are obliged to support eFTI and accept data that is provided via an eFTI platform.
The timeline for implementing eFTI is very short, with the eFTI Regulation published on July 15th 2020 and the deadline for full compliance by the relevant authorities set for August 2025, with no clear view on the common data set, overall architecture and certification process at the time of writing.

FEDeRATED and FENIX are two very similar initiatives for federated (decentralized) data exchange in freight transport and logistics. Their objectives are to create an open and neutral data sharing infrastructure that is accessible to all stakeholders, offering interoperability between existing and future platforms. Using a translation layer (called a connector or a basic data sharing infrastructure) between the external network and the internal system (called a platform or node), all systems are able to communicate and share data in the same way, regardless of their internal implementation. By using a common language, guarding data sovereignty, applying identity and authentication mechanisms and enabling discoverability, a safe and trustworthy decentralized data sharing solution can be built. Via living labs (proof of concepts) and pilot projects and sites, the potential of both FEDeRATED and FENIX is investigated in different European projects.

While the aforementioned initiatives are mostly still in a conceptual phase, **Port Community Systems** already provide operational platforms for sharing information with and from IWT and other transport modes and relevant stakeholders. These platforms often support a wide range of existing standards for data exchange from different transport modes, including translation services, alongside their own custom (real-time) APIs and data formats for specific use cases. These Port Community Systems form a rapidly growing ecosystem in the transport chain, providing added-value services to the transport community, and are often looking to connect to River Information Systems such as EuRIS to increase the Quality of Service they can offer to their clients in the hinterland. The Port Community Services PortBase, RiverPorts Planning and Information System, Bremer Hafentelematik, Dakosy and Hamburg Vessel Coordination Center are investigated in this report.

When looking across the modal borders, the **RailNetEurope** association, a body for the coordination of the individual railway infrastructure managers, is acting as this so-called 'one-stop shop' by coordinating, harmonizing, developing and offering several services to international railway undertakings. Using a Common Interface, they link the internal systems of rail operators and other rail stakeholders to each other in a Peer-to-peer network, a setup that is very similar to the FENIX Connector. While the main goal of this Common Interface is to enable message exchange for the TAF TSI regulations[5], the system is flexible and allows message exchange beyond that scope as long as the communicating parties adhere to the basic message structure.

From the pure technology side, an interesting development is **Linked Data** and the Linked Data Event Stream (LDES), which use a combination of HyperText Transfer Protocol (HTTP), Uniform Resource

[4] Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information
[5] EU Commission Regulation No 1305/2014 on the technical specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union

Identifiers (URIs) to identify and locate information, the SPARQL Protocol and Resource Description Framework (RDF) Query Language to retrieve and modify the data, and metadata containing related URIs to link the data to other data, enabling the discovery of more information.

A **Technology Readiness Level** analysis is made of the researched initiatives and technologies to assess their maturity and determine if they are ready for adoption by the waterway authorities.

1.2 Recommendations

An analysis is made of the input from the other DIWA Sub Activities regarding connectivity platforms, resulting in a list of requirements for an IWT Connectivity Platform (CP). The other DIWA Sub Activities also indicated that EuRIS has a very close match to the features they expect from an IWT Connectivity Platform. As a result, the EuRIS platform is investigated on a high level, with focus on its CP potential. It is concluded that, although the centralized setup of EuRIS may seem in contradiction with the idea of a CP, EuRIS has a lot of potential to provide CP functionality. A recommendation is formulated to **extend EuRIS with Connectivity Platform functionality on two levels**: (1) Web Modules for human readable information and (2) Connectivity Services for machine readable information.

When considering European Data Spaces, it can be concluded that EuRIS meets all of the requirements for a European Data Space. A recommendation made to **validate EuRIS's conformance with the European Data Spaces requirements** and to **promote the role of EuRIS as an inland waterway transport Data Space**. Several other recommendations are made to further increase the EU Data Space compliance of EuRIS and start preparing for the connection of EuRIS with other EU Data Spaces and obtain the necessary funding to **realize EuRIS's potential as an EU-wide common data space in the domain of inland waterway transport**.

Naturally, the **implications for EuRIS** on the operational, governance, legal, funding, … level are also considered, and important questions that should be answered before transforming EuRIS into a Connectivity Platform and/or EU Common Data Space are formulated.

Decentralized data exchange platforms (e.g. Federated, FENIX) **and sharing standards** (e.g. LinkedData) should be **followed closely** to obtain an idea of the **relevance** for **and impact** on our fairway information services (EuRIS), enable a quick response to **further developments** and the possible emergence of an **industry standard**.

eFTI should be considered **an opportunity for IWT** with the potential of **creating a competitive advantage** for IWT. As the eFTI architecture is not final yet, it is however difficult to give tangible recommendations. Even though the impact of eFTI on ERI and IWT in general could be limited, it is recommended to **stay closely involved in the elaboration and finalization of the eFTI architecture and certification process**. If the opportunity arises, it could be interesting to consider transforming existing ERI-systems into eFTI compliant service providers, thus helping to reduce the administrative burden for the IWT community.

There is a lot of activity and innovation in Port Community Systems, and linking these PCSs with the existing RIS of the inland waterway authorities could create a mutual advantage. It is **recommended to start a cooperation between the European PCSs and fairway authorities to optimize and digitalize processes in cooperation with stakeholders**. After approval which data services are relevant, a more technical assessment is recommended on how to share data (API) and how to share identities and authorizations of common stakeholders.

There are many interesting recommendations and suggestions from this DIWA Sub Activity. Together they paint an **ambitious path towards a cross-modal connected and digitized IWT**, without losing track of the core RIS values of safety, efficiency, and sustainability. It seems that **EuRIS will be an important cornerstone of this future IWT ecosystem**.

2 Introduction

This report considers the technological developments on information management in inland transport on European corridors. Linking data sources to one another via a Connectivity Platform, thus creating a one-stop-shop for information is investigated, also from a rail point-of-view, as well as new and upcoming initiatives and technologies like eFTI, FEDeRATED, FENIX, Linked Data and (European) Data Spaces. Some Port Community Systems are also examined and evaluated.

3 Work approach

This report was drafted during several meetings with the members of this Sub Activity. During the Kick-Off meeting a brainstorm session fed by ideas from the Work Program, SuAc Members and input for DIWA Activity 2 resulted in a list of interesting topics. These topics were investigated via Desktop Research, and the results were presented and discussed in the second SuAc meeting. By the end of the meeting a common view on most relevant topics for the SuAc report materialized. This common view resulted in a first draft report containing several placeholders for Desk Research topics that should be further elaborated or written down in a structured way. This was partially achieved during a second draft report meeting and finalized during the final report meeting. During the meeting on the final draft report, held in conjunction with the final draft report meeting for DIWA SuAc 3.4, the visions and ideas were fully aligned, allowing the finalization of the report for review by the PMT by the end of October 2022. During the life cycle of this Sub Activity there were also meetings with external experts on some of the relevant topics, which allowed a deep-dive into topics on which none of the Sub Activity members are experts and added significant new insights and interesting recommendations.

Due to the many actual developments on the related topics, some research could not be finalized by the end of the SuAc life cycle. Therefore some crucial new information may need to be incorporated during the Activity 5 life cycle.

4 Objectives of this study

The objective of this SuAc is to describe the new technological developments on IWT connectivity platforms and related digital transformations. The focus is on a set of proposals for integral and harmonized technological solutions for the (future) business developments related to the digital transformation of Inland Waterways for each development.

Given the many current (and often early stage) developments related to this SuAcs topic, the study will focus on high level information, identifying trends and interesting avenues rather than investigating and clarifying technical implementations or detailed architectures of initiatives that may not reach the required maturity or level of adoption that is required to make them an actual candidate for implementation in IWT.

5 Initiatives and technologies related to Connectivity Platforms

In this chapter the current state of affairs on Connectivity Platform related initiatives and technologies is presented and analyzed.

5.1 Maritime Connectivity Platform

At the start of the Masterplan DIWA project conception in 2018 the developments in the maritime domain regarding a Maritime Connectivity Platform (MCP) were identified to be of interest for IWT. At that time the MCP was envisioned to be developed to support the electronic exchange of information for e-Navigation services. It would be beneficial to coastal states of the EU if there was synergy between such a platform and separate development for maritime and IWT could be prevented. This gave rise to the use of the term *IWT connectivity platform* for sub activity 3.2.

Maritime Connectivity Platform[6] is an architecture with a set of standards covering ship - shore data exchange (Figure 1). It is governed (the architecture and standards) by the Maritime Connectivity Consortium (MCC).
MCP is not intended to be a centralized concept. The idea is that an organization (not the MCC) will set up a connectivity platform adhering to the MCP architecture and standards and that maritime services will be offered (also by other parties) via this platform. By adhering to the standards vessels would be able to use services offered by MCP instances anywhere in the world.

Figure 1: High level overview of an MCP[7].

The main components of MCP are:

- Service registry: listing all the services available on the MCP instance
- Identity registry: containing all identities allowed to use the MCP instance
- The (data) services themselves

Although extensive concept development has been done within and outside of international maritime organizations (e.g. IALA), actual operational implementations are limited thus far.
Currently there are 2 MCP instances operational, operated by:

- Navelink (www.navelink.org): a commercial consortium
- The Korean ministry of Oceans and Fishery

IWT platforms (and other maritime platforms) have a different architecture than MCP (Figure 2):

[6] https://maritimeconnectivity.net/
[7] Source: https://maritimeconnectivity.net

- Each application / platform has its own identity registry and is typically centralized.
- The organization(s) running the application / platform offer only their own services

However, MCP could be implemented similarly: offering services from just one organization but adhering to the MCP standards.

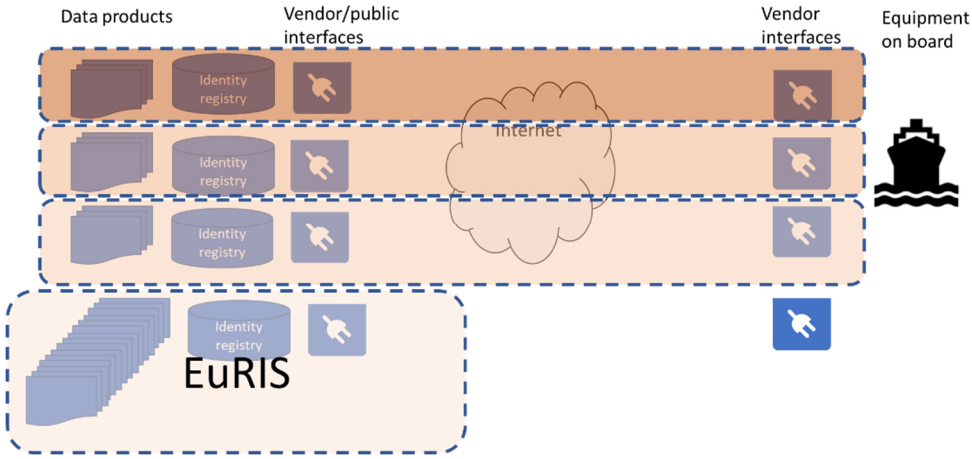


Figure 2: IWT platform/application implementations

The main architectural difference between the EuRIS portal for IWT in Europe and the MCP is the explicit inclusion of a service registry in the MCP. Another important difference is that the body that conceived the MCP does not intend to implement an MCP instance themselves, while the EU partners behind the EuRIS portal implemented an operational platform themselves.

Possible synergies to be gained from the MCP could include the underlying S-100 standard (further addressed in sub activity 3.5) and the service registry concept which surfaced several times in the activity 2 reports (see paragraph 6.1).

5.2 European Mobility Data Spaces

In the European Strategy for Data, data spaces are mentioned as a key element in enabling the EU to become an attractive, secure and dynamic data economy[8]. The strategy defines a set of complementary actions:

- Setting clear and fair rules on data access, use and governance across sectors;
- Investing in next-generation tools and infrastructures to store and process data;
- Joining forces to build a European federated cloud capacity;
- Deploying common and interoperable data spaces in key sectors to help pool, share and re-use data;
- Developing competences by investing in digital skills, data literacy and capacity building in SMEs.

Indeed, the European data strategy of February 2020 announced the creation of data spaces in 10 strategic fields: health, agriculture, manufacturing, energy, **mobility**, financial, public administration, skills, the European Open Science Cloud and the crosscutting key priority of meeting the Green Deal objectives[9]. The website further specifies the following:

> Common European data spaces bring together relevant data infrastructures and governance frameworks in order to facilitate data pooling and sharing. They:

[8] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[9] https://digital-strategy.ec.europa.eu/en/library/staff-working-document-data-spaces

1) deploy data-sharing tools and services for the pooling, processing and sharing of data by an open number of organizations, as well as federate energy-efficient and trustworthy cloud capacities and related services;
2) include data governance structures, compatible with relevant EU legislation, which determine, in a transparent and fair way, the rights concerning access to and processing of the data;
3) improve the availability, quality and interoperability of data – both in domain-specific settings and across sectors.

The creation of EU-wide common, interoperable data spaces in strategic sectors will overcome existing legal and technical barriers to data sharing and, as such, unleash the enormous potential of data-driven innovation.
It will allow data from across the EU to be made available and exchanged in a trustworthy and secure manner. Businesses, public administrations and individuals in Europe will be in control of the data they generate, while knowing that they can trust the way in which it is used to boost innovation. Common European data spaces will therefore enhance the development of new data driven products and services in the EU and thereby create the core tissue of an interconnected and competitive European data economy. It should be noted that in the common European data spaces, data sharing can go beyond the data sharing obligations set out in the Union or Member States legislation.

When considering the key features of a common European data space, we find the following applies[10]:

- A secure and privacy-preserving infrastructure to pool, access, share, process and use data.
- A clear and practical structure for access to and use of data in a fair, transparent, proportionate and/non-discriminatory manner and clear and trustworthy data governance mechanisms.
- European rules and values, in particular personal data protection, consumer protection legislation and competition law, are fully respected.
- Data holders will have the possibility, in the data space, to grant access to or to share certain personal or non-personal data under their control[11].
- Data that is made available can be reused against compensation, including remuneration, or for free.
- Participation of an open number of organizations/ individuals.

Focusing on the European mobility data space we find that the overall goal is to accelerate the digital transformation of the European transport sector and to fully reap the benefits of data for the sector and for society at large.

The EU acknowledges that the mobility and transport sector has important frameworks and initiatives for sharing relevant data B2B, B2G, G2B and G2G. Moreover, there are several initiatives (by both governmental and private actors) that aim to further improve/extend on these frameworks and provide data governance, technical infrastructure and economic models to create a data economy in the mobility sector.

Related to digitalization in IWT, three important aspects of the European mobility data space initiative could be summarized as follows: The mobility data space(s)

- aim to create an environment where both digital passenger and freight information can move freely across (national, regional, company, …) borders[12].
- building upon existing frameworks and contributing to their harmonization on governance and infrastructure level
- while enabling data sharing with linked sectors.

[10] https://ec.europa.eu/newsroom/dae/redirection/document/83562
[11] In the proposal for a European Data Governance, a data holder is defined as "a legal person or data subject who, in accordance with applicable Union or national law, has the right to grant access to or to share certain personal or non-personal data under its control" (COM(2020) 767 final)
[12] As such, the mobility data space could be seen as a digital equivalent of the Schengen Zone.

The last aspect certainly seems to present an interesting challenge for the logistics sector: initiatives for structured data sharing between modes are often still in their infancy, while the EU data space initiative already aims at sharing with external sectors like buildings, energy, environment or health.

A common element of the current mobility data space initiatives is that they provide membership of a community where mobility data providers and data consumers can interact within an established set of rules and standards, sometimes with additional (technical) support to link data provider systems with data consumer systems (e.g. https://mobility-dataspace.eu, https://ishare.eu , https://www.mydata.org). Some communities focus on creating the global standard for international data spaces (IDS) and interfaces (internationaldataspaces.org), others go a step further and develop standards and software frameworks for exchange of data across organizations (https://gaia-x.eu/). These communities seem similar to the Maritime Connectivity Consortium (see Maritime Connectivity Platform5.1) in the sense that they rely on other parties to implement the standards and software frameworks in actual operational instances.

Given the current state of affairs, a (European) mobility data space should not be construed as a (single) operational (technological) instance where data consumers can plug in and extract mobility data from plugged in data providers, but rather as an alliance of parties that can assist with some or all aspects of mobility data exchange.

5.3 DTLF: eFTI, FEDeRATED & FENIX

This chapter provides high-level information on the Digital Transport and Logistics Forum (DTLF) and some highly relevant initiatives that are a result of the work of DTLF: eFTI, FEDeRATED and FENIX.

5.3.1 DTLF, the Digital Transport and Logistics Forum

The DTLF is a consultative platform of the European Commission for the coordination and cooperation between stakeholders from a cross-modal and cross-sectorial perspective to support the European Commission in promoting the digital transformation of the transport and logistics sector. The DTLF is composed of more than 100 experts representing EU Member States' authorities, other public entities, as well as private organisations and individuals operating in the transport and logistics business[13].
"The aim of DTLF is to foster efficient electronic exchange of information in transport and logistics across Europe by removing technical, operational and administrative barriers between and within transport modes" [14].
The DTLF itself spans the umbrella for two working groups whose main areas of work are described in more detail below (see Figure 3).

[13] See https://transport.ec.europa.eu/transport-themes/digital-transport-and-logistics-forum-dtlf_en
[14] Source: See the Subgroup 1 Final Report Executive Summary from the first DTLF Mandate at https://ec.europa.eu/transparency/expert-groups-register/core/api/front/expertGroupAddtitionalInfo/38916/download

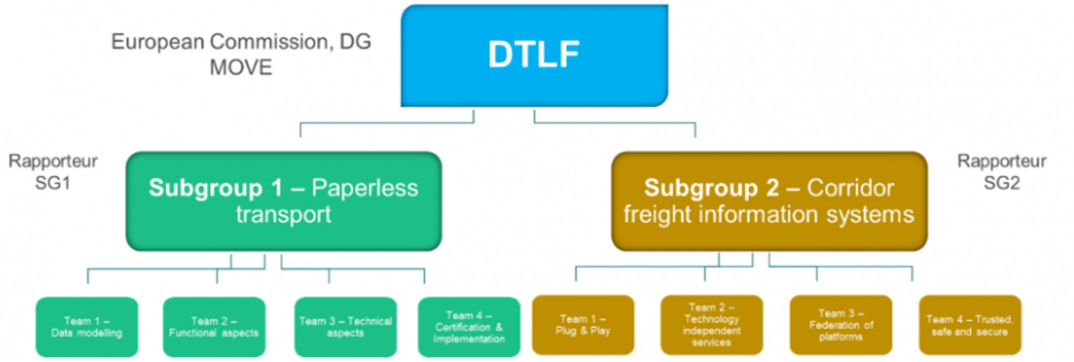


Figure 3: DTLF organization [15]

Subgroup 1 – Paperless Transport on the one hand, focuses, among other things, on defining the data requirements for the new eFTI regulation on "electronic Freight Transport Information". This regulation states that related competent authorities[16] are obliged to accept electronic reporting by economic operators, provided that the reporting is eFTI-compliant. SG 1 is – in addition to defining the eFTI Data Requirements - also responsible for defining the "common data set" that is shared by the seven underlying already existing regulations. Furthermore, SG 1 investigates B2G communication lines (as can be established by eFTI-compliant electronic reporting). The work of SG 1 can be divided into two phases: first tackling cargo, then transport. See chapter 5.3.2 for further information.

