European Commission

Digital Inland Waterway Area

Towards a Digital Inland Waterway Area
and Digital Multimodal Nodes

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TNO innovation for life

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Digital Inland Waterway Area

Towards a Digital Inland Waterway Area and Digital Multimodal Nodes

Service contract MOVE/B3/SER/2015-224/SI2.720619

Study on support measures for the implementation of the TEN-T core network related to sea ports, inland ports and inland waterway transport

Lot 2 - Towards Digital Inland Waterway Area and Digital Multimodal Nodes: waterborne digital services between maritime and inland ports

Task A - Contribute to the elaboration of a strategy establishing a Digital Inland Waterway Area (DINA) and Digital Multimodal Nodes (DMN)

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EXECUTIVE SUMMARY

This report is the result of a study on the future digitalization of inland waterway transport. Digitalization is affecting many sectors and industries. In transport and logistics the use of digital technologies is essential to streamline business processes between shippers and logistics actors. Several modes of transport have adopted different kinds of intelligent transport systems and are investigating the possibility of using (semi-)autonomous vehicles. Rapid technological developments have reduced the implementation barriers for such approaches. Public authorities are responded by providing the necessary regulatory frameworks and through specific digitalization initiatives. In a European context this includes the Digital Single Market initiative and the Digital Transport & Logistics Forum.

It is essential for the future competitiveness of inland waterway transport to follow this trend: in some cases inland waterway transport (IWT) competes with other modes of transport whilst in other cases IWT is part of a larger multi-modal chain making collaboration an essential prerequisite.

This research has identified three areas where digitalization is critically important for IWT:

1 The improvement of navigation and management of traffic: this is necessary to make more efficient use of the capacity of the infrastructure and to reduce fuel costs for vessel operators.

2 The integration with other modes of transport, especially in multimodal hubs: this is necessary to optimize processes in terminals and to allow for an improved integration of IWT in supply chains and multi-modal logistics operations, thereby potentially attracting additional customers.

3 A reduction of the administrative burden: reducing the number of business-to-government declarations (thereby saving costs and improving efficiency) and making law-enforcement more efficient and effective.

Several underlying problems have been identified. These range from the lack of data sharing capabilities to the limited size of the IWT market (in comparison to other modes of transport).

The proposed Digital Inland Waterway Area (DINA) is a concept to interconnect information on infrastructure, people, operations, fleet and cargo in the inland waterway transport sector and to connect this information with other transport modes.

An architecture is proposed that allows for the controlled sharing of this information which can serve as platform for future developments.

- DINA builds on existing investments and developments such as existing components of River Information Services. Extensions are proposed to enable real-time data exchange and the improved integration of other actors such as shippers, logistics service providers and inland ports.

- Furthermore a digital environment (‘data platform’) for barge operators is needed to allow them to control data on their vessel, voyages, cargo and crew. They can use this data for their own purposes such as smart navigation but also share it in a controlled way with others actors, e.g. for reporting purposes.

- It is envisioned that a new on-board toolkit (e-IWT) will be needed to connect barges with this digital environment and provide functionality for skippers as one of the end-user categories.

The report recommends to focus on two aspects as part of the implementation roadmap for DINA:

- Standardization and governance: providing adequate governance mechanisms to develop and maintain the standards used in DINA. This can provide the necessary economies of scale. In addition, this is needed to align with developments in other modalities.

- Public-private collaboration and shared innovation programmes to develop the various components of DINA and to encourage the development of new digital service as part of it.

Various policy options exist for financing DINA. This includes finding a mix between public and private funding, as well as national and European funding. A possibility is to fund certain development and set-up costs, lowering the investment barrier for barge operators and others to acquire the required tools and digital services.

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1.1. Context

1.1.1. Digitalization

In the past decade digitalization has driven change in many industries. Smartphones and mobile internet have changed the way people communicate. Digital platforms enable individuals and groups of organizations to share data and work together. Smart internet enabled devices are creating an 'internet of things'. Data is starting to become an increasingly important economic asset.

This has given rise to new applications not just by streamlining processes but also by fully transforming business models and business practices. These result in significant changes in the way industries are structured: new value providers emerge which reduce profit margins for others. In this way digitalization is both an opportunity and a threat.

The Digital Single Market is the European Commission's main priority to move this trend forward. It provides a regulatory framework to ensure an open and level playing field for users and providers of technology. Additionally, it fosters new digital initiatives and drives digitalization in specific sectors.

Transport and logistics are considered to be key sectors in the Digital Single Market strategy [1]. In many ways new digital technologies such as the internet-of-things, data sharing technologies and big data analytics enable increases in efficiency and reliability. For example:

- New manufacturing technologies and e-commerce processes change the supply chain of businesses and require new transport services;
- New logistics paradigms such as 'synchromodality' and the 'Physical Internet' all rely on new underlying data-infrastructures to bring together the supply and demand of transport services:
  - *Synchromodality* relates to the strategic, tactic and operational planning of shipments and transport operations based on real-time availability of available logistics services, data on the transport means (e.g. the location of trucks or barges and their available capacities) and data on the infrastructure (e.g. expected delays). By sharing this data stakeholders can optimize their transport operations.
  - The *Physical Internet* is a new paradigm based on intelligent cargo technology. Cargo is routed through a self-organizing multi-modal transport network. Intelligent hubs or nodes ensure that cargo is routed to its destination allowing for optimizing cargo flows between these hubs.
- In many modes Intelligent Transport Systems and (semi-) autonomous vehicles make transport more efficient, reduce emissions and enhance the capacity of Europe's infrastructure;
- Electronic data exchange between businesses and government can assist in reducing the administrative burden.

1.1.2. Inland waterway transport

This report focuses on digitalization in the inland waterway domain. Inland waterway transport plays a significant role in various transport corridors and industries. In addition, due to the congestion of road traffic and the climate friendliness of waterway transport makes it an interesting alternative for combined transport.

Nevertheless various challenges remain. Studies indicate that there is a lot of unused capacity and therefore room for growth. Specific actions were taken up by the European Commission to address barriers for growth:

- The overarching NAIADES II programme [2] of the European Commission aims to create the conditions for inland navigation to become a quality mode of transport, assisting the overall transport objective of shifting freight transport to waterborne transport and rail. The programme proposes measures in the field of infrastructural improvements, innovation and the functioning of the market. Specific actions include the review of technical requirements for vessels and assessing the barriers for the further development of inland ports. Further action will be taken in the field of lowering emissions and in the field of workers' qualifications.
- Various TEN-T corridors include inland waterways. Under the TEN-T programme the European Commission and the member states are investing in the quality of these inland waterways.

A reference of studies used as a basis for the preparation of this report is included in Appendix 0.

Digitalization has been a part of many of the aforementioned initiatives to introduce intelligent transport systems in the inland waterway sector, as has been the case in other modes of transport. Such systems aim to provide users of such systems with information on the traffic situation and available routes and to provide managers of the infrastructures with more capabilities to ease congestion and to ensure safety.

For inland waterways the introduction of intelligent transport systems was mainly driven by fairway authorities using the 'River Information Services' paradigm. The main objective of River Information Services is to improve safety and facilitate efficient navigation, management of traffic and use of infrastructure. River Information Services systems have been implemented by the various fairway authorities in EU member states and third countries to provide fairway information to skippers/barge operators and to provide (internal) services for traffic management and calamity abatement. The European Commission has sponsored this strategy stimulating the roll-out across many inland waterways

The full potential scope of River Information Services is covered in guidelines as managed by PIANC [3]. The European RIS Directive [4] and underlying Commission regulations, as well as relevant regulations by river commissions such as the Rhine Commission (CCNR) made the provisioning and use of some of these services and technologies mandatory. This includes:

- The provision of electronic charts and the electronic chart display system
- Electronic notices to skippers
- The mandatory use of AIS positioning equipment for vessels
- Standards for electronic ship reporting

Projects such as the CEF funded 'Corisma' and ‘COMEX’ project focus on further developing the functionalities of RIS to enable efficient navigation through entire inland waterways corridors [5].