Subgroup 2 – (Digital) Corridor Freight Information Systems, on the other hand, focuses on the long term. It aims at resolving the current lack of interoperability between implementation guides, platforms etc. by defining a federative platform that offers interoperability for standardized platform services supporting data sharing between different organizations. SG 2 therefore focuses on topics such as the (sub) business processes defining transport needs, semantic modeling, architectural principles and governance. SG 2 investigates both B2B and B2G communication lines.
The main target of DTLF SG2 is therefore to describe how a federated network of platforms can solve the current lack of interoperability between the different IT systems of enterprises, both customers and logistics service providers. This is targeted in a way that the IT back-office systems can stay mainly as they are, but are extended with "access points" that can be accessed in a "plug & play" way. This way, the enterprise can link up with the federated network using technology independent services.
Implementation guidelines for data sharing frameworks are executed in the projects FEDeRATED and FENIX (see chapters 5.3.3 and 5.3.4).

5.3.2 eFTI regulation on "electronic Freight Transport Information".

The European Parliament and the Council of the European Union (EU) approved the Regulation on electronic freight transport information (eFTI) 2020/1056, which has been published in the Official Journal of the EU on the 15th of July 2020 and entered into force in August 2020. As of 21st of August 2024 it will become fully applicable (see Figure 4).

[15] Organisation of DTLF - source : https://transport.ec.europa.eu/transport-themes/digital-transport-and-logistics-forum-dtlf_en

[16] The eFTI regulation defines a competent authority as follows: 'competent authority' means a public authority, agency or other body which is competent to perform tasks pursuant to the legal acts referred to in Article 2(1) and for which access to regulatory information is necessary, such as checking, enforcing, validating or monitoring compliance on the territory of a Member State.

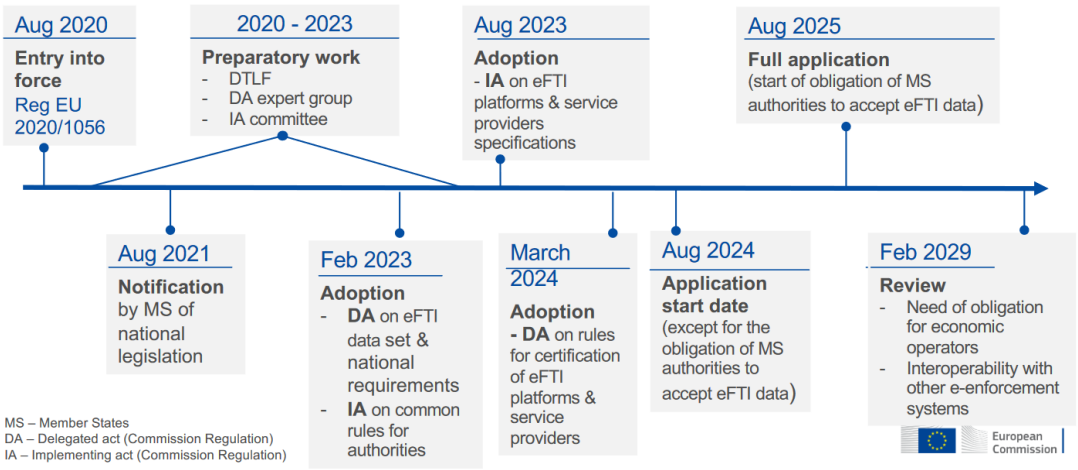


Figure 4: Detailed timeline of eFTI implementation[17]

The movement of goods, including waste, is accompanied by a large amount of information which is still exchanged in paper format among businesses, and between businesses and competent authorities. The use of paper documents represents a significant administrative burden for logistics operators and an additional cost for logistics operators and related industries (such as trade and manufacturing), in particular for SMEs, and has a negative impact on the environment.

The aim of the new Regulation (EU) 2020/1056 is to encourage the digitalization of freight transport and logistics to reduce administrative costs, improve enforcement capabilities of competent authorities, and enhance the efficiency and sustainability of transport.

Therefore, the eFTI Regulation establishes the legal framework for electronic information exchange/provision between the economic operators and the related authorities on the movement of cargo in the European Union. The information concerned is that required by the EU and national legislation to prove compliance with EU and national rules on the movement of goods by rail, road, inland waterways and air.

The current legal framework requires transport documents to be onboard in case of control activities by respective authorities. In the eFTI approach this transport information shall be made available by a pull mechanism accessible at any time and location via an access point (but only to the persons with the proper authorization).

The main component of relevant information is the Transport Document which equals the **eFTI common data set**. The main motivations for starting the initiative lay outside the IWT domain with the result that some important aspects of RIS and border control were not considered in the basic elaborations. However, this drawback was identified and a working group of CESNI/TI has defined the scope and missing elements of eFTI for the operational processes in IWT. The expert group specified the relevant interactions of IWT with the eFTI common data set in Figure 5, which reflects the data elements that are common to the seven regulations that are in scope (Rates & Conditions, Combined Transport, Cabotage, Waste Shipments, Dangerous Goods, Aviation Security, Rail interoperability).

[17] Source: EU Commission, Presentation about EU Regulation on eFTI & DTLF; unece.org

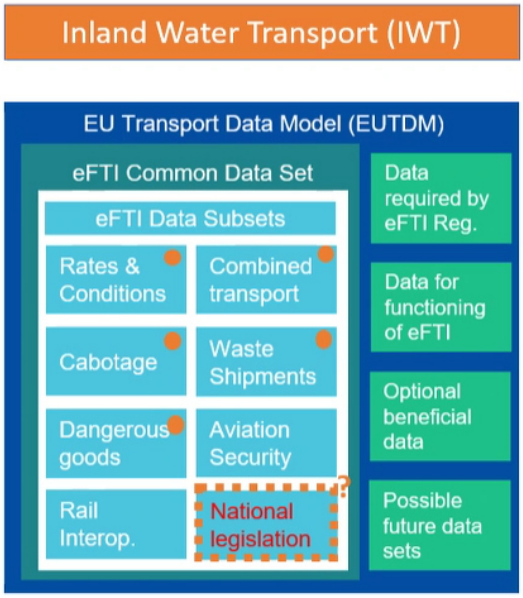


Figure 5: eFTI Data Requirements[18]

In the moment of writing this report, the expert groups are working on further enhancing the eFTI common data set from Figure 6 and mapping the relevant identified subsets to the data requirements. Most important in that respect is the dangerous goods reporting via the ERINOT standard that is widely spread and implemented in IWT. The common goal is to include the relevant eFTI data elements in the revised ERINOT standard.
The eFTI Data Requirements (common data set/data model) have a strong link to DIWA SuAc 3.4 on data registries & information models, which provides further recommendations on that aspect of eFTI in its report.

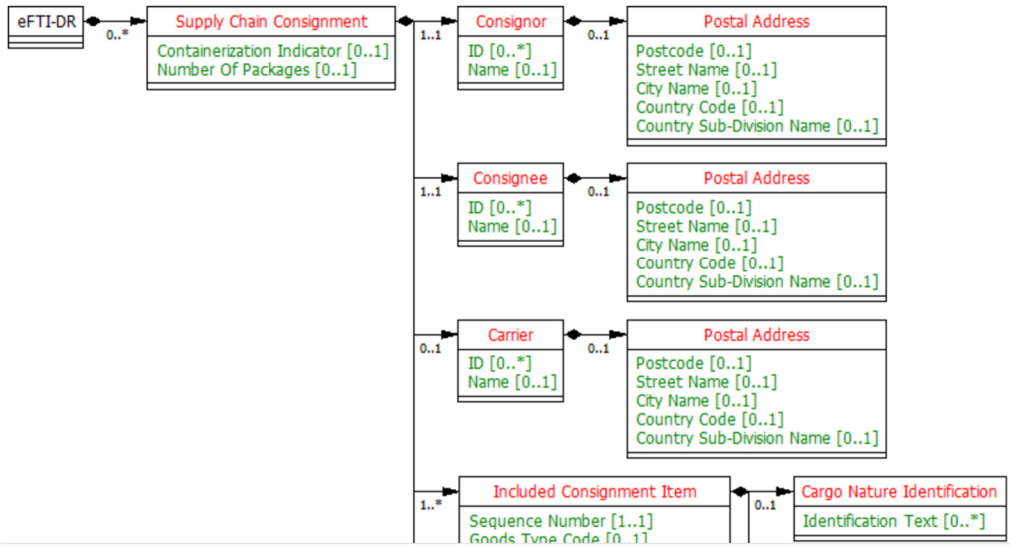


Figure 6: Extension of the eFTI common data set[19]

5.3.2.1 Objective and scope of eFTI

Article 1 states that the Regulation:

[18] Source: DTLF workgroup & European IWT platform: presentation on EU Transport Data Model (EUTDM)
[19] Source: DG MOVE – eFTI Data Requirements: https://svn.gefeg.com/svn/efti-publication/HTML/001.htm

- lays down the conditions including technical specifications for acceptance and a common data set based on which competent authorities in all EU member states are required to accept regulatory freight transport information when that information is made available electronically by the economic operators concerned;
- lays down rules on the provision of services related to making regulatory information available electronically and in a harmonized format by the economic operators concerned to competent authorities.

The scope of the regulation is defined precisely in Article 2. On a high level, the regulation focusses on freight transport of dangerous and non-dangerous goods, also including waste in all transport domains. The regulation addresses only subjects within the area of responsibility of DG MOVE. Digitalization aspects in the thematic area of crew and passenger data fall under the jurisdiction of another EC Department General. DG MOVE recognized the need to extend the eFTI philosophy to other thematic areas as crew reporting and referred to a future extension step.

Furthermore, the interoperability of existing IT systems and solutions is an important prerequisite to promote digitalization in freight transport and logistics.

5.3.2.2 Overview of the content of the regulation

Essential elements of this legal framework are the functional requirements applicable to an eFTI platform, which should be used by economic operators to make regulatory freight transport information available to competent authorities in electronic form in order to meet the conditions for the mandatory acceptance of this information by competent authorities.

This eFTI-platform can be foreseen as a new building block to be developed by the economic operator in its existing inhouse system. But in most cases the economic operator shall rather make use of an intermediate "ready-to-use" eFTI platform. This eFTI platform can also be based on an existing IT platform that is enriched to become eFTI compliant.

The legal framework also includes requirements for third-party platform service providers (eFTI service providers).

All those requirements shall ensure that all eFTI data can be processed solely in accordance with a comprehensive rights-based access-control system that provides assigned functionalities, that all competent authorities can have immediate access to that data in accordance to their respective regulatory enforcement competences.

To build confidence, eFTI platforms have to be certified by an accredited external body.

The European Commission is empowered to adopt delegated acts to supplement Regulation (EU) 2020/1056 by laying down rules:

- on the certification of eFTI platforms
- on certification of eFTI service providers

The Commission shall also adopt delegated acts no later than 21 February 2023 to supplement this Regulation by establishing and amending the eFTI common data set and eFTI data subsets in relation to the respective regulatory information requirements referred to in Article 2(1), including corresponding specifications on the definition and technical characteristics for each data element included in the eFTI common data set and eFTI data subsets.

5.3.2.3 Understanding what an eFTI platform is

An eFTI platform is an approved software that can be accessed by a national authority to retrieve information made available by an economic operator. eFTI platforms need to comply with certain functional requirements to ensure, among others, data authenticity, integrity and cybersecurity. The

related service providers must meet a set of requirements (keep data for a certain period of time, provide access to authorities, secure data) and receive certification.

Each economic operator may use an eFTI (certified) platform of its choice. The certification of these platforms is conducted by competent bodies accredited in the different member states on the basis of the common requirements set out by the regulation.

The economic operator is encouraged to use an eFTI platform but has no obligation to do so. If it does not use an eFTI platform, it can continue to behave "the old way". However, if it uses a certified eFTI platform, the receiving authority will not be authorized to refuse to receive the data this way once the regulation is applicable (21/08/2024).

One of the most important features of the eFTI platform is the access-right management. On the one hand, the data shall be made available at any time to any third party[20] that has the right to access it. This is also called the "pull" mechanism, meaning that the national authority does not passively "receive" the data but needs (or can) actively go and search for it. It is worth mentioning that nor the economic operator nor the eFTI platform needs to intervene when the data is accessed. But on the other hand, the eFTI platform shall also block any unauthorized access to data. In other words, not ALL member states can access ALL the data, and the eFTI platform needs to implement who can access what.

The following **requirements** apply for **eFTI platforms** (article 9 (1):

a) personal data can be processed in accordance with Regulation (EU) 2016/679;
b) commercial data can be processed in accordance with Article 6;
c) competent authorities can access and process data in accordance with the specifications adopted by means of delegated and implementing acts referred to in Articles 7 and 8;
d) the economic operators concerned can make information available to competent authorities in accordance with Article 4;
e) a unique electronic identifying link can be established between a shipment and the related data elements, including a structured reference to the eFTI platform where the data is made available, such as a unique reference identifier;
f) data can be processed solely on the basis of authorized and authenticated access;
g) all data processing is duly recorded in operation logs in order to allow, as a minimum, the identification of each distinct processing operation, the natural or legal person having made the operation and the sequencing of the operations on each individual data element; if an operation involves modifying or erasing an existing data element, the original data element shall be preserved;
h) data can be archived and remain accessible for competent authorities in accordance with the relevant Union legal acts and national law laying down the respective regulatory information requirements;
i) the operation logs referred to in point (g) of this paragraph are archived and remain accessible for competent authorities for auditing purposes for the period of time specified in the relevant Union legal acts and national law laying down the respective regulatory information requirements and, for monitoring purposes, for the periods of time referred to in Article 17;
j) data is protected against corruption and theft;
k) the data elements processed correspond to the eFTI common data set and to eFTI data subsets as established by the delegated acts referred to in Article 7, and can be processed in any of the official languages of the Union as provided for by the relevant Union legal acts and national law laying down the respective regulatory information requirements.

The following **requirements** apply for **eFTI operators**:

[20] In particular the national authorities, but not only. However, this platform is only intended for B2A (Business to Administration)

a) data is processed only by authorized users and according to clearly defined user role and processing rights within the eFTI platform, in accordance with the relevant regulatory information requirements;
b) data is stored and accessible for an appropriate period of time, in accordance with the relevant regulatory information requirements;
c) authorities have immediate access to regulatory information concerning a freight transport operation processed by means of their eFTI platforms, when this access is given to the authorities by an economic operator concerned;
d) data is appropriately secured, including against unauthorized or unlawful processing and against accidental loss, destruction or damage.

5.3.2.4 Certification of an eFTI platform

Before it can be used by an economic operator, an eFTI platform needs to be certified. The member states decide the conformity assessment bodies that are accredited to conduct the certification assessments.

Article 9 of the Regulation gives the functional requirements for eFTI platforms. There is a set of general functionalities that are described (including the access-right management), but for the details, the Regulation stipulates that the European Commission shall adopt implementing acts "*taking into account relevant existing technical solutions and standards*" before 21 August 2023.

5.3.3 FEDeRATED – Federated Network of Platforms

FEDeRATED is an EU project for digital co-operation, aimed to deliver the foundations for a trustworthy and interoperable business and administrative data-sharing infrastructure for freight transport and logistics. The objective of FEDeRATED is to create an open and neutral data sharing infrastructure that is accessible to all stakeholder (level playing field, which means that also SMEs should be able to join the architecture). The infrastructure consists of a so-called 'federated network of platforms' which implies that installed base of platforms and investments done by stakeholders are safeguarded. The Federated Network of platforms depicts 23 Living Labs executed by 15 project partners to proof the concept in real life applications.

The design principles for the applications ground on four main aspects being Plug and Play, Trusted, safe and secure, technology independent infrastructure services and peer-to-peer solutions (see Figure 7).

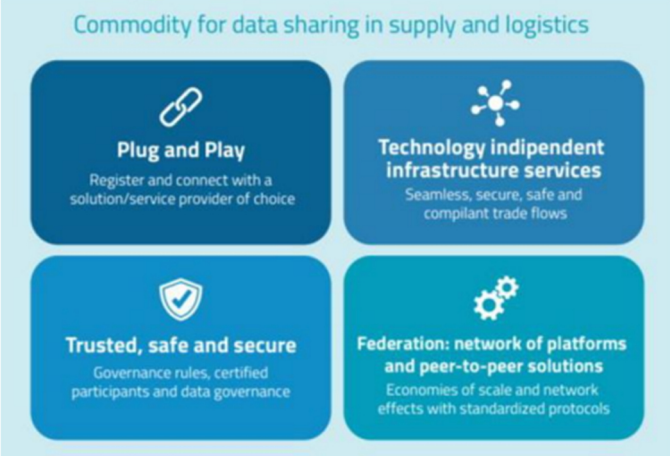


Figure 7: Design principles[21]

Figure 8 highlights the services enabled for transport and logistics by facilitating the originating data categories and linking information platforms to a federated network of platforms.

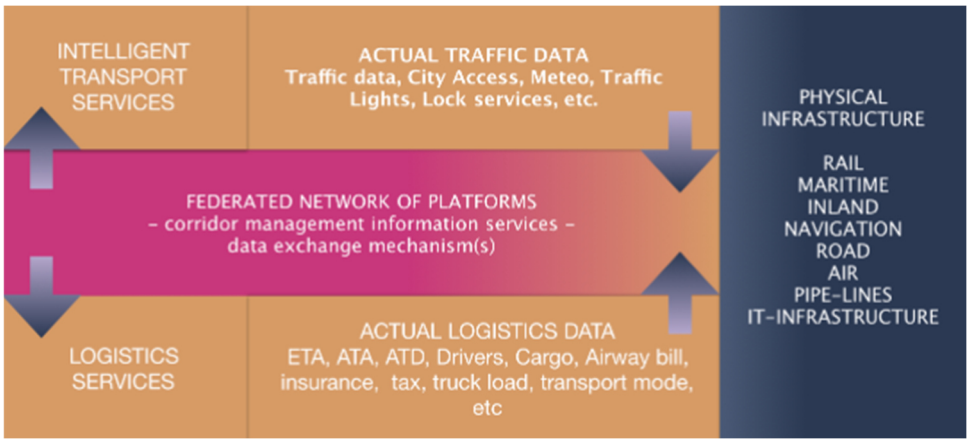


Figure 8: Services enabled for transport and logistics[22]

[21] Source: http://www.federatedplatforms.eu/index.php/library/item/basic-data-sharing-architecture-mitchell-out-it-architcture-group-june-2022
[22] Source: http://www.federatedplatforms.eu/index.php/library/item/visionreport-milestone1?category_id=2

The schematic architecture foresees an event-based peer-to-peer model of the complete supply chain (see Figure 9). The digital representation (digital twin) of the real-world logistics processes collect and provide all state changes to the involved stakeholders.
Getting more technical, the FEDeRATED Semantic model gives insights in the main components from a technical point of view. Integration of the building blocks via APIs is the crucial aspect in linking various information sources together. If more platforms are linked via API it can already act as Federated platforms. For the customer/user though a single API shall act as entry point to the linked information.