Another project, the e-IWT project [6], was started in 2016 to investigate a potential toolkit for supporting the new Professional Qualifications Directive [7] and – more globally to develop digital tools for facilitating compliance and enforcement of inland waterway transport legislation [8].

At the same time developments in other modes of transport and new trends in digital technologies impact digitalization in inland waterway transport. For example:

- The Digital Transport & Logistics Forum is actively looking into the adoption of e-transport documents related to freight across the various modes of transport. This will impact the relationship between barge operators and their customers (shippers and/or logistics service providers). The Digital Transport & Logistics Forum is also looking into optimisation of cargo flows along transport corridors [8].
- New cloud based technologies are changing the way data is shared amongst actors. Whereas previous generations of technology primarily focused on electronic data exchange using messages these new technologies shift towards cloud based controlled data sharing. Several providers have started to develop such platforms for use in transport and logistics.
- New wireless communication technologies, such as 5G, promise more reliable communication and improved coverage.

1.2. Project objectives

This report is the result of the work carried as part of a broader ‘Study on support measures for the implementation of the TEN-T core network related to sea ports, inland ports and inland waterway transport’ (service contract MOVE/B3/2015-224).

The aim of the project is to provide analytical input for the development of strategies to create a Digital Inland Waterway Area (DINA) and Digital Multimodal Nodes (DMN) as part of the implementation of the Digital Single Market Strategy for inland waterway transport.

River Information Services (RIS) are expected to become an important component of the new Digital Inland Waterway Area. The objective of the project was to also identify relevant technologies and developments beyond RIS that could support the development of DINA.

Key objectives of the project were to:

- Identify the potential scope of the Digital Inland Waterway Area: which problems are currently encountered by stakeholders that could be addressed through DINA?
- Analyse the underlying data requirements and define an architectural concept of DINA based on this analysis.
- Elaborate a feasible roadmap/implementation plan for DINA.

1.3. Approach and methodology

This report is the result of both desk research and discussion with a project taskforce.

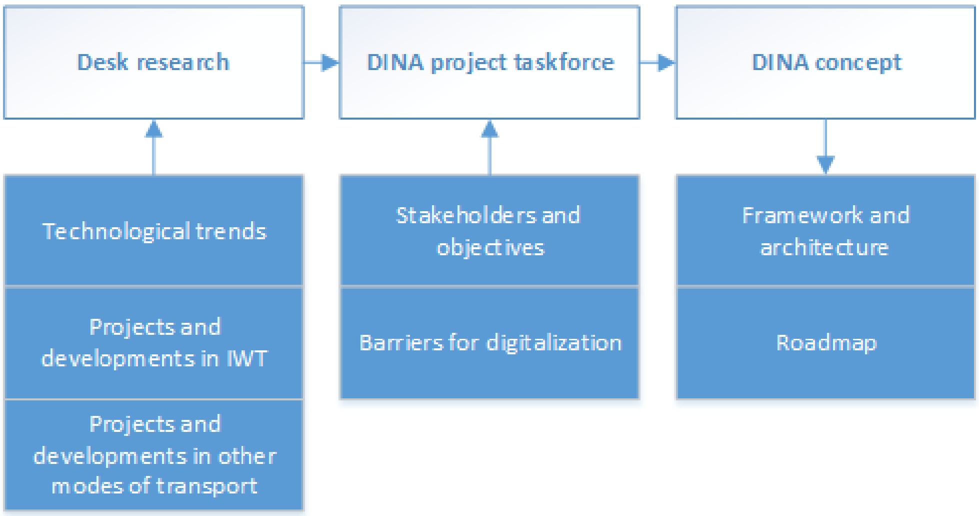


Figure 1 : Methodology

Desk research was carried out to identify technological trends impacting digitalization. In addition, projects and developments in inland waterway transport and other modes of transport were studied to identified possible shortcomings and synergies. A link was established with several related projects and initiatives, including the e-IWT initiative, the COMEX project and several initiatives in other modes of transport. Where applicable their input was taken into account in this report. In addition the work of the Digital Transport & Logistics Forum was considered when identifying measures to ensure interoperability with developments in other modes of transport.

A **taskforce** was set-up with representatives of various categories of actors relating to inland waterways transport. The taskforce provided input on the possible objectives of DINA and the barriers they currently experience. The taskforce met three times in the periode of 2016-2017 to discuss the outcomes. A list of taskforce members is included in Appendix C.

The outcomes of the desk research and the task force meetings were used to put forward a **concept of DINA**, including a framework (scope), architecture (how this could be implemented) and a roadmap.

1.4. Reading guide

The figure below shows an overview of the content and the structure of this report:

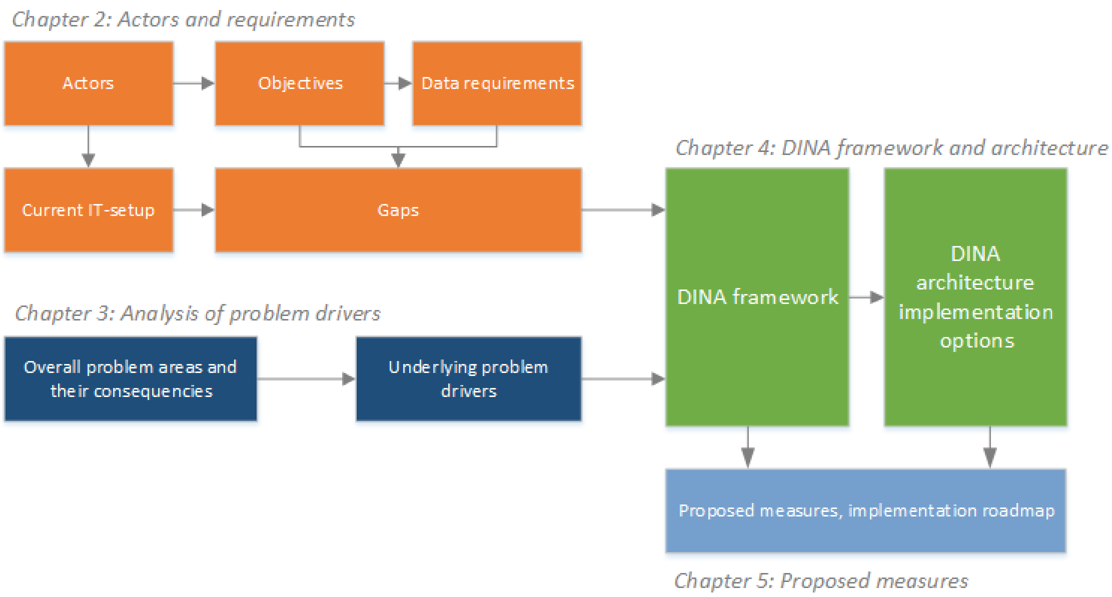


Figure 2: overview of the report

- Chapter 2 provides an overview of the **actors** relevant to DINA and their individual requirements/objectives. This provides an overall view of the challenges which can potentially be addressed through DINA.
- Chapter 3 provides a more in-depth analysis of the **problem drivers**.
- Chapter 4 provides a **framework for DINA:** a conceptual overview of the future architecture for DINA.
- Chapter 5 highlight **possible measures** for realizing this architecture.
- Chapter 6 summarizes the **conclusions and key recommendations** of this research.

2. ACTORS AND REQUIREMENTS

2.1. Introduction

This chapter provides an overview of the categories of actors related to the Digital Inland Waterway Area (DINA). For each category the number of actors is estimated (order of magnitude), their generic needs related to digitalization are identified as well as their current state of digitalization.

We do this to establish a baseline for our problem analysis and conceptual approach for DINA. Where possible the categorization of actors used in this report is aligned with the definitions in the PIANC RIS Guidelines [3] [1].