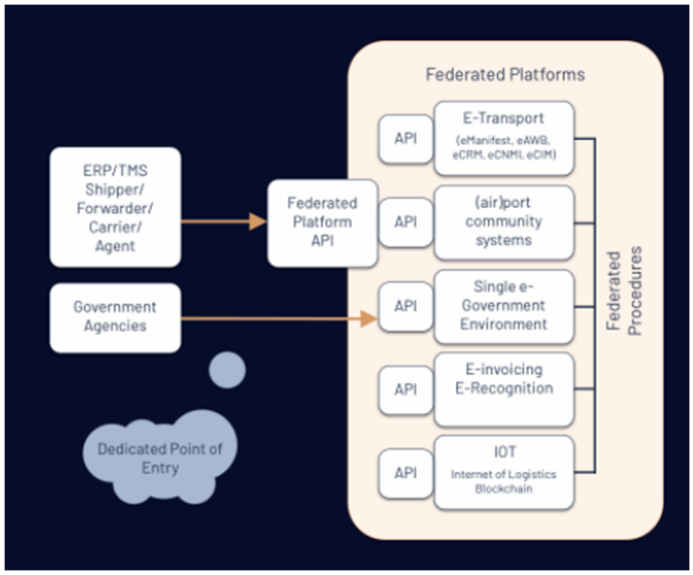


Figure 9: FEDeRATED Semantic Model[23]

Various communities have developed guiding principles for data sharing, e.g. the Digital Transport and Logistics Forum (DTLF) which is an expert group raised and chaired by EC DG Move, the CEF funded FEDeRATED Action, and the International Data Space Association (IDSA). The ones of FEDeRATED as listed in the Interim Master Plan are the most detailed. These refine the ones of DTLF and are therefore taken as a starting point.

5.3.3.1 General principles and proposal to set up a living lab for IWT

To achieve interoperability of the platforms, a set of technology independent agreements principles or agreements needs to be reached that enable organizations to share data. These agreements are:

- **Common language** – both the semantics and their representation for data sharing should be clearly specified to automatically share and process data by different IT systems, supported by IT services (APIs – Application Programming Interfaces). This is called the semantic model. The APIs enable business process collaboration. FEDeRATED proposes the implementation of a semantic API, i.e. one API where the functionality is formulated as a view of the semantic model (e.g. a so-called SPARQL query and triples (RDF (Resource Description Framework) and/or JSON-LD (JSON Linked Data)).
- **Identity and Authentication** – each organization should have a unique identity that is issued by a certified identity provider and can be authenticated. Multiple identification domains may have to be specified, each based on its certification mechanism supported by an identity broker. eIDAS (electronic IDentification, Authentication, and trust Services) is an example where the EU Member States have implemented an agreed certification mechanism for B2G data sharing, both for users and IT systems. Open standards should be applied, in combination with APIs (e.g. OAUTH2.0 and Java Web Tokens (JWT)).
- **Data sovereignty** – each enterprise should be able to control its data sharing, compliant with any restrictions (e.g. GDPR) and regulations (e.g. UCC and eFTI). This is part of access control.

[23] Source: http://www.federatedplatforms.eu/

- **Discoverability** – for inclusiveness and optimization it should be possible to discover commercial information, business services, available logistics capacity, and the past (e.g. a trace or container track), present, and future (e.g. a planned flight, itinerary, or voyage with available capacity) state of supply and logistics chains in networks. State changes are shared via events that support business collaboration. Additionally, information services like weather conditions must be findable.
- **Data sharing solution** – the actual means for reliable and secure transfer of data, including facilities supporting non-repudiation (log and audit trail). Such data sharing solutions provide connectivity, based on (secure) protocols like Transport Link Security (TLS). Most implementations of these standard protocols have an additional layer to facilitate data sharing, where data is the payload with an envelope containing control information required for processing the payload at reception.

There are various technology solutions to deploy these concepts in practice. Blockchain technology inherently supports non-repudiation and can, additionally, also support data integrity. Corda, a technology developed by major EU banks, provides a peer-to-peer data sharing solution with temporary data storage in a Corda node, supported by an underlying notary network for non-repudiation and data integrity (see figure 10).

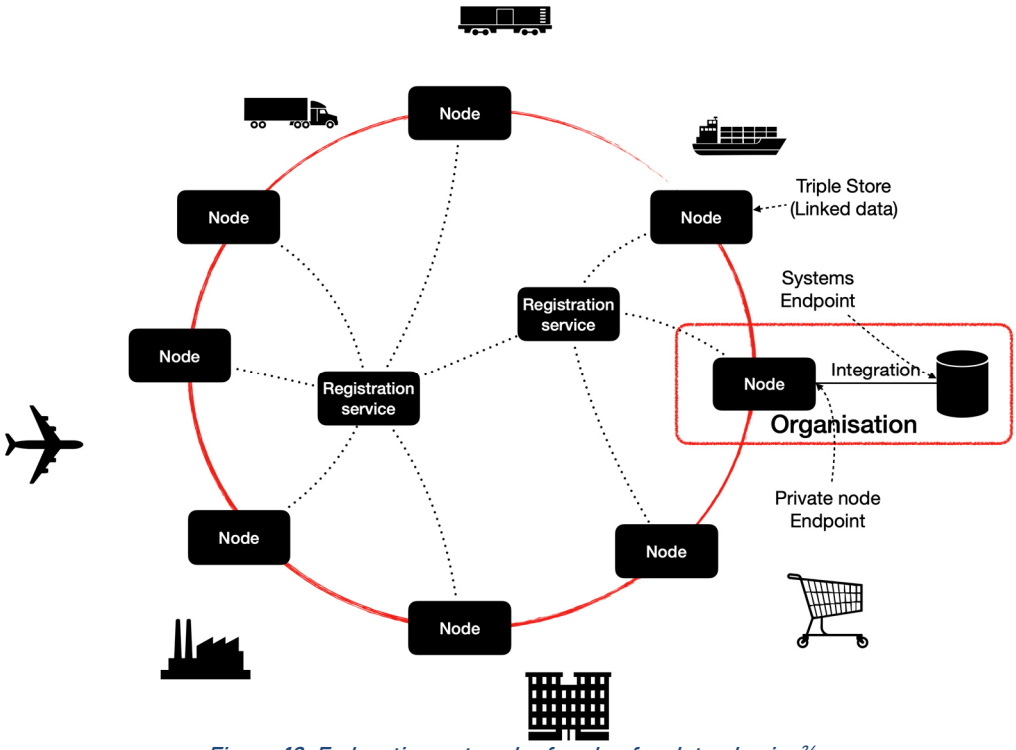


Figure 10: Federative network of nodes for data sharing[24]

The deployment of this concept is quite new and needs to be implemented and tested in practice. A description of Living Lab for IWT has been elaborated[25], based on a business transaction model for the transport of containers from a seaport to an inland port including all the transactions and roles (barge operator, skipper, etc.). Also, some variations of business transactions are described. These transactions are mostly B2B transactions, which means that commercial companies need to (be facilitated/implement) the connection to a federative data sharing infrastructure, with help of an independent organization. Within this living lab proposal for IWT, the EuRIS platform can be positioned as Node for sharing open data (infrastructure and traffic management data services) and privacy sensitive data, like ETA data with consent of the skipper. This will mean that a connector needs to be built (or current EuRIS API's needs to be adjusted) to comply with the above agreements.

[24] Source: Wout Hofman, TNO: Discussion paper on positioning EuRIS in the context of a BDI node

The common language has already been specified. In the Dutch Living Lab, the **Basic Data sharing Infrastructure** (BDI) is developed, where nodes constitute a network. These nodes fully implement the common language and semantically share data (RDF/JSON-LD and SPARQL queries). Any type of query can be formulated on this model, for instance 'container track' or 'traffic density'. Such a large degree of freedom is too complex to handle by most logistics stakeholders, especially SMEs. Thus, predefined settings must be provided like for eFTI, eCMR, and eB/L.
A **BDI node** which is part of the network, consists of a Corda node for data sharing and a triple store that supports discoverability. The triple store contains all events that are shared in a peer-to-peer setting (this means that BDI nodes all contain different data). Each participant implements a BDI node (or its required functionality), thus constructing the BDI. The BDI can have more than one registration service at which one registers its node. The current version of the BDI utilizes the Corda network management service for registering the Corda node as a BDI component to the network.
Industry associations and regulatory bodies can play an important role for predefined settings. They are key stakeholders in the governance. This will allow large scale application of solutions, whilst organizations are still able to innovate. These governance bodies and first movers implementing the solution will drive market acceptance.
The solution can be implemented like a regular change project where new sets of APIs are introduced, but it can also be a paradigm shift. Complete implementation of the semantic model (and any changes) supported by predefined settings and tools to formulate queries does not require standardization like we currently know (for instance of APIs and messages). The infrastructure is open, neutral, and fully distributed. Data sharing platforms are not required; value added functions to support data sharing (e.g. data transformation, data analytics) and logistics (e.g. dynamic chain planning) are required.
Such an infrastructure is expected to drive innovation and enable all types of new services and business models, based on data sovereignty. Various views of supply and logistics can be given, for instance for maintenance and repair and bundling of goods flows.

At the time of writing FEDeRATED is more a R&D than an implementation project. Therefore, the relevance for Act. 3.2 is limited as there is not one connectivity platform elaborated but rather the concept of a federated network shown by the living labs. As explained the implementation of a federated network is rather complex and adaptation of EuRIS to fit in this architecture is needed. However, the concepts of federation and design principles are interesting, potentially resulting in an EU data space / ecosystem in which EuRIS can fit as node or European Access point and even as a reference for some data sources (IWT network).

5.3.4 FENIX – A European Federated Network of Information exchange in logistics

FENIX is a three year long Connecting Europe Facility project aiming to support the development, validation and deployment of the digital information systems along the EU transport Core Network. The EU project including 45 partners is developing a federated architecture for data sharing, serving the European logistics community of shippers, logistics service providers, mobility infrastructure providers, cities, and authorities in order to offer interoperability between any individual existing and future platforms. Eleven pilot sites will be rolled out in nine European countries to further develop the work conducted under the Living Labs in AEOLIX and SELIS projects by structuring the actors and services according to the corridors.

Similar to FEDeRATED, the FENIX network is also based on federation and the same design principles (see Figure 7 and Figure 11).

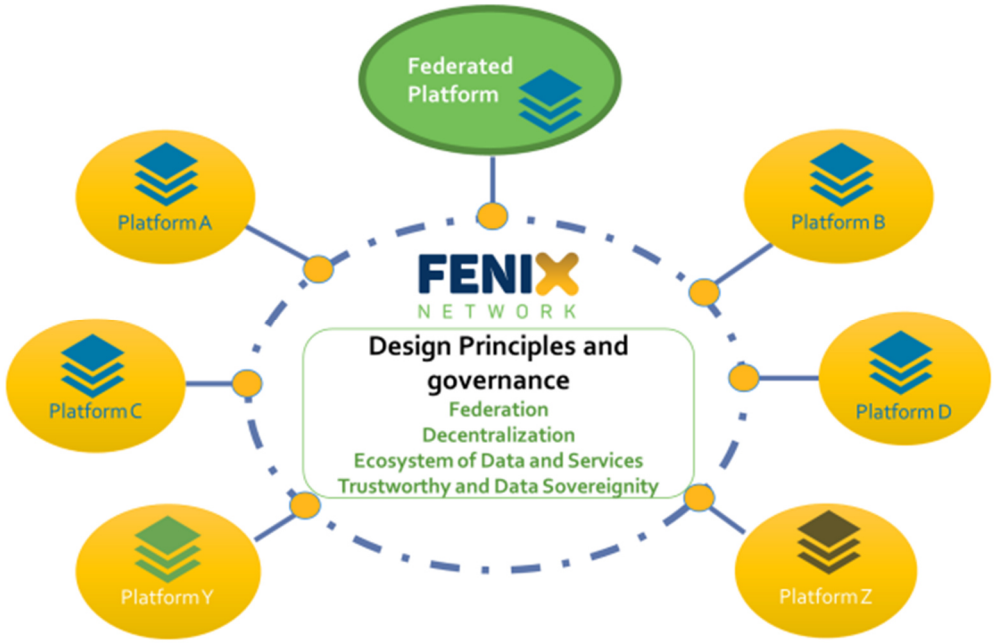


Figure 11: FENIX architecture concept based on design principles[26]

The main difference is that the federated platforms shall be interconnected to the FENIX network via a so-called FENIX connector. The FENIX connector (see Figure 12) is a standardized API which needs to be implemented to get part of the community. The API has been specified and implemented during the project and serves as infrastructure layer. Technical specifications of the FENIX connector are available in the intermediate project results.

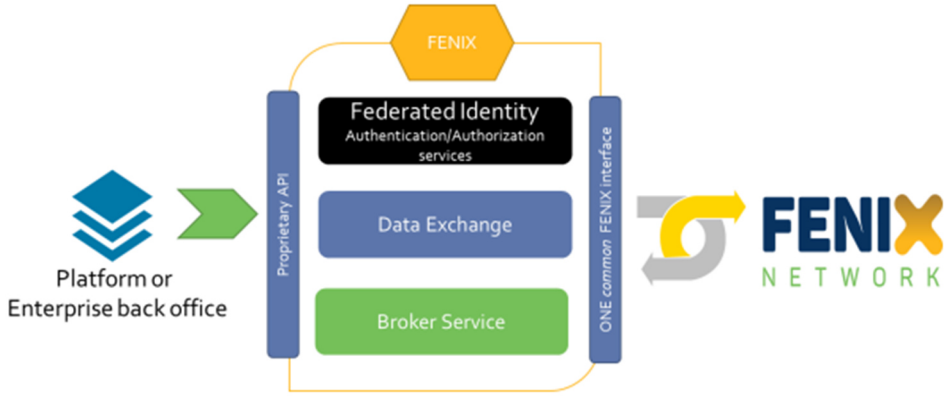


Figure 12: FENIX Connector architecture[27]

5.4 Port (Community) Systems

In this chapter several Port (Community) Systems are investigated.

5.4.1 Portbase

The development of the platform started in 2000 and since 2002 Portbase is the national port community system in the Netherlands. The Ports of Rotterdam and Amsterdam are the shareholders of Portbase. Portbase is positioned as a neutral platform with national coverage and is a not-for-profit organization. Portbase supports the digitalization of business to business processes and business to government processes. Portbase services are smart IT solutions aimed at facilitating the

[26] Source: FENIX Architectural Design Specification: https://fenix-network.eu/deliverables/
[27] Source: FENIX Architectural Design Specification: https://fenix-network.eu/deliverables/

easy and efficient exchange of data in the logistics chain. The 4 main processes are supported with services (https://www.portbase.com/en/services/):

1. Ship calls (sea ships). Services for agents, shipping lines and cargo handling agents active in bulk and containers for handling ships' calls.
2. Import cargo. These services help agents, shipping lines, cargo handling agents, importers and forwarders to import efficiently.
3. Hinterland transport. Smart services for road, barge and rail sectors
4. Export Cargo. Services for forwarders, exporters, agents, shipping lines and cargo handling agents for handling export formalities.

See Figure 13 for an overview of the Portbase environment. Process 1, 2 and 4 do have already a number of services. Process 3 Hinterland transport is under development.

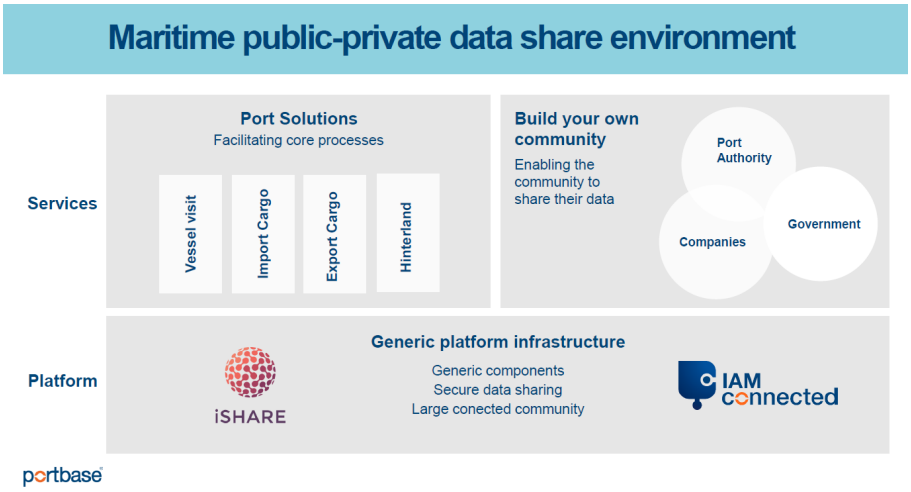


Figure 13: Overview Portbase environment (source: Portbase)

Hinterland transport (3) includes barge transport with a focus on container transport. The following hinterland services are being developed and will be continuously improved for IWT:

- Hinterland container notification: Multimodal portal for the pre-notification of calls and containers via all hinterland modalities – truck, train and barge – at deep sea terminals, inland terminals and depots.
- Hinterland Container Notification Barge (identical service available for road and rail): Pre-notify barge calls and containers at terminals and depots through one single portal. Furthermore, Hinterland Container Notification (HCN) Barge provides the input for the integrated planning of each port call by Nextlogic (see section 5.4.2)

The Portbase project to support the hinterland connection is called Datafuel. See Hinterland Programme: Data Fuel - Portbase for a detailed overview of available services.

In Figure 14 below the status of developments is showed. Portbase is working from the bottom left corner (services operational) towards the upper right corner.