2.2. Categories of actors

The figure on the next page provides an overview of the various categories of actors related to DINA and how they interrelate. There are three 'layers' to be considered:

- The **users of inland waterway transport**: shippers and logistics service providers.
- The **transport sector itself**: barge operators, terminal operators and their links to other modalities.
- **Authorities**: authorities (or agencies operating on their behalf) to perform a certain public function, ranging from collecting and publishing statistics to calamity abatement and the management of fairways.

Within the context of this report we mainly focus on goods transport. It should be noted that some of the digital services also apply to passenger transport (e.g. river cruise vessels using services to transmit passenger lists) and pleasure craft (e.g. using digital services for navigation purposes).

Shipper and Logistics Service Provider

These organizations represent the demand side of inland waterway transport. In some cases the shipper/cargo owner deals directly with a barge operator. In other cases a logistics services provider or forwarder is involved operating on behalf of the shipper.

Their aim is to efficiently ship the cargo from its origin or destination. They need to find, contract and track a suitable transport services. To do so they work with both barge operators and/or operators in other modes of transport. In many cases the shipper or logistics service provider needs to arrange additional services in terminal or hub. Examples include arranging onward transport or the stripping of a container (unloading of the cargo).

It is difficult to assess the total number of shippers and logistics service providers working with inland waterways. Statistics are collected on the cargo volume only and not on the number of shippers and logistics service providers.

[1] For some aspects the PIANC guidelines further specify certain roles and actors (e.g. the different sub-roles of the waterway manager). In this report we choose to use the main roles and (in some case) link them to terminology used in other modalities and logistics in general.