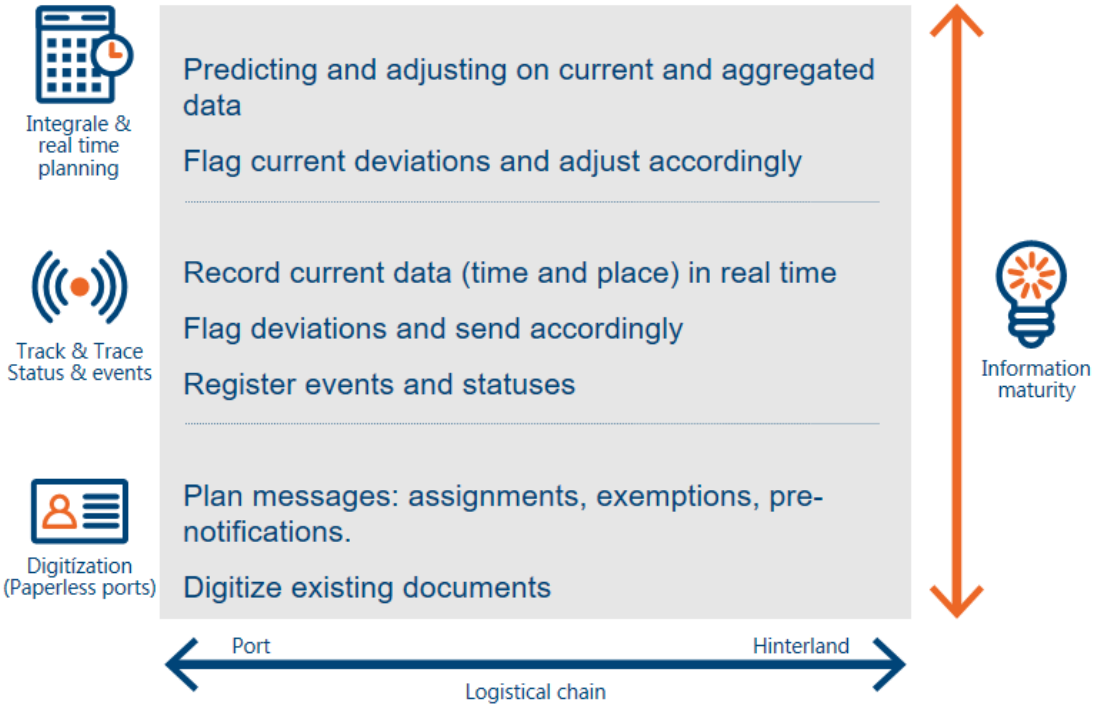


Figure 14: Status of Portbase developments (source: Portbase)

Portbase is working towards integrated data sharing with other stakeholders with authorizations via IAMconnected. The module IAM connected is used for Identification, authentication and authorization of your own digital service(s), see Figure 15 for an overview. The user list is easily kept up to date, like:

- Add, remove (and deactivate) users per service
- Add and edit user groups
- Modify company data

This includes managing the identities of barge operators.

Portbase is an iSHARE satellite, and contains a lot of identities (besides skippers, shippers, also trucks). Portbase uses these identities e.g. for port fees for skippers. EuRIS and also the Electronic reporting systems of the fairway authorities do contain identities of shippers and skippers. It is not clear yet if identities can be reused or shared, so one registration should be sufficient.

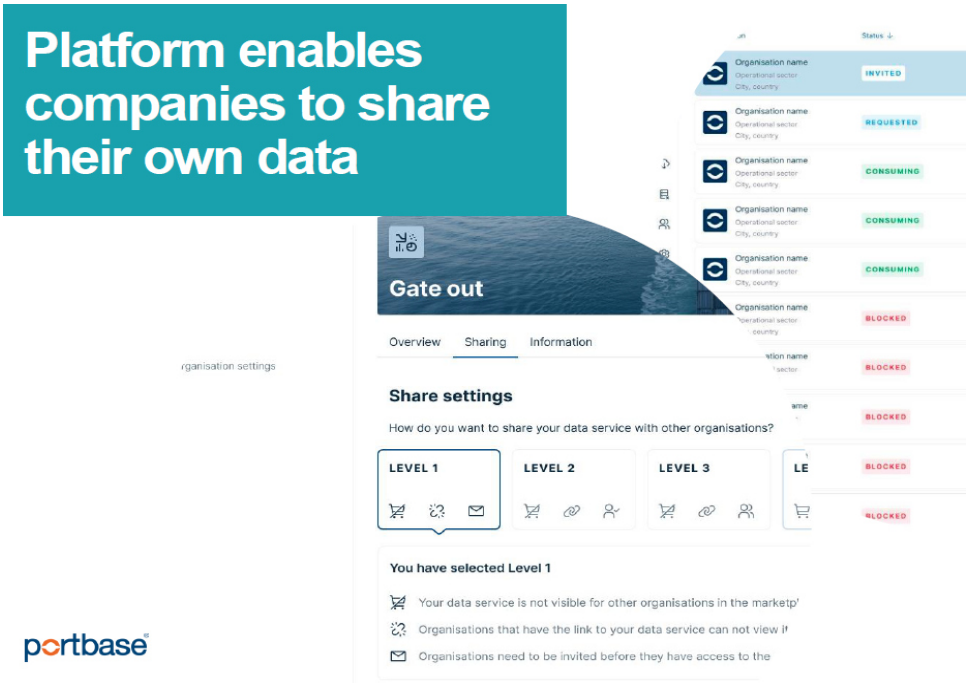


Figure 15: Overview of functionality of IAMconnected (source: Portbase)

After consultation with Portbase, a better insight was provided into the standards and options for sharing data, which is also relevant for sub activity 3.4 of the Masterplan DIWA project 'IWT Data Model & Information Registry. The Portbase data model and exchange is originally based on Maritime standards https://smdg.org/about-us/members/ and https://unece.org/sites/default/files/2021-10/T%2BL13%20-%20SMDG%20-%20update.pdf
SMDG has its origin in EDIFACT, but using it in practice for API's showed that these standards weren't adopted yet by the stakeholders, therefore Portbase looked also at the open trip model (SUTC), but the latter wasn't considered fully ready for container transport. Portbase API's are based on SMDG, however Portbase has it's 'own' data standard.

Portbase does create connectors with other modalities by adopting their standards, like for train compositions (Rail BAPLIE). Portbase didn't chose to use EDI standards as they do not support real-time data and are quite complex and costly, a governance structure is missing to support the standard. Therefore Portbase doesn't invest in EDI API anymore.

Most trips do start at seaports and need real time API's, and Portbase sees DCSA (Shipping Standards | Digital Container Shipping Association (dcsa.org)) as a good candidate for standards to extend to IWT, although harmonization and a critical mass is needed for a successful implementation.

So there isn't a clear standard for a IWT data model for transport for seamless data exchange between seaports, customs, terminals, etc. In most cases data exchange in IWT transport consists of business to business (B2B) transactions. A number of scenarios and candidates are possible for a common data model:

- By legislation, e.g. customs, eFTI
- By CESNI/TI
- By the big companies/carriers
- By PCS
- By using semantics in federative network

The API's are event driven at Portbase, which is called 'long pulling' by Portbase.

An important note is that the above elaboration accounts for container transport. Portbase has a large hinterland project and clear roadmap to connect stakeholders, e.g. through the service Cleared Container Release (shipment file).

At the time of writing no EuRIS data services are being used by Portbase although the data service overview of EuRIS has been provided and the expectation is that some data services will be incorporated by the hinterland program of Portbase.

5.4.2 Nextlogic

Nextlogic is a separate module focusing on improving the handling of inland container shipping in the port of Rotterdam. In collaboration with the market, Nextlogic develops innovative systems and processes, offering terminals, empty depots and barge operators a neutral and integrated planning. Nextlogic is working towards a more efficient handling of inland container shipping, with profits for the whole logistic chain. Nextlogic focuses on reducing inefficiencies in inland container shipping, not only to facilitate, but also to stimulate the growth of this modality. Nextlogic stimulates a reliable and thus predictable turnaround time, better use of the quays, cranes and barges and fewer (small) calls in the sea port. The main difference between previous initiatives and Nextlogic is the integrated, port-wide approach. A distinctive approach based on joint effort by all parties in the logistic chain. Nextlogic will have a tool that is capable of providing integrated planning for all terminals, depots and barge operators in and around the port of Rotterdam in a neutral and dynamic manner. This will bring us within reach of making the integrated planning of inland container shipping a reality

5.4.3 RiverPorts Planning and Information System (RPIS) by RheinPorts

RheinPorts was founded in 2017 by the ports in the border triangle of Switzerland, France and Germany. Before that, RheinPorts had already been working for several years to determine the requirements for the future digital infrastructure. In 2022, Duisburger Hafen AG (duisport) joined RheinPorts as a further shareholder.

RheinPorts aims to quickly and securely unite the logistics port industry in the European hinterland in a network across company, country, and waterway borders. In this way, the data and information required for the processes are to be exchanged among each other as barrier-free as possible.

RheinPorts focuses on connecting inland navigation via a shared digital infrastructure to integrate it more efficiently into logistics chains. To this end, RheinPorts wants to establish RPIS, the world's first multi-port community system for inland navigation, as a sustainable standard system for inland ports and multimodal logistics clusters on the Rhine and in the European hinterland.

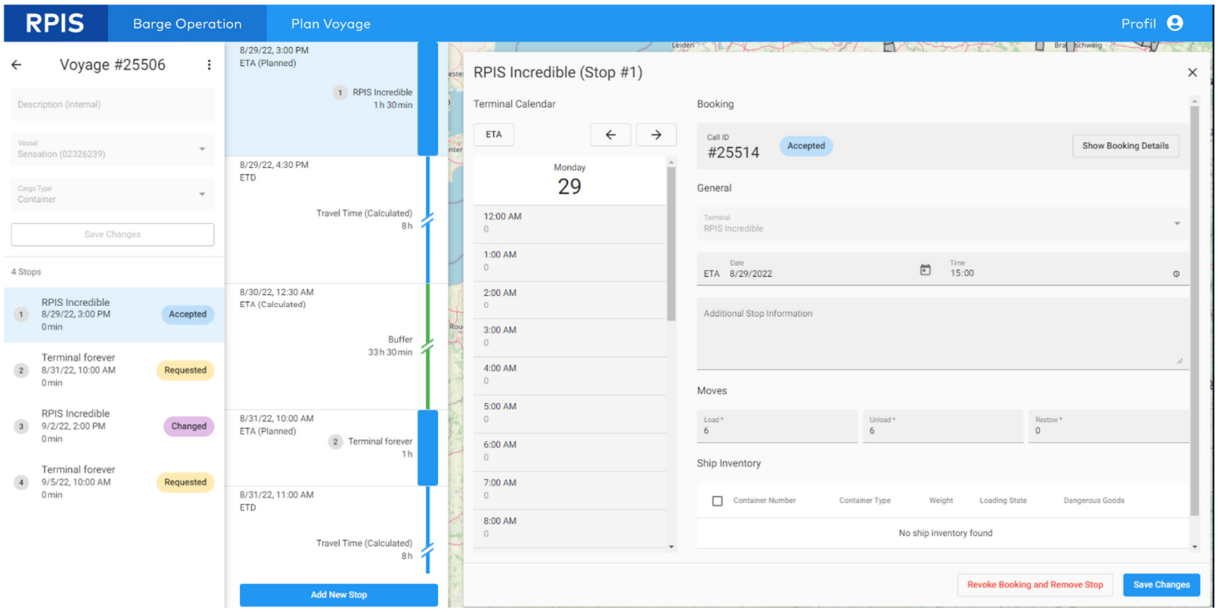


Figure 16: Screenshot of RPIS[28]

The following services are provided by RPIS:

- Coordination of barge calls
  - Tracking the status of a slot-booking request
- Container data administration
- Customs processes

RPIS does not compete with existing systems but provides open, configurable interfaces to support sustainable data exchange between different systems and user groups. In the future, RheinPorts aims to expand RPIS both functionally and geographically. One example of planned functional expansion is offering applications for rail freight transport at logistics hubs. RPIS is also expanding its geographical reach. Recently, Portbase and RheinPorts signed an agreement to exchange knowledge and expertise, with the aim of further digitising the important Rotterdam-Basel-Genoa corridor. By 2023, an initial pilot on sharing data among Portbase, RheinPorts and companies in the community is expected.

The link with EuRIS is another example of cooperation between RPIS and other systems: The latest version of RPIS is already interfacing data from EuRIS. At the moment the implemented data on the dashboard comprise locks and bridges including actual status if available (see Figure 17) and an IENC overlay. The data is fetched via the EuRIS Open APIs on constant basis.
The integration shall not stop on the level of fairway information but evolve towards traffic- and voyage related information in the near future.

[28] Source: https://rheinports.eu/en/

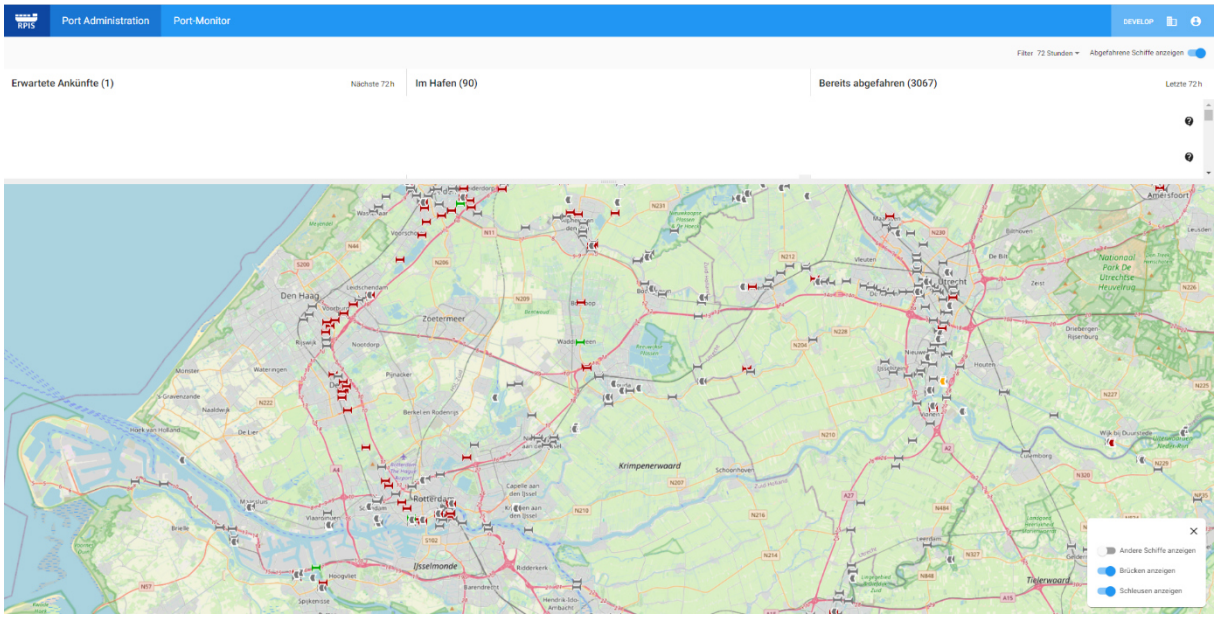


Figure 17: RPIS dashboard including EuRIS data (locks, bridges and its status) (Source: RPIS)

5.4.4 Bremen Port Telematics (BHT)

BHT (Bremer Hafentelematik) is operated by dbh Logistics IT AG and is the central communication platform for the Ports of Bremen. The functions can be accessed via the web. Different services and stakeholders of BHT are summarized in Figure 18 below.

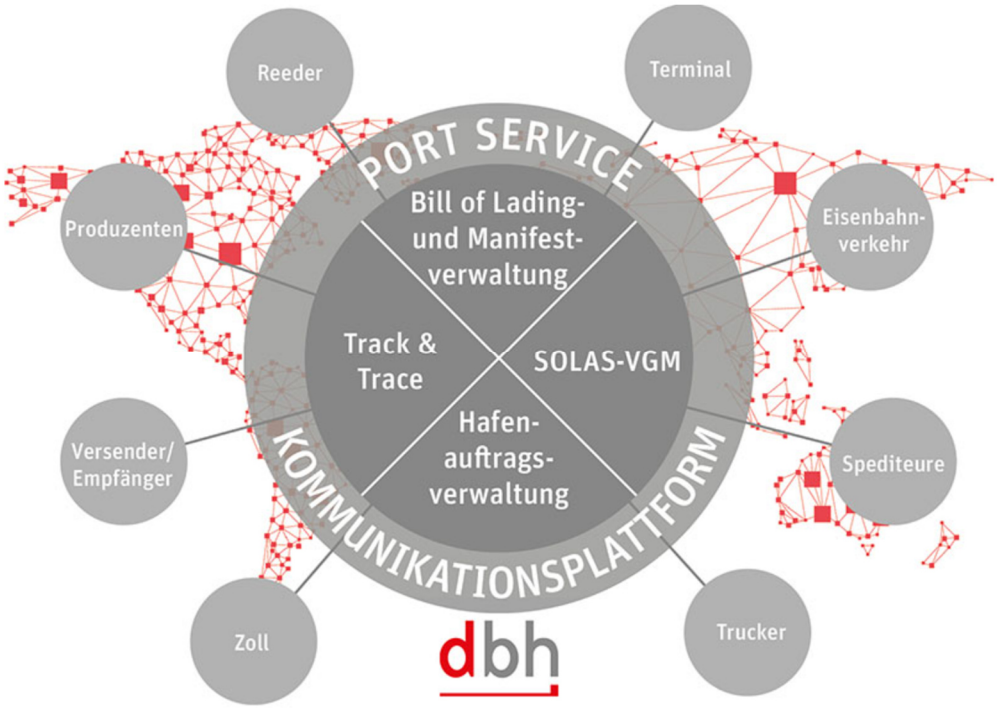


Figure 18: Services & stakeholders of BHT[29]

[29] Source: https://www.dbh.de/en/port-management/dbh-portservice/

The benefits of the BHT are summarized below:

- **One communication node for all connected partners:** Secure, transparent electronic data exchange with a single connection to dbh.
- **High data quality:** Incomplete data sets are avoided, data is available on time, at the same time only relevant data is distributed.
- **Interface-independent communication:** dbh supports all common protocols from AS2 via email and http(s) to SAP, sftp and X.400.
- **No need for own converter software and trained personnel:** dbh processes all common message formats such as EDIFACT, Odette, ANSI, VDA, ZUGPFerd and many more and has extensive experience in data conversion and mapping.
- **Any scalable system without maintenance:** ISO/IEC-27001 certified dbh datacentre available 24 hours a day including monitoring, logging and archiving.

5.4.5 DAKOSY (Hamburg)

The port community system for the Port of Hamburg is DAKOSY. Some of the services provided relevant for Hinterland and IWT are summarized below. Additional services include customs processing and slot booking. A summary of all platforms and services provided by DAKOSY is displayed in Figure 19.

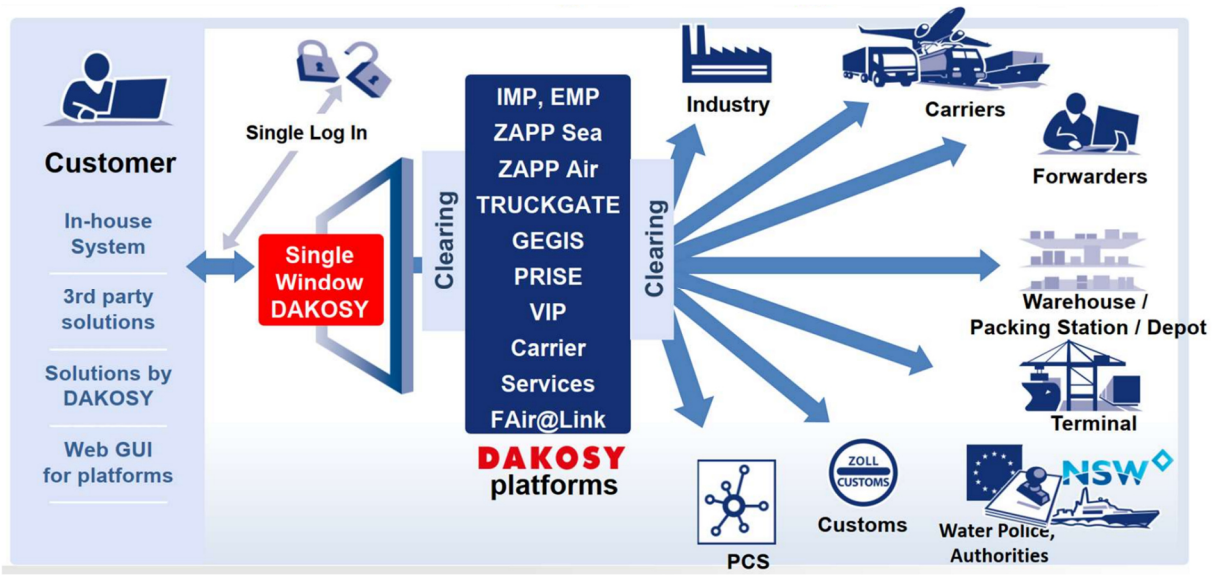


Figure 19: DAKOSY platforms & services[30]

Status management

Event-based status information for the following topics can be received via email, EDI, web, or API:

- Processing status
- Customs processing
- Decisions by authorities
- Container movements
- Releases

[30] Source: https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1615296130.pdf

Track and trace

Through this service, the current data is compared with the individual stages of the transport plan and the client is then informed of any relevant deviations from the transport plan. Delays in the transport are thus made transparent at an early stage so that you can intervene in the process.

Transport order

Via this service, the barge operator or skipper can electronically exchange orders for the loading and unloading of vessels, for example directly with the port. This service allows to transmit transport orders to rail, truck and barge carriers and receive updates on status information for your shipment.

5.4.6 Hamburg Vessel Coordination Center (HVCC)

The Hamburg Vessel Coordination Center (HVCC) is a central, neutral, cross company coordination point for large size vessels, feeder and barges, which takes care of the vessel traffic management in the Port of Hamburg.

HVCC's job is to exchange data and to continuously improve the port system as a whole with as many parties involved as possible. It has been successful at this job, with almost all shipping companies with mega-ships making use of NTC (Nautical Terminal Coordination) services, while the FLC (Feeder Logistics Center) coordinates the rotation of over 4,000 incoming feeder and inland waterway ships at the Port of Hamburg.

The FLC handles the registration and coordination of feeder and barge approaches, and rotation and stow planning at the Hamburg container terminals and other loading points for the inland shipping companies. It is the central contact for terminals, shipping companies and ship management. With the early, mutual provision of planning, a high degree of reliability is achieved for port rotation and handling. Additionally, the approach of inland vessels is monitored via the HVCC's software, and the rotation is continually coordinated with the shipowner and the skipper. The system reacts dynamically to operational changes and thus optimises throughput times in the port.
The FLC focusses on the inland waterway around Hamburg and the neighbouring inland terminals (see Figure 20).

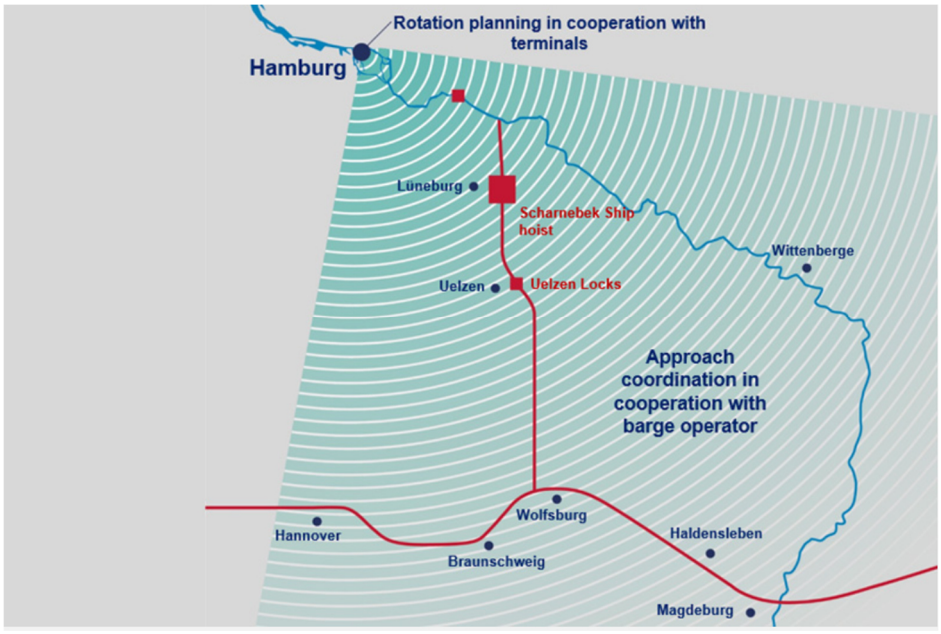


Figure 20: Geographical scope of the FLC[31]

[31] Source: https://www.hvcc-hamburg.de/en/binnenschiffe/

5.4.7 Usage of RIS

Table 1 below shows a high-level overview of some Port Community Systems and Sea Port Systems, indicating the River Information Services they are currently using as a source of information for their internal processes, which means they really use RIS data provided by Fairway Authorities (via a national information portal or via EuRIS).
Apart from this overview, there are also several inland ports and local (port) authorities that use the EuRIS portal and/or the EuRIS APIs to obtain information on the vessels, voyages and traffic in their area of competence, A system where the area of competence of such parties can be uploaded to EuRIS by a EuRIS Partner provides a low threshold option for disclosing high-value information towards an important segment of the IWT community.

Table 1: High level overview of selected Port (Community) Systems and their usage of RIS.

	Port of Brussels	Port of Antwerp-Bruges	North Sea Port	Port of Ostend	RPIS	Port of Rotterdam/ Amsterdam
Network related information	X				X	X
Infrastructure related information	X				X	X
Dynamic vessel information	X	X	X	X		X
Static vessel information	X	X	X	X		
Convoy information	X	X	X	X		
Voyage related information (locations & timing)	X	X	X	X		X
Cargo related information	X	X	X	X		
Passenger & crew information	X					
Traffic related information	x					X

5.5 RailNetEurope

The association RailNetEurope (RNE), a body for the coordination of the individual railway infrastructure managers, is acting as this so-called 'one-stop shop' by coordinating, harmonizing, 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.
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
- **IT Strategy / Infrastructure**
- Rail Freight Corridors
- Network Statement & Corridor
- Information Document
- Legal Matters
- Temporary Capacity Restrictions

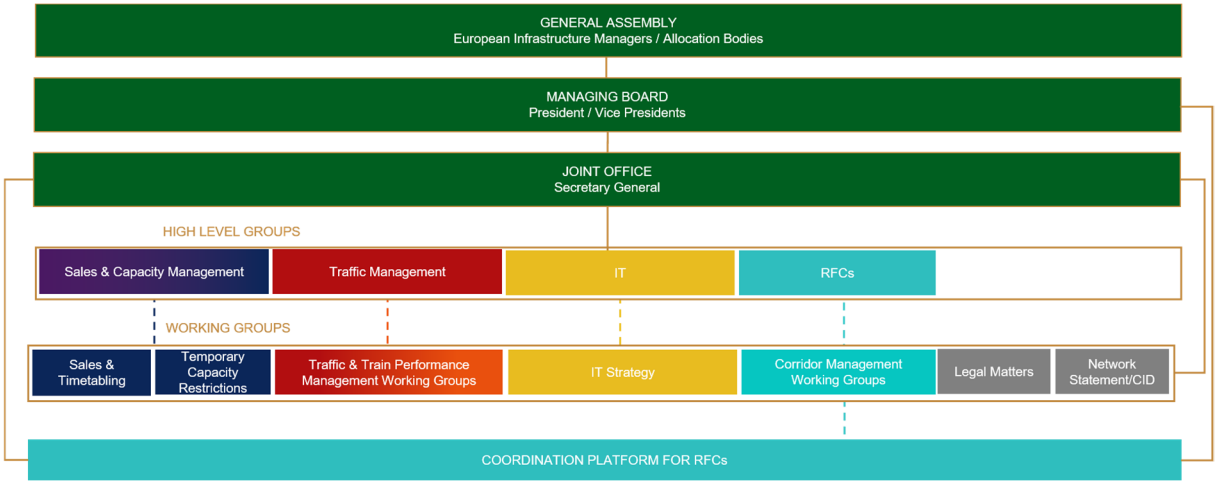


Figure 21: Structure of RNE[32]

These groups provide input into RNE strategy, give proposals for new projects and induce the implementation of project results.

The RailNetEurope is currently offering different information services (more detailed description is available in the report of Sub-Activity 2.5 ITS, ERTMS & eNavigation) to users and stakeholders:

- Train Information Service (TIS)
- Customer Information Platform (CIP)
- Path Coordination System (PCS)
- Rail Facility Portal (RFP)
- Charging Information System (CIS)
- Network and Corridor Information Portal (NCI)

5.5.1 Technical requirements of telematics applications

The basic framework for a harmonized and interoperable rail system is the Directive 2016/797 of the European Parliament and of the Council from the 11 May 2016. It defines the conditions to be met to

[32] Source: RNE Approach & Structure; www.rne.eu/

ensure technical interoperability between the national rail infrastructure companies. This enables the improvement and development of rail transport services within the European Union and other countries and to contribute to the completion of the single European railway area and the progressive achievement of the internal market. The annex III to the directive refers to the requirements of telematics applications for freight and passenger transport as well as the network for information services:

Table 2: Excerpt of Annex III of Directive (EU) 2016/797 on the interoperability of the rail system[33]

"2.7.1. Technical compatibility

The essential requirements for telematics applications guarantee a minimum quality of service for passengers and carriers of goods, particularly in terms of technical compatibility.

Steps must be taken to ensure:

- that the databases, software and data communication protocols are developed in a manner allowing maximum data interchange between different applications and operators, excluding confidential commercial data
- easy access to the information for users.

2.7.2. Reliability and availability

The methods of use, management, updating and maintenance of these databases, software and data communication protocols must guarantee the efficiency of these systems and the quality of the service."

The EU Commission Regulation No 1305/2014 on the technical specification for interoperability relating to the telematics applications for freight subsystem of the rail system in the European Union (TAF TSI) defines the concept of data exchange between the infrastructure managers (IMs) as well as with railway undertakings (RUs). It also describes interoperable business processes between IMs and RUs. The systems are connected using an open network and a Common Interface (CI) which is mandatory to be part of the community network. The common interface specifies a number of functions that are legally required in order to be able to participate in RU/IM communication (see Figure 22).

According to TAF TSI the Common Interface has to be able to handle:

- message formatting of outgoing messages according to the metadata
- signing and encryption of outgoing messages
- addressing of outgoing messages
- authenticity verification of incoming messages
- decryption of incoming messages
- conformity checks of incoming messages according to the metadata
- handling the single common access to the various databases

… and some more

[33] Source: European Union Law; https://eur-lex.europa.eu/eli/dir/2016/797/oj

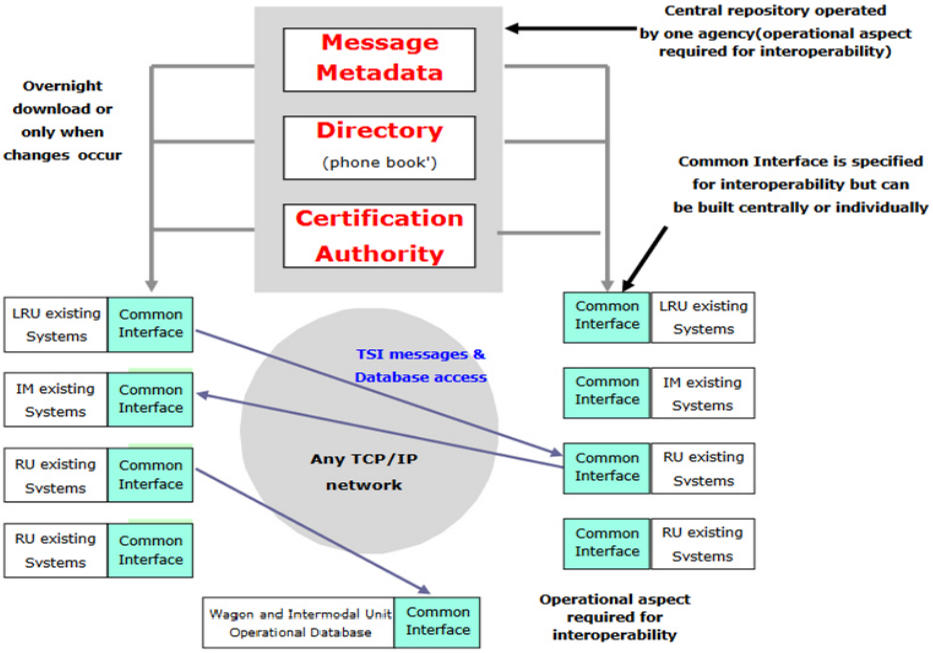


Figure 22: General Architecture of the Rail IT Network[34]

The Common Interface used by a company can be either the commonly built CI, developed under the supervision of the RailNetEurope working group "Common Components System" (CCS), or another own development with the required functions. If a company is programming a new application, the message exchange works right away without a need of additional applications or interfaces. Just like (lead) railway undertakings and infrastructure managers, also station masters, databases, information platforms, etc. are connected to the network via the interface.

5.5.2 The Common Interface (CI)

This interface is a P2P (peer-to-peer) application supporting the exchange of messages. It is designed to be installed directly at a user or organization so that they can communicate and exchange data with the already existing members in the network. The CI also supports the exchange of messages outside the scope of the TAF TSI regulations if the conditions regarding the message structure are met. This can be a great added value as the CI can also be used for customized business opportunities.

[34] Source: European Railway Agency – Interoperability Unit - TAF TSI - ANNEX A.5; www.era.europa.eu

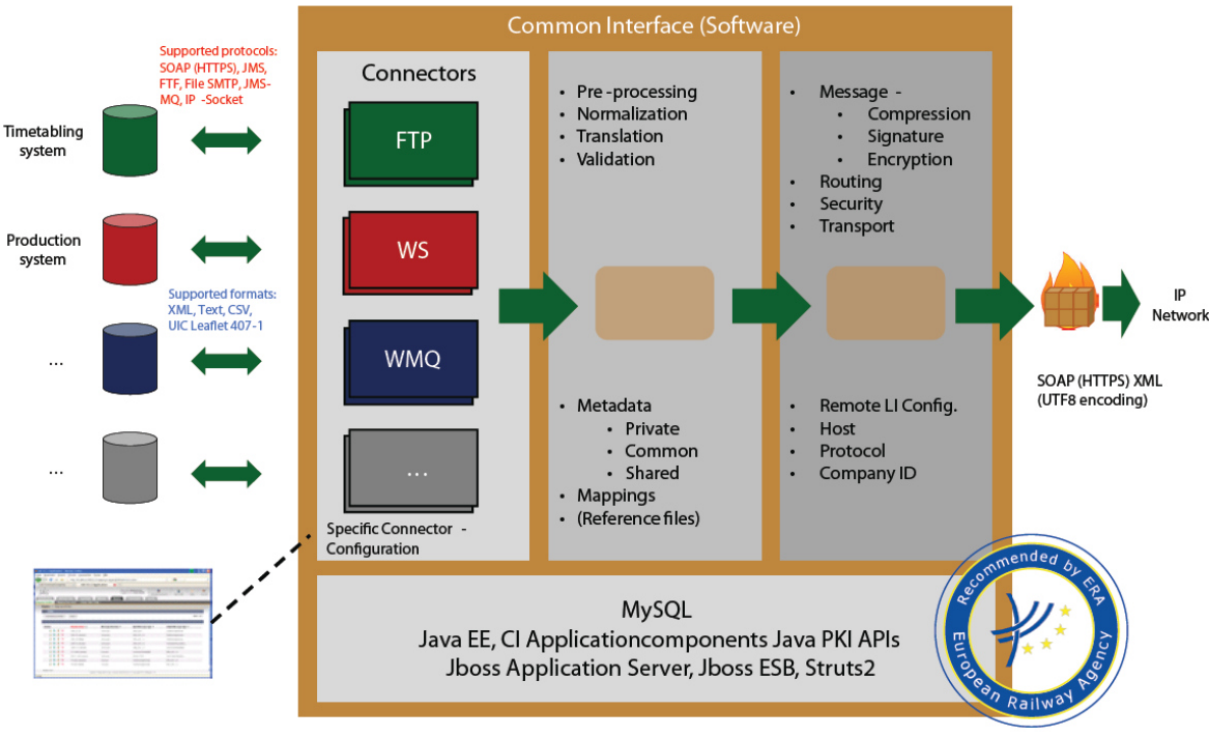


Figure 23: Functional structure of the Common interface[35]

5.5.3 Multimodal future of rail transport

The rail sector has already several times expressed its intention to be better integrated in multimodal logistics chains in the future. In a draft version of Europe's Rail Masterplan of the European Commission (year 2021) it is stated that the rail sector has five areas of priority (see enumeration below) in the coming years. One priority for the European rail transport is to become a key role in a multimodal transport system. In order to achieve their goals, they have to develop a rail system reactive to demand building upon demand forecasts, long-term and real-time multimodal transport system. Consequently, they have to improve their transport planning management and operation tools (optimized routing, capacity management, load and empty flows equilibrium) to enhance the cooperation with other transport modes. This should further increase the efficiency and capacity of rail freight, enabling real-time management of offers, resources and transport flows.

The 5 five areas of priority for EU-Rail (Europe's Rail Masterplan):

- **European rail traffic management and supporting rail's key role in a multimodal transport system**
- Digital and automated train operations
- Sustainable and digital assets
- Competitive digital green rail freight
- Smart solutions for low density traffic lines (cost-efficient regional lines)

5.5.4 Rail transport and DTLF

The rail sector is strongly represented in the Digital Transport and Logistics Forum (DTLF) advising the Commission in the elaboration of the specifications for implementation. The Commission will develop and adopt implementation specifications on the basis of which Member State authorities and economic operators will develop and implement IT tools.

[35] Source: RNE Common Components System; ccs.rne.eu

The Digital Transport and Logistics Forum (DTLF) was established by DG MOVE in 2015 to support the digital transition in transport and logistics. It's an advisory platform, with stakeholders from different transport and logistics communities (public and private), i.e. also from the rail sector. Currently, the exports of DTLF are assisting the Commission in preparing the implementation specifications of the eFTI Regulation.

5.5.5 Rail freight transport using eFTI

The electronic data exchange does not come by itself. The TAF TSI (incl. repealed versions) has already served as the basis for the development of telematic applications for twenty years, but now more and more messages are being exchanged via the digital system and the TAF TSI shall be an accelerator for further digitalization as it is at the heart of rail business processes.
A main initiative in the next years is the electronic freight transport information (eFTI). The idea is that all transports that are carried out will be reported and collected in integrated and interoperable information systems. The messages shall be exchanged via the digital system and no longer via paperwork.
The aim of the EU Regulation 2020/1056 on electronic freight transport information ("The eFTI Regulation") of the European Parliament and the council of the European Union is to encourage the digitalization of freight transport and logistics. Further details on applicability and its timeline are available in chapter 5.3.2.

With the involvement of the Community of European Railways and Infrastructure Managers (CER), International Rail Transport Committee (CIT) and International Union for Combined Road-Rail Transport (UIRR) in DTLF it is important for the European rail sector to follow closely the developments in eFTI in order to ensure eFTI compatible solutions, such as electronic consignment notes as well as telematics applications for freight services (TAF).

5.5.6 Rail transport and FENIX

FENIX is a Connecting Europe Facility project aiming to support the development, validation and deployment of digital information systems along the EU transport Core Network.
In the framework of FENIX, the pilot sites have identified possible use cases of the eFTI Regulations, i.e. also for the rail sector. The pilot sites dealing with B2A operations (business to authority), other than maritime-port-hinterland operations, will consider the future framework set up by the eFTI regulation, mainly focusing on the CT Directive, dangerous goods and waste. Currently, many pilot sites do not yet use these regulations in the current set of use cases (further described in the FENIX deliverable D2.1.1).
As shown in Figure 11 (chapter 5.3.4), the concept of FENIX involves the interconnection of different platforms that exchange data with each other according to the principles. Each of these platforms also has its own data sets or services (e.g. ETA service, planning service, etc.). One of these connected platforms could be, for example, a portal/system of RailNetEurope. This would be a step towards realizing a multimodal information system for the future. The approach with using a common interface seems to be already very similar to the concept of RNE.

5.5.7 Conclusion

The RNE operates several service portals or platforms and tries to further expand and to improve the offered services. EU regulations provide a framework for further harmonization of IT infrastructure and digitalization of services in the rail sector. A specially designed Common Interface ensures interoperability between the actors in the European rail transport communication network and it supplies an easy and flexible connection to the existing network to exchange messages and data. Further development of these and the ambition to be part of a multimodal information system is very favourable for cooperation with other transport modes are essential elements for a strong multimodal transport or even synchro modality in the future.
The rail sector is also very active in the Digital Transport and Logistics Forum (DTLF) and contributes to the development of cross-modal IT tools. The DTLF is doing important preparatory work to develop implementation specifications for creating multimodal networks and enabling harmonized information

exchange, such as with electronic freight transport information (eFTI). The EU regulation for eFTI is a big step towards smooth cross-modal freight transport in the coming years.
The FENIX project demonstrates another concept or vision of linking several platforms of different transport modes, but only the next few years will show how the plan to connect freight transport by rail, waterway and road can be implemented.
In summary, the rail sector is showing effort to realize a connectivity with other transport modes in the exchange of transport information in the coming years. Other initiatives offer additional opportunities to successfully develop a common network among transport modes.

5.6 Linked Data & LDES

5.6.1 The Semantic Web

The Semantic Web (Web 3.0) is an extension of the worldwide web through standards set by the World Wide Web Consortium (W3C). The goal of these standards is to provide software programs with computer-interpretable data descriptors of the published information and data on the Web. This way, computers are able to make meaningful interpretations similar to the way humans process information to achieve their goals. In the context of the Semantic Web, the word "Semantic" indicates machine-processable (what a machine is able to do with the data). To make this Semantic Web a reality, it is important to have the huge amount of data on the web available in a standard format, reachable and manageable by Semantic Web tools. Moreover, relationships among data should be defined, to enable interlinking across servers. This collection of interrelated datasets on the Web can also be referred to as **Linked Data**.

5.6.2 The Design Principles of Linked Data

Linked Data provides the best practices to make links between datasets that are understandable, to both humans and machines, possible. Tim Berners-Lee, the inventor of the World Wide Web and the director of W3C, proposed **the four design principles** of Linked Data in 2006:

1. **Use URIs as names for things.**

The Uniform Resource Identifier (URI) is an identification system used for giving unique names to anything, from digital content available on the Web to real-world objects and abstract concepts. The use of URIs makes it possible to distinguish between different things, but also to know that one thing from a dataset is the same as another in a different dataset.

2. **Use HTTP URIs so that people can look up those names.**

HyperText Transfer Protocol (HTTP) is the foundation of communication for the World Wide Web. It provides a simple mechanism for retrieving resources. When things are identified by URIs in conjunction with the HTTP protocol, they become easier to find. Via HTTP you are able to look up the URI and get more information about the entity which is behind this URI.

Example of a HTTP URI: http://dbpedia.org/resource/Tim_Berners-Lee

3. **When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL).**

The Resource Description Framework (RDF) is a W3C standard model for data publishing and interchange on the web. It has become the general method for description and exchange of graph data. The way RDF connects data pieces together is via triples.

An RDF graph statement (also called "RDF triple") consists of:

1) a node for the **subject**,
2) an arc that goes from a subject to an object for the **predicate,**
3) a node for the **object.**

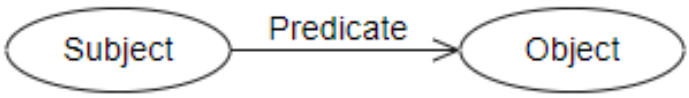
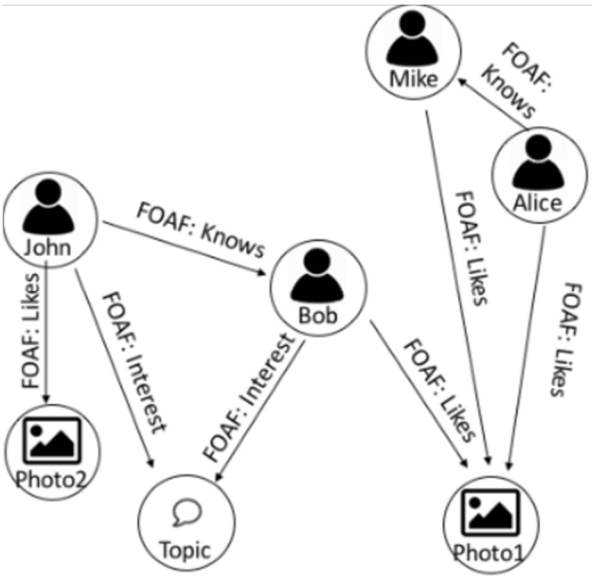


Figure 24: RDF graph with two nodes (Subject and Object) & triple connecting them (Predicate)[36]

Each of the three parts of the statements can be identified by an URI. With the help of an RDF statement, just about anything can be expressed by a uniform structure, consisting of three linked data pieces. Being a powerful and expressive framework for representing data, RDF is used for building knowledge graphs: richly interlinked, interoperable and flexible information structures (see Figure 25Figure 25: RDF triple store representing a graph).



Subject	Predicate	Object
Alice	knows	Mike
Alice	Likes	Photo1
Mike	Likes	Photo1
Bob	Likes	Photo1
Bob	Knows	John
Bob	Interest	Topic
John	Interest	Topic
John	Likes	Photo2

Figure 25: RDF triple store representing a graph[37]

To retrieve and modify data stored in an RDF format, SPARQL (**S**PARQL **P**rotocol **A**nd **R**DF **Q**uery **L**anguage) is used. It is pronounced "sparkle". SPARQL helps users to focus on what they would like to know instead of how a database is organized. In contrast to SQL, SPARQL queries are not constraint to working within one database.

There are four types of SPARQL queries:

1) **ASK** whether there is at least one match of the query pattern in the RDF graph data
2) **SELECT** all or some of those matches in a tabular form
3) **CONSTRUCT** an RDF graph by substituting the variables in these matches in a set of triple templates
4) **DESCRIBE** the matches found by constructing a relevant RDF graph.

The leading semantic graph databases that support SPARQL have intuitive SPARQL editors with autocomplete, explorer and many other features that facilitate building powerful SPARQL queries.

4. Include links to other URIs, so they can discover more things.

Links to other URIs makes data interconnected and enables us to find different things. The more links there are between datasets, the easier it will be to understand the meaning of the data and to use this data in a global way. By interlinking new information with existing resources, the reuse of existing data is maximized and a richly interconnected network of machine-processable meaning is created.

[36] Source: https://www.w3.org/TR/rdf11-concepts/#dfn-rdf-graph
[37] Source: Hajeer, Mustafa & Dasgupta, Dipankar. (2016). Distributed genetic algorithm to big data clustering. 1-9. 10.1109/SSCI.2016.7849864.

5.6.3 Linked Data Event Stream

A Linked Data Event Stream (LDES) is a collection of immutable objects, each object being described using a set of RDF triples.

Take for example a collection of sensor observations. Each observation has a *resultTime* and a *simpleResult*. Every 10 minutes a new observation (member) gets added to the collection (See Figure 26):

```
<C1> a ldes:EventStream ;
    tree:member <Observation1>, <Observation2>, <Observation3> .
<Observation1> a sosa:Observation ;
               sosa:resultTime "2021-01-01T00:00:00Z"^^xsd:dateTime ;
               sosa:hasSimpleResult "..." .
<Observation2> a sosa:Observation ;
               sosa:resultTime "2021-01-01T00:10:00Z"^^xsd:dateTime ;
               sosa:hasSimpleResult "..." .
```

Figure 26: Sensor observations expressed as LDES[38]

Other examples of immutable objects are version objects or archived representations. The goal of an LDES is to allow consumers to replicate the history of a dataset and efficiently synchronize with its latest changes. As the objects in a LDES are immutable, an LDES always grows. However, an advantage of the immutability is that a consumer only has to process each member of a collection once. A combination of multiple Linked Data Event Stream collections can be seen as a "dataset". A sensor data platform for example can consist of an LDES containing all sensors and another LDES containing all observations.

Example use case:
The European Railway Agency (ERA) has created a Route Compatibility Check (RCC) tool to check if a certain railway vehicle can travel the route from operational point A to operational point B. The application works on the knowledge graph of ERA, which is created out of independently maintained datasets from the member states railway infrastructure managers (Infrabel, Deutsche Bahn, …). All infrastructure managers publish LDES of their own master data. Based on these published LDESes the European Railway Agency has set up a geospatial fragmentation, which is used for the RCC application. The railway undertakings (companies that drive vehicles across these tracks) can use the application to check if a specific type of vehicle is compatible with the available set of tracks.

[38] Source: Pieter Colpaert «Linked Data Event Streams: the specification and how it works with TREE» https://www.youtube.com/watch?v=Jp4ciO4Y63U Timestamp 00:03:05

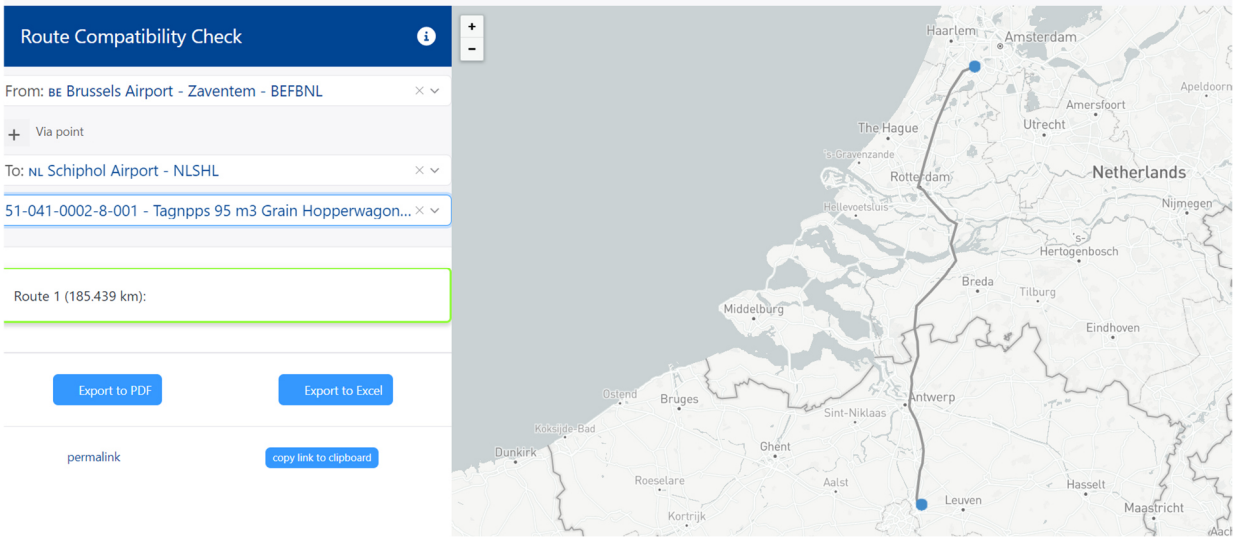


Figure 27: Route Compatibility Check (RCC) tool of ERA based on LDES [39]

5.7 Technology Readiness Level/Conclusions

In order to assess the usability of the developments for IWT described in the previous paragraphs (and relate them to each other) an assessment metric is required. Within DIWA sub-activity 3.5 a DIWA assessment metric was developed consisting of five parameters:

- Technology Readiness Level (TRL) (how mature is it?)
- Adaptability (how easily can it be adapted to IWT?)
- Adaptation demands (how much effort will adaptation take?)
- Technology radar (when will it be available?)
- IWT Digitisation Level (IDL) (which Digitalisation Maturity Model level does it cover?)

The methodology behind the metrics is extensively described in the DIWA sub-activity 3.5 report (chapter 3) and will not be repeated here. A quick reference is available in Annex 2

Maritime Connectivity Platform

DIWA Assessment metrics	Assessment results
DIWA-TRL	8 (Initial market introduction)
DIWA-Adaptability	O (Adaptable with substantial modifications)
DIWA-Adaptation demands	+ (Intermediate adaptation resource/time demands)
DIWA-Technology radar	2027-2032
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Rationale: There are only 2 operational instances in the world at the moment of writing. Concepts can be adapted to IWT, but would need to be adapted to the inland situation and installed base. Having an installed base which can be used as a starting point is beneficial for the required time/demands. Concepts like the service registry would help raising the maturity level to Connected.

European Mobility Data Spaces

DIWA Assessment metrics	Assessment results
DIWA-TRL	5 (Prototyping & Incubation – testing prototype in user environment) 4 (Concept Validation – lab prototype) 3 (Concept Validation – first assessment feasibility)
DIWA-Adaptability	+ (Adaptability with minor modifications) O (Adaptable with substantial modifications)

[39] Source: https://data-interop.era.europa.eu/ (Route Compatibility Check Tool)

DIWA-Adaptation demands	++ (Little adaptation resource/time demands) + (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands)
DIWA-Technology radar	2022-2026
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Rationale: European Mobility Data Spaces range from concepts and standardization initiatives to actual implementations. Adaptability and effort depend on where the developments are going. If a standard or interaction concept differs greatly from the de facto IWT standard (e.g. the current EuRIS implementation) substantial modifications will be necessary, requiring substantial effort. Should EuRIS be recognized as a European Mobility Data Space as-is, the effort will be minor.
Recognition as a European Mobility Data Space will help raise the maturity level to Connected.

DTLF
The metrics do not really apply, since DTLF is an organisational platform to support promoting the digital transformation of the transport and logistics sector. Because of its nature it should be followed closely by fairway authorities working on digitalization topics.

eFTI

DIWA Assessment metrics	Assessment results
DIWA-TRL	4 (Concept Validation – lab prototype) 3 (Concept Validation – first assessment feasibility)
DIWA-Adaptability	+ (Adaptability with minor modifications) 0 (Adaptable with substantial modifications)
DIWA-Adaptation demands	+ (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands)
DIWA-Technology radar	2022-2026 2027-2032
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Since it is still in a conceptual phase, the official timeline (implemented before 2026) is very ambitious (but mentioned here anyway). Depending on the eventual outcome of the data model, architecture and applicability discussions impact could range from minor to major. eFTI in itself will contribute to raising the maturity level to Connected.

FEDeRATED

DIWA Assessment metrics	Assessment results
DIWA-TRL	5 (Prototyping & Incubation – testing prototype in user environment) 4 (Concept Validation – lab prototype)
DIWA-Adaptability	0 (Adaptable with substantial modifications)
DIWA-Adaptation demands	0 (Substantial adaptation resource/time demands)
DIWA-Technology radar	2027-2032
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Concepts are being tested in living labs. The distributed nature and "node"-concept does not fit readily with the EuRIS implementation, requiring considerable effort to connect. It does however contribute to raising the maturity level to Connected.

FENIX

DIWA Assessment metrics	Assessment results
DIWA-TRL	5 (Prototyping & Incubation – testing prototype in user environment) 4 (Concept Validation – lab prototype)
DIWA-Adaptability	+ (Adaptability with minor modifications) 0 (Adaptable with substantial modifications)
DIWA-Adaptation demands	+ (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands)

DIWA-Technology radar	2022-2026 2027-2032
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

FENIX API has been implemented, but current actual use and scope is unclear. Depending on the datatypes and API adaptability may vary. Using FENIX data exchange will contribute to raising the maturity level to Connected.

Port Community Systems

DIWA Assessment metrics	Assessment results
DIWA-TRL	9 (Market expansion)
DIWA-Adaptability	++ (Seamless Adaptability) + (Adaptability with minor modifications) 0 (Adaptable with substantial modifications)
DIWA-Adaptation demands	++ (Little adaptation resource/time demands) + (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands)
DIWA-Technology radar	2022-2026
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Port Community Systems have been operational for several years and primarily cover business to business data exchange. Interconnecting an IWT Connectivity platform like EuRIS is relatively straightforward for governmental open data but, will require increasing amounts of efforts when incorporating B2B data. Interconnections will contribute to raising the maturity level to Connected.

RailNetEurope

DIWA Assessment metrics	Assessment results
DIWA-TRL	9 (Market expansion)
DIWA-Adaptability	- (Adaptable by redesign in analogy)
DIWA-Adaptation demands	- (High adaptation resource/time demands)
DIWA-Technology radar	2027-2032 'Future Box'
DIWA-IDL impact	II (Connected IWT fairway & navigation domain)

Rail solutions are of course not readily usable for IWT purposes, however, the similarities with EuRIS (central service solution with participation of large number of EU partners, interest in intermodal data exchange initiatives) are of interest and may provide opportunities to approach intermodal data exchange jointly, thus contributing to raising the maturity level to Connected.

Linked Data & LDES

DIWA Assessment metrics	Assessment results
DIWA-TRL	9 (Market expansion) 8 (Initial market introduction) 7 (Pilot production demonstrated)
DIWA-Adaptability	+ (Adaptability with minor modifications) 0 (Adaptable with substantial modifications)
DIWA-Adaptation demands	+ (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands)
DIWA-Technology radar	2027-2032
DIWA-IDL impact	III (Intelligent IWT fairway & navigation domain) II (Connected IWT fairway & navigation domain)

Although linked data as a technology has been around for a while, applications within the IWT domain are limited. Except for basic applications, larger scale implementations would require significant modifications to established systems. Projects like FeDERATED use linked data as the main intermodal data sharing technology. Therefore it is considered to contribute to raising the maturity level to Connected or even Intelligent.

6 Possibilities & recommendations

In this chapter possibilities and recommendations for the future development of an IWT Connectivity Platform and the related technologies and initiatives are formulated based on the results of the SuAc 3.2 meetings, meetings with external experts, the desk research and the input form the other DIWA Activities.

6.1 Input from other DIWA sub activities

In Masterplan DIWA activity 2 (Business developments), the need for an IWT connectivity platform and services it is expected to provide, is a recurring theme.

Smart shipping (SuAc 2.1)

Sub activity 2.1 (SuAc 2.1 report par 4.2 and 5.2) identifies the EuRIS platform and its central access point for harmonized and standardized (web)services as the future information platform for IWT in Europe. Further harmonization of service level across borders, more forecasting and prediction services and a clear overview of availability and quality of services on (parts of) the fairway network are foreseen as requirements to support smart shipping. The platform should also keep aligned with other parties in the transport chain in terms of data architecture and data exchange in order to enable a coordinated transport system.

Synchro modality (SuAc 2.2)

EuRIS is seen as an important step towards enablement of synchromodal transport planning by sub activity 2.2, provided it will be interconnected with similar platforms in other transport modes and it will be used by at least half of the IWT private parties. Also commercial services are advised to be included in EuRIS (SuAc 2.2 report - par 5.2).

Port & terminal information service (SuAc 2.3)

The need to connect EuRIS via API/interface standards with vessels, port and terminal operators is stated by sub activity 2.3. Again extension of EuRIS with commercial services is mentioned as a promising possibility next to facilitating information exchange among commercial platforms. Fairway authorities are considered to be in a good position to facilitate the formation of a neutral exchange platform which should become a centrepiece for information sharing and data exchange on IWT and a main tool for barge operators / skippers. (SuAc 2.3 report - Chapter 8).

RIS enabled corridor management (SuAc 2.4)

Sub activity 2.4 is understandably geared towards expanding EuRIS. Regarding an IWT transport platform aspects such as scope, content, data and users of the platform are important to define. The relationship with RIS (requirements from RIS towards the platform and from the platform towards RIS) should be further explored.

ITS, ERTMS, E-navigation (SuAc 2.5)

Investigations in the developments in other domains (road, rail and maritime) provided a number of things an IWT connectivity platform should take into account:

- Interconnection and interoperability with platforms in other domains using harmonized information exchange;
- Commission Regulation (EU) No 1305/2014 which specially defines the technical specification for the interoperability of 'telematics applications for freight subsystems' (TAF TSI);
- Coverage of the entire network instead of only corridor coverage;
- Advanced trip planning functionality should be provided by a platform;
- Offering services towards recreational fairway users should be incorporated.
- Fall-back scenario's in case the platform is unavailable

While activity 3 sub activities are still under way, several preliminary results are already available for sub activity 3.2 to take into account.

New technologies (SuAc 3.1)

The importance of technological developments such as data exchange platforms and predictive (traffic) concepts are reiterated in this study as a prerequisite for being able to achieve a holistic digital twin harmonizing all modalities.

Technology in other transport domains (SuAc 3.5)

Sub activity 3.5 identifies adoption of the maritime S-100 standard as an opportunity for an IWT connectivity platform to make interconnection and interoperability with the maritime world easier. In particular the move towards providing services via secured data link and providing access to services through ECDIS (requiring interoperable services) are deemed of importance for an IWT connectivity platform.

Summarized conclusions from other DIWA sub activities

An IWT connectivity platform:

- Must support machine to machine communication (M2M more relevant than H2M!);
- Must provide an overview of available services;
- Must be connected to (or even integrated with) platforms (modalities and/or actors in the logistics chain);
- Must be embraced by its intended user group;
- Must cover the entire network and all relevant items within;
- If successful, will be a single point of failure so must not fail;
- Requires extensive harmonization and standardization;
- Must provide predictive traffic services;
- Must indicate how it interacts with Maritime Connectivity platform(s) and to what extent S-100 standards & concepts are supported/used/etc.;
- Should cater for recreational fairway users;
- Should facilitate services requiring payment by the user.

Considering the current status in IWT, the other DIWA sub activities are of the opinion that EuRIS is a very close match with the expected features of a IWT Connectivity Platform, and its potential as a IWT Connectivity Platform should thus be further investigated.

6.2 EuRIS

EuRIS is a single web portal that seamlessly combines River Information Services of 13 European partners[40]. As one of the results of the EU funded RIS COMEX project[41], it is an operational platform backed by a solid governance model, including financing agreements allowing sustainable operation. As it discloses a treasure of high quality IWT information on many levels and over a huge geographical area, it is set to become an important, if not the, access point for information on inland waterways and inland waterway transportation.

6.2.1 EuRIS as a Connectivity Platform

While the setup of EuRIS may seem to render it incompatible with the idea behind an IWT Connectivity Platform, the opposite is true.

- Yes, EuRIS follows a centralized approach, fetching information from national and regional RIS systems and storing it locally, harmonized and in a uniform way,

[40] https://www.eurisportal.eu/
[41] https://www.riscomex.eu/

- Yes, the IWT relevant GIS data from the 13 countries is uploaded to EuRIS and stored on its central servers, forming a connected network enabling route & voyage computation from the black sea to the south of France.
- Yes, EuRIS receives the electronic reporting data from all the relevant countries.
- Yes, EuRIS combines all this data, processing and enriching it on its central servers to provide high quality information to the IWT stakeholders, including but not limited to the RIS Operational Services,

So, yes, when considering the data that is 'owned' by the RIS authorities of the 13 participating European countries, EuRIS is quite the opposite of a Connectivity Platform.

However, EuRIS also has a very agile and secure system for sharing privacy and/or commercially sensitive information, and it supports federated authentication of users using industry standards[42]. All functionality of the portal is backed by Application Programming Interfaces (APIs), making all the available information readily available for consumption by other systems via machine to machine interfaces. The platform itself is built using the Service Oriented Architecture (SOA), enabling it to combine existing services (even external ones!) to create new functionality and disclose new or further enriched information.

Considering the above, it becomes clear that EuRIS has potential to also provide Connectivity Platform functionality. This is especially interesting when considering the other players in the IWT community. Inland and seaports, terminals providing services for inland vessels, (commercial) parties providing added-value services for skippers, logistics operators, cargo senders and others. These parties can provide yet another level of high-quality information for the IWT stakeholders, but are often experiencing difficulties reaching their potential consumers. For these parties, **EuRIS could be extended on two levels to provide information on the merits of IWT service providers on a single-stop-shop for IWT information**:

- Web Modules providing human readable information, offering a 'shop window' for the service provider, and
- Connectivity Services providing machine readable information, offering a pointer towards the relevant systems and APIs of the IWT service provider.

Both preferably in a standardized format for each type of service provider, enabling harmonization throughout the IWT community and towards other transportation modes (and beyond).

A nice example of connectivity platform functionality that could easily be incorporated in EuRIS is the Berth Reservation service. This service could be extended to enable owners of private berths to claim their terminals (much alike claiming a vessel). Once successfully claimed, the owner could set operating times, manage reservation requests, add links to their own systems to embrace full functionality, …

6.2.2 EuRIS as a Mobility Data Space

When considering the different requirements for a European data space[43,44] it can be concluded that **EuRIS matches each and every one of the requirements**:

- A secure and privacy-preserving infrastructure to pool, access, share, process and use data.
  - EuRIS is hosted on Azure (where data is physically stored within data centres located in the EU), and the internal environment has been set up to using the best practices and with great attention to security and protection of privacy.
- A clear and practical structure for access to and use of data in a fair, transparent, proportionate and/non-discriminatory manner and clear and trustworthy data governance mechanisms.
  - All data that is not privacy or commercially sensitive is freely available via open APIs. The European Corridor Management Agreement (including its instruments Core Arrangement 1 & Core Arrangement 2) provides a clear and trustworthy data governance mechanism.

[42] For example OAuth 2.0 and Active Directory Federation Services
[43] https://ec.europa.eu/newsroom/dae/redirection/document/83562
[44] Platina III discussion paper 'Setup for digitalisation strategy: Proposed process for the development of a holistic digitalisation strategy for Inland Waterway Transport'

- European rules and values, in particular personal data protection, consumer protection legislation and competition law, are fully respected.
    - EuRIS is developed and managed in line with the GDPR and also protects commercially sensitive information.
- Data holders will have the possibility, in the data space, to grant access to or to share certain personal or non-personal data under their control.
    - EuRIS data sharing is based on privacy classes which enable the user to share the information they own (or that is under their control) as they see fit. The system is fine-grained and access to shared data can be revoked, limited in time, …
- Data that is made available can be reused against compensation, including remuneration, or for free.
    - Currently all data available on EuRIS can be reused for free. This could change in the future, but as EuRIS is governed by European RIS Authorities, future compensations should never conflict with proportionate and/or non-discriminatory clause.
- Participation of an open number of organizations/ individuals.
    - Anyone can use EuRIS's Open APIs, and anyone can create a free account on EuRIS to get access to more functionality and/or claim data ownership/control for free.

When considering the design principles for the common European data spaces, it can be seen that the match of EuRIS does not dwindle. Two examples from the Commission staff working document on Common European Data Spaces[45] supplementing the previous list are highlighted below:

- Data Control: (…) In line with the applicable legislation, data holders could use these tools to ease the uploading of data into data spaces, to give or revoke their authorization to data and to change access rights and specify new conditions of how their data can be accessed and reused over time.
- Respect of EU rule and values: (…) In addition adequate technical, legal and organizational measures will be put in place to prevent unauthorized access to personal and non-personal data.

The necessary actions could be taken to **validate EuRIS's conformance with the European Data Spaces requirements**, and if it does indeed meet all the requirements, **the role of EuRIS as a Data Space should be promoted to the public and communicated by all relevant instances** (including the European Commission and its promoting websites[46]).

While EuRIS already ticks a lot of the common European data space boxes, there is also a lot of work to be done to **prepare it for connection with other common European data spaces**, and to **achieve full compliance**. While some actions are not fully tangible yet, other actions can already be taken on very short notice to improve the position of EuRIS as a common European data space.

- Investigate the IDS global standard and the Design Principles For Dataspaces position paper to identify amendments to EuRIS that would make it easier to link with other dataspaces.
- Data collected in the various data spaces, when made available to the public, should be presented in accessible formats to persons with disabilities on equal basis with other citizens.
- To avoid fragmentation, high integration costs and the creation of silos, the common European data spaces could (…) be interconnected and progressively made interoperable to lead to a genuine European data space (…).
- An investigation should also be performed to determine the level of compliance EuRIS has with the Free Flow of Non-Personal Data Regulation, ePrivacy Directive and Platform to Business Regulation. In case of non-compliance actions should be planned to make the necessary amendments, and in case of compliance, this compliance should be formalized.

The EuRIS partners could **consult with the European Commission to help obtain the necessary funds for transforming EuRIS into a true EU-wide common data space**. Indeed, the Commission has stated that it will facilitate the development of EU-wide common data spaces in strategic areas (logistics being one of those), working in collaboration with relevant stakeholders. Furthermore, the

[45] https://digital-strategy.ec.europa.eu/en/library/staff-working-document-data-spaces
[46] Website on data spaces: https://digital-strategy.ec.europa.eu/en/policies/mobility-data

Commission will fund the creation of common European data spaces in specific sectors where the EU financial contribution will have an impact on their deployment as European digital infrastructures.

6.2.3 Implications for EuRIS

The implications on promoting EuRIS to an EU mobility data space as well as a connectivity platform must thoroughly be evaluated. First, the strategic body of the EuRIS governance shall be informed on the potential evolution aspects of EuRIS and come to a common agreed strategy before addressing the European Commission on further steps. Important questions to tackle but not limited to those, are:

- What is still missing to make EuRIS (part of) a Data Space and what are governance, legal implications
- What aspects of a Connectivity Platform could be added to EuRIS
- How does EuRIS match with the Linked Data concept
- Required amendments to EuRIS to make it a human & machine connectivity platform for PCS, including consequences and cost/benefit analysis
- Required amendments to EuRIS to make it part of/compatible with FEDeRATED/FENIX, including consequences and cost/benefit analysis

6.3 eFTI

The impact of the eFTI Regulation on the overall transport sector is high as the affected transport information must be accepted electronically by the related competent authorities if the user decides to submit by digital means. In IWT transport information and most commonly dangerous goods transports are already reported electronically by means of the ERINOT standard in various areas. The challenge of matching the eFTI requirements with the already established infrastructure and information processes in inland shipping is envisioned in Figure 28.

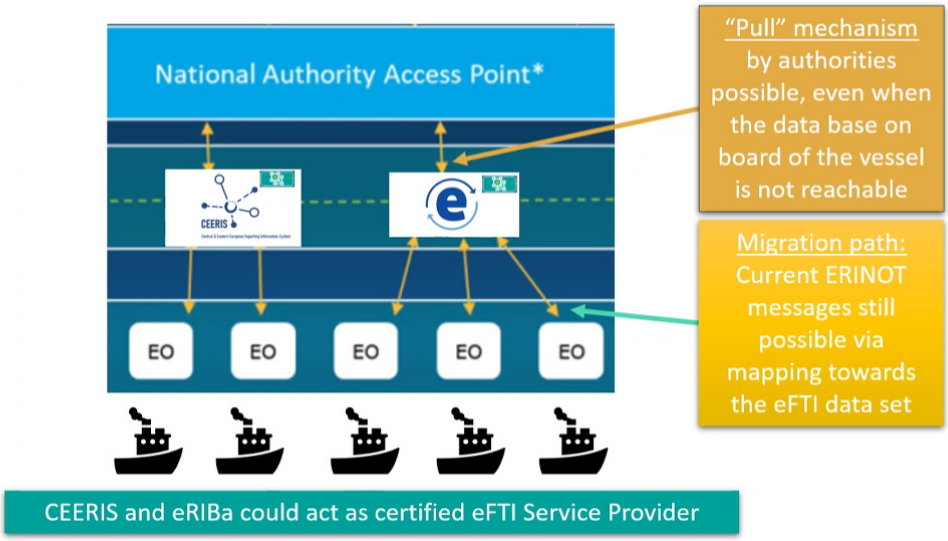


Figure 28: Challenges of matching eFTI requirements with already existing infrastructure & information processes[47]

[47] Source: DTLF workgroup & European IWT platform: presentation on EU Transport Data Model (EUTDM)

Already established reporting systems on national or regional level could be improved to certified eFTI Service Providers to act as "translators" in the middle. The process would foresee that ERINOT information from inland vessels can be processed and mapped to an eFTI data set by the reporting systems and access can be provided via the National Authority Access Point. This way, there is no need for Economic Operators to exchange the IWT information in a new format in order to become eFTI-compliant, and skippers/reporting parties switching to eFTI could have large parts of their ERI messages pre-filled with their provided eFTI information, allowing them to adhere to the additional RIS Electronic Reporting Requirements with minimal effort.
Examples of reporting systems that could be adjusted for this purpose are the Central and Eastern European Reporting Information System (CEERIS) and the electronic Reporting for Inland Barges System (eRIBa), but the options are not limited to those. It should however be noted that the eFTI requirements regarding traceability, operation logs, preservation of modified/deleted records, … may have an impact on the storage requirements for such systems.

In the ideal scenario a uniform data translation module mapping eFTI and ERI is developed which can be implemented on all applications dealing with those information processes and being relevant for IWT.

At the moment of writing this report a final eFTI common data set is still under elaboration and not available for evaluation. This implies that also the data mapping and matching process could not have been finalized and agreed.
Having in mind the full applicability of the eFTI Regulation in 2025 a clear recommendation shall be that

- **The eFTI common data set shall be finalized as soon as possible**
- **The mapping of eFTI requirements towards ERI are finalized and accepted**
- **The impact of improving existing reporting applications to certified eFTI Service Providers shall be evaluated**
- **The required work shall be supported by a European project to guarantee the resources of the involved experts**

6.4 Federative platforms

6.4.1 FEDeRATED

FEDeRATED is more a R&D than an implementation project. Therefore, the relevance for Act. 3.2 is limited as there is not the one connectivity platform elaborated but rather the concept of a federated network shown by the living labs. As explained earlier the implementation of a federated network is rather complex and adaptation of EuRIS to fit in this architecture is needed. However, the concepts of federation and design principles are interesting, potentially resulting in an EU data space / ecosystem in which EuRIS can fit as node or European Access point and even as a reference for some data sources (IWT network).

Under the current fragmentation of information systems on company, national or regional level the one and only central information platform seems very unrealistic resulting in the need of linking various information sources together via APIs.

As IWT is underrepresented in the practical living labs of the project a parallel initiative of the DIWA consortium was taken if and how the EuRIS platform could act as information node within the federated concept This gives a good idea about the complexity and impact of the implementation of a federated network of nodes, see 5.3.3.1. Therefore, it is **recommended to closely follow federative developments and the impact on our fairway information services (EuRIS) so we are able to respond quickly to further developments**.

Points of attention, which accounts also for other initiatives, are:

- The technology readiness level of the initiative
- The impact on the data model, API's and architecture of EuRIS
- The added value for IWT (both Business and Fairway Authorities)

At the moment of writing this report the FEDeRATED project is still ongoing and no final conclusions were drawn on the concepts for the data models/architecture.

6.4.2 FENIX

The project has actually specified and implemented a standardized API (FENIX connector) to interconnect the concerned information platforms to a federated FENIX network. From an outside perspective the FENIX connector seems an interesting entry point to the connectivity platform of FENIX. It is **recommended to investigate further if the gathered information via the FENIX network is relevant for IWT and to which extent an information exchange with e.g. EuRIS is envisioned**. The FENIX network can be seen as connectivity platform but with limited scope for IWT.

In the moment of writing this report the project was not finalized yet which means that also no statement can be given on the further elaboration or implementation of this concept on a broader scope. The recommendation towards DIWA is to **closely follow the results of FENIX and next steps taken on European level**. As many initiatives are dealing with the federated concept but using different technologies a "winning" concept is hard to predict. Therefore, monitoring these initiatives and taking the right actions in time seems the most feasible approach in this point in time.

6.5 Port Community Systems

The Port community system Portbase of the Port of Rotterdam does not use data directly from the national Dutch Fairway information portal vaarweginformatie.nl or electronic reporting messages forwarded by Rijkswaterstaat. Portbase uses their own data model and API's to connect to stakeholders in the hinterland, although the data model is based on international standards. This accounts to a point for the other seaport PCS in Western Europe as well.
With the new EuRIS services there are a number of opportunities for sharing transport related data, like sharing voyage and cargo information, travel times, waiting times, track and trace information, ETA, etc. to facilitate and optimize the logistic processes. With the development of the hinterland services by, for example, Portbase and NextLogic, it is **recommended to start a cooperation between the European PCSs[48] and fairway authorities to optimize and digitalize processes in cooperation with stakeholders**. The recommendation from sub activity 2.3 of the Masterplan DIWA project to come up with a strategy to connect to inland ports and PCS and the first results are visible in RPIS.
After approval which data services are relevant a more technical assessment is recommended on how to share data (API) and how to share identities and authorizations of common stakeholders e.g. barge operators. Most likely this data-sharing will at first happen using the existing, possibly slightly adapted, APIs of EuRIS and not via systems like FEDeRATED/FENIX/… due to the insufficient level of maturity of these initiatives and the currently prohibitively high cost of implementation.

7 Roadmap

In this chapter a roadmap is painted based on the information from the previous chapters. The different recommendations are classified based on their topic, complexity (technical, legal, organizational), time horizon and assumed priority.

While it may not be possible to fully implement all recommendations within the time horizon considered by DIWA (2022-2032), they should at the very least be part of the bigger picture for the evolution of IWT in the upcoming decade.

[48] Possibly via IPCSA, the International Port Community Systems Association.

7.1 EuRIS

EuRIS is a single web portal that seamlessly combines River Information Services of 13 European partners[49]. As one of the results of the EU funded RIS COMEX project[50], it is an operational platform backed by a solid governance model, including financing agreements allowing sustainable operation. As it discloses a treasure of high quality IWT information on many levels and over a huge geographical area, it is set to become an important, if not the, access point for information on inland waterways and inland waterway transportation.

Below are the recommendations concerning EuRIS:

- Inform the EuRIS Partners on the Connectivity Platform potential of EuRIS to create a one-stop-shop for all IWT related information.
    - It is advisable to perform a solid investigation on the aspects of a Connectivity Platform that could be added EuRIS
    - This recommendation has a Low priority, Medium to Long time horizon, a High technical complexity, Medium organization and Low legal complexity.
- Suggest to the EuRIS Partners to validate and extend EuRIS's position as a EU Mobility Data Space
    - Consult with the European Commission to validate EuRIS's conformance with the European Data Spaces requirements, to promote it as a EU Data Space and obtain funding to
    - Extend EuRIS to become fully compliant with all EU Data Space requirements.
    - This recommendation has a High priority, Short to Medium time horizon and a Medium to High technical, legal and organizational complexity.
- Start a cooperation between PCSs, inland terminals, service providers, … and fairway authorities to exchange relevant information via existing APIs.
    - A cost/benefit analysis for APIs that could/should be added/extended and possible impact on the load of the system should be executed.
    - The recommendation has a High priority, Short time horizon, a Low to Medium technical complexity and a Low legal and organizational complexity.

7.2 eFTI

eFTI should be considered an opportunity for IWT with the potential of creating a competitive advantage for IWT. As the eFTI architecture is not final yet, some of these recommendations could become more difficult to achieve (or even obsolete) once the final architecture is published and the effective scope of eFTI is clarified.

Below are the recommendations concerning eFTI:

- Stay closely involved in the elaboration and finalization of the eFTI architecture and certification process.
    - This recommendation has a High priority, Short time horizon, and Low technical, organizational & legal complexity
- Consider transforming existing ERI-systems into eFTI compliant service providers.
    - A common IWT eFTI compliant service provider could enable skippers and IWT logistics providers to participate in eFTI without the need to for large IT investments.
    - A common IWT eFTI compliant service provider could strengthen the position of IWT in the multimodal and synchromodal chain.
    - This recommendation has a Medium priority, a Short time horizon and a potentially High technical, organizational & legal complexity. Financial impact might be significant due to increased storage requirements resulting from eFTI requirements.

It should be noted that several more recommendations concerning eFTI are formulated as part of the DIWA SubActivity 3.4 – IWT Data Model & Information Registry report.

[49] https://www.eurisportal.eu/
[50] https://www.riscomex.eu/

7.3 Federative platforms

Federative platforms are an interesting cross-modal evolution. Due to their currently still low level of maturity, it is difficult to give a clear recommendation towards one or the other initiative, technology or eco-system. Therefore it is recommended to closely follow up federative developments (FEDeRATED, FENIX, IDS, …) and their (potential) impact on river information services implementations, especially for those developments aiming towards Connectivity Platform functionality.

7.4 Conclusion

There are many interesting recommendations and suggestions from this DIWA Sub Activity. Together they paint an ambitious path towards a cross-modal connected and digitized IWT, without losing track of the core RIS values of safety, efficiency and sustainability. It seems that EuRIS will be an important cornerstone of this future IWT ecosystem.

8 Bibliography

The bibliography contains the references to source material that was not referenced in-line or via footnotes in the main text of the report.

- RNE – RailNetEurope; www.rne.eu
- 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 (recast); https://eur-lex.europa.eu/eli/dir/2016/797/oj
- 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 Text with EEA relevance; https://eur-lex.europa.eu/eli/reg/2014/1305/oj
- Commission Implementing Regulation (EU) 2021/541 of 26 March 2021 amending Regulation (EU) No 1305/2014 as regard the simplification and improvement of data calculation and exchange and the update of the Change Control Management process; http://data.europa.eu/eli/reg_impl/2021/541/oj
- Technical Document TD-104: TAF TSI - ANNEX D.2: APPENDIX E - COMMON INTERFACE, European Union Agency; https://www.era.europa.eu/sites/default/files/filesystem/taf/technical_documents/baseline_3.2.0/era_technical_document_taf-td-104_d_2_appendix_e.pdf
- Technical Document TD-100: TAF TSI - ANNEX A.5: Figures and Sequence Diagrams of the TAF TSI MESSAGES, European Union Agency; https://www.era.europa.eu/sites/default/files/filesystem/taf/technical_documents/baseline_3.2.0/era_technical_document_taf-td-100_annex_a5.pdf
- RailNetEurope – Common Interface; https://ccs.rne.eu/common-interface/
- TAP TSI and TAF TSI - Sector Handbook for the Communication between Railway Undertakings and Infrastructure Managers (RU/IM Telematics Sector Handbook), submitted on 21st October 2021; http://taf-jsg.info/wp-content/uploads/2021/10/211018_JSG-Handbook_3.0_with_XSD_3.0.2.pdf
- Europe's Rail Joint Undertaking - Masterplan - Draft, 2022; European Commission, https://rail-research.europa.eu/wp-content/uploads/2022/03/EURAIL_Master-Plan.pdf
- REGULATION (EU) 2020/1056 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 July 2020 on electronic freight transport information
- EU Commission, Presentation about EU Regulation on electronic freight transport information (eFTI); https://www.inlandwaterwaytransport.eu/wp-content/uploads/20200903_CESNI-TI_eFTI.pdf
- EU Commission, Presentation about EU Regulation on electronic freight transport information (eFTI) & DTLF Paperless Transport; https://unece.org/sites/default/files/2021-10/T%2BL10%20-%20EU%20Project%20eFTI%20-%20update.pdf
- FENIX network, Deliverable D2.1.1 – Pilot Sites description; https://fenix-network.eu/wp-content/uploads/2020/07/FENIX-Deliverable-D2.1.1_v2.0_FINAL-1.pdf
- FENIX network, Deliverable D3.1 – FENIX Architectural Design Specification; https://fenix-network.eu/wp-content/uploads/2020/07/FENIX-Deliverable-D3.1-final.pdf
- Semantic web:
  - https://www.ontotext.com/knowledgehub/fundamentals/what-is-the-semantic-web/
  - https://www.w3.org/standards/semanticweb/data
- Linked Data:
  - https://www.youtube.com/watch?v=CubeRifQy7I
  - https://youtu.be/bl4MnMBdYpc?list=PLoOmvuyo5UAfY6jb46jCpMoqb-dbVewxg
  - https://www.w3.org/DesignIssues/LinkedData.html
- RDF:
  - https://www.w3.org/RDF/
  - https://www.ontotext.com/knowledgehub/fundamentals/what-is-rdf-triplestore/
- SPARQL:
  - https://www.w3.org/TR/sparql11-overview/
  - https://youtu.be/L_eB7Z84M4c

    - https://www.ontotext.com/knowledgehub/fundamentals/what-is-sparql/
- LDES:
    - https://youtu.be/89UVTahjCvo
    - https://youtu.be/Jp4ciO4Y63U
    - https://semiceu.github.io/LinkedDataEventStreams/
- Railway Compatibility Check tool:
    - http://data-interop.era.europa.eu/

Annex 1. Detailed principles of FEDERATED

FEDeRATED provides detailed principles that might be applicable to this proposal. These are shown in Table 3 below. The last column shows the applicability of a particular principle to inland waterways. As the 'Applicability' column shows, all principles are applicable, except 31. The assumption is made in this document to apply the BDI, which means there is not a choice. A peer-to-peer data sharing is performed.

All principles need to be elaborated further by showing for instance the transactional relations (principle 6) and reporting to infrastructure managers (principle 15, which is push based with ERINOT).

Table 3: Detailed principles of FEDeRATED[51]

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
Level Playing Field	1	All supply chain operators and public authorities involved in freight transport and logistics must be able to participate.	Y, for all stakeholders in inland waterways
Electronic/digital format	2	The information is to be encoded digitally, using a revisable structured format.	Y. When needed, a Graphical User Interface (GUI) needs to be developed to catch data.
	Principle 2 refers to technical interoperability. The information is to be encoded digitally, using a revisable structured format, which can be used directly for storage, and processing by computers, such a structured format for digitally encoded messages that can be transformed into for instance PDF.[52]		
Compliance with existing rules	3	Data sharing must be compliant to existing legislation (e.g. GDPR) and privately agreed rules.	Y (maybe more legislation is applicable)
	Principle 3 refers to legal interoperability		
Business service	4	Each participant must formulate the business service(s) it provides (service provider) or requires (customer).	Y (expressed in standard business services provided by FEDeRATED extended with

[51] Source: Wout Hofman, TNO: Discussion paper on positioning EuRIS in the context of a BDI node
[52] XML, EDIFACT, JSON(-LD), and RDF(s) are supported. Mail attached files, i.e. PDF, Excel, Access, and JPEG, are not supported

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
			specific ones for inland waterways)
	Principle 4 addresses organizational interoperability for enterprises		
Business relations	5	Trust between enterprises is primarily driven by their real work relationships.	Y
	E.g. an enterprise can trust a (known) service provider, but not necessarily another one with whom that enterprise did not do business		
Supply and logistics chains	6	The business relations between participants are shown according to their outsourcing hierarchy from the perspective of for instance a shipper and/or consignee.	Y (this will be elaborated in the next section)
Data requirements of enterprises	7	Business services and commercial mechanisms supporting negotiation between a customer and service provider specify the data that they will share.	Y (see principle 4, combined with the FEDeRATED business process choreography)
	Principle 7 contributes to semantic interoperability.		
Data requirements established by an authority	8	Data requirements set by an authority are related to the legislative basis afforded to that authority.	Y (an authority needs to link its data requirements to a regulation; these data requirements can be formulated as views of the semantic model)
	Principle 8 refers to legal interoperability and organizational interoperability for authorities		
Data processing	9	Any organization can specify its internal processing.	Y (either organizations have their IT systems or they use a GUI to interface with a BDI node)
		E.g. outsourcing strategy (enterprises) or governance of cargo flows by risk assessment (authorities like customs).	
Fit for purpose	10	Public authorities that access enterprise data require a legal basis to refer to.	Y (see principle 8)

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
	Principle 10 refers to legal- and organizational interoperability		
Publication of data requirements	11	Public authorities publish their data requirements in a machine-readable form.	Y (see principle 8: the data requirements formulated as view on the semantic model are made available as SPARQL query for BDI)
	Principle 11 iterates that public authorities publish these data requirements to enable rapid and consistent implementation of these requirements by enterprises, thus reducing errors and supporting rapid changes.		
Business Service Discovery	12	Business services of all enterprises are discoverable according to harmonized search criteria	Y (the Service Registry is used for this purpose. Examples need to be given of how to use the registry)
Data as proof	13	A public authority or enterprise must be able to proof compliance or non-compliance with data.	Y (supported by the notary network of the Corda node that is part of the BDI node)
	Principle 13 stipulates data needs to be stored in a non-repudiated manner to allow such proof.		
Authorities providing data (authority services)	14	Public authorities can share their data with enterprises for policy reasons within a legal framework	? (to be assessed)
	Principle 14 refers to legal interoperability and organizational interoperability for authorities		
Push/pull	15	A legally binding data sharing mechanism is: • a push, data to be duplicated by enterprises to authorities; • a pull, data being made accessible to authorities.	Y (currently, a data push is implemented (ERINOT); potentially also a pull can be applied depending on requirements)

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
	Principle 15 is part of technical interoperability. In case a regulation does not prescribe a mechanism, the pull mechanism is preferred to prevent unnecessary data duplications and thus errors. A reporting data set is only virtual: it is not stored separately but extracted from all other data sets based on a data pull by an authority. The eMSW data set consists of additional data sets like passengers and waste, which is for further development. However, the eMSW data set will be made available in a similar manner		
Publish/subscribe	16	An organization must have the ability to subscribe to any relevant new data in accordance with fit for purpose (public authority) or a commercial relationship (enterprise).	Y (this should be done via the Service Registry to enable decoupling between data holder and -user(s))
	Principle 16 is part of technical interoperability. A data provider issues a unique link to the relevant data and will distribute data when it becomes available.		
Combining data requirements	17	Whenever a public authority is responsible for governance of more than one regulation, the data requirements of those regulations will be combined into one data set.	Y (see also principles 8 and 11)
	Principle 17 refers to legal interoperability and organizational interoperability for authorities		
Identification of organizations	18	Each organization is able to identify itself uniquely according agreed attestations with transparent validation processes of these attestations (e.g. Chamber of Commerce Registration, AEO certificate)	Y (this needs further definition in inland waterways)
Identification of users	19	Persons that act on behalf of an organization can identify themselves as such and should be known and employed or delegated by that organization	Y (a chain of trust needs to be established that is (legally, organizational, and technically) acceptable to both private and public sector as elaborated in section 6 of the

Co-funded by the European Union

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
			FEDeRATED architecture)
User capabilities	20	The capabilities. i.e. the actions that may be performed, of an identified user are transparent to all other relevant users/organizations	Y (this should be part of the trust framework, see also the previous principle)
Data sensitivity	21	Sensitive data should not be accessible or changed by unauthorized users or organizations.	Y (this is part of data sovereignty and accessibility)
	Principle 21 implies access to data that is stored or shared via some solution/platform. is applicable to for instance commercial sensitive data.		
Metadata of data sharing	22	Any metadata specifying which data is accessed or shared between any two enterprises is not accessible by unauthorised users or organizations.	Y (this is covered by peer-to-peer data sharing between BDI nodes)
	Principe 22 addresses that business patterns can be derived from data shared between any two enterprises and should be hidden from third – non authorised - parties. It implies that metadata of data sharing between public authorities and enterprises is open data.		
Identification of systems	23	IT systems of an organization that support the roles data provider and -receiver, are uniquely identifiable	Y (to be further specified)
Data sharing policy	24	A common policy or agreement specifies the use and reuse of data as well as the way it is stored or removed.	Y (EU acts like the Data Governance -, Data – and any other relevant Act is applicable, including archiving regulations)
Data sovereignty	25	A data owner determines the data it will share and retains full rights and controls over this data	Y (this is specified in its profile published and accessible via the Service Registry)
Data at source	26	Single sharing of links, multiple (controlled) access to data	Y (supported by the Index implemented by a BDI node; events have to be

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
			specified for inland waterways)
	Principle 26 indicates that data should be stored at the source to prevent any duplication and potential errors, unless prescribed by a regulation or agreed upon by two organizations that share the data. To have data at the source, these organizations only share links to that data.		
Data sets	27	The data sets of which links can be shared is given by the semantic model	Y (see prinicple 26, the events and data that is accessible can be specific to inland waterways)
	Principle 27 addresses semantic interoperability.		
Baseline standards	28	Use of baseline standard(s) that provide all common terminology, data formats, code values, etc. that can be re-used for implementation of the FEDeRATED models.	Y (BDI supports SPARQL, RDF, and JSON-LD. Local integration can be based on REST APIs and webhook)
	Principle 28 on baseline standards address for instance code values like ISO country codes, ISO standards for date/time formats and terminology with formats like specified in the UN CEFACT Core Component List (see chapter 7)		
Data timestamps	29	An event for sharing milestones has its own timestamp that can differ from the timestamp of a milestone.	Y (implemented by the semantic model)
	Principle 29 identifies the need for difference between these timestamps to be small in the context of process synchronization		
Unique identifier(s) of data (sets)	30	Unique identifiers are used to create and share links of relevant data sets between any two enterprises.	Y (UUIDs are used for uniquely identify data sets like Digital Twins and document data sets – UUID – Universal Unique Identifier generated by IT systems)
	Principle 30 identifies that unique identifiers might differ from identifiers used in the real-world, e.g. a		

FEDeRATED LEADING PRINCIPLES			
Principle	**No.**	**Description**	**Applicability**
	container has a unique container number and can have a unique link for data sharing.		
Data sharing solution	31	Organizations select a solution of choice for data sharing with others (platform, peer-to-peer)	N (BDI nodes are applied)
Federation	32	Organizations can share or access data with others	Y (via BDI nodes)
Data validation	33	Data is either validated by a data provider or a – receiver against data sharing specifications (e.g. XSD).	Y (based on SHACL, a validation mechanism supporting the semantic model)
	Principle 33 identifies that a data receiver will always receive an indication of validation to prevent any double validation. Data validation is on completeness and correctness.		
Data Exchange integrity	34	Accuracy and consistency of data over its entire lifecycle is required	Y (implemented by a pull of data at the source and validations supported by the BDI node (e.g. event logic, to be specified for inland waterways))
	Principle 34 identifies that the fundamental elements of trust in data are to ensure data audits and non-repudiation hitch. Data delivery must also be guaranteed to ensure trustworthy data exchange		
Historical data	35	Historical data sets are stored for optimizing business processes (public authorities and enterprises), based on legal requirements (e.g. archiving),	Y (to be further elaborated for inland waterways)
	Principle 35 iterates that data can also be used to support Research & Development and statistics.		
Logging and audit trail	36	Organizations store a (shared) immutable log and audit trail of the data they have shared.	Y (via the Corda notary network of a BDI node)
Monitoring	37	Each organization can trace with whom and at what time particular data has been accessed/shared with any other organization.	Y (via the Corda notary network of a BDI node)

Annex 2. Quick reference DIWA assessment metrics

Table 4: Summary table for DIWA assessment metrics (Fig 15 from DIWA subactivity 3.5 report)

DIWA Assessment metric (short names)	Assessment results
DIWA-Technology Readiness Level	9 (Market expansion) 8 (Initial market introduction) 7 (Pilot production demonstrated) 6 (Pilot production – pre-production product) 5 (Prototyping & Incubation – testing prototype in user environment) 4 (Concept Validation – lab prototype) 3 (Concept Validation – first assessment feasibility) 2 (Invention – Technology concept formulated) 1 (Invention – Basic principles observed)
DIWA-Adaptability	++ (Seamless Adaptability) + (Adaptability with minor modifications) 0 (Adaptable with substantial modifications) - (Adaptable by redesign in analogy) -- (Not adaptable)
DIWA-Adaptation Demands	++ (Little adaptation resource/time demands) + (Intermediate adaptation resource/time demands) 0 (Substantial adaptation resource/time demands) - (High adaptation resource/time demands) -- (Not feasible)
DIWA-Technology Radar	2022-2026 2027-2032 'Future Box'
DIWA-IDL Impact	Supportive for transformation into III (Intelligent IWT fairway & navigation domain) II (Connected IWT fairway & navigation domain) I (Digitised IWT fairway & navigation domain) 0+ (Organised IWT fairway & navigation domain) 0- (Reactive IWT fairway & navigation domain)