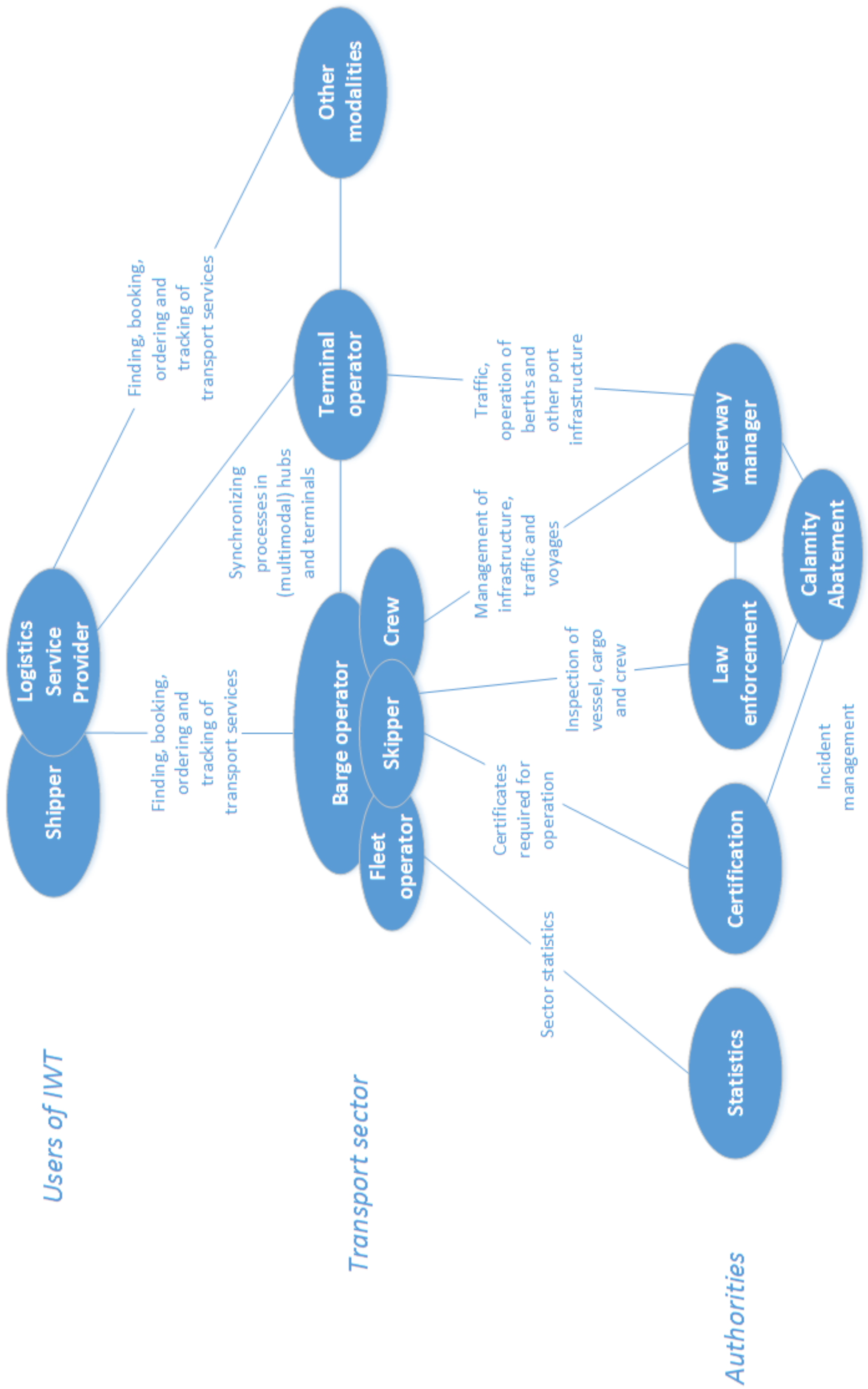


Figure 3: Overview of categoris of actors (roles) and their interrelationships

Based on Eurostat statistics it can be shown however that the biggest volume is concentrated in North-Western Europe.

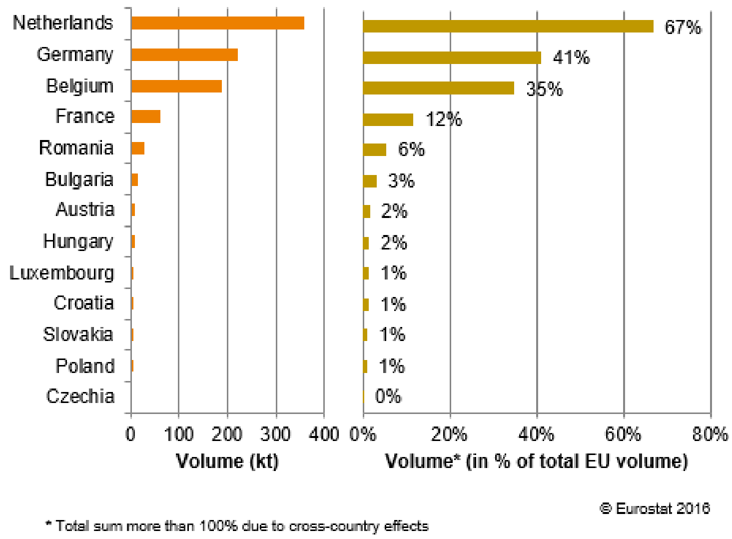


Figure 4: Volume of goods transported using inland waterway transport

On a macro-level the logistics industry is quite fragmented. As an example there are over 500.000 companies active in Europe as a logistics service provider. Most of these companies are SMEs. Some (+/- 10%) provide planning services such as forwarding others also provide actual logistics services (e.g. 80% of the companies provides road transport/trucking services).

On a micro-level the situation is different. Barge operators deal with a limited number of customers. In the DINA taskforce it was indicated that barge operators have a number of customers in the range of 10 (for smaller organizations) to 100 (for large fleet operators).

Barge operator

The barge operator provides transport services on inland waterways. Most barge operators are small sized enterprises operating only one barge (self-employed skippers). There are also a few larger operators which operate a large fleet of barges, either directly owned or chartered – in this case a distinction can be made between the fleet operator and the operator of an individual barge.

In total about 5 700 barge operators are registered in Europe. As illustrated in figure the figure below, about 60% of the operators in Europe are registered in the Netherlands.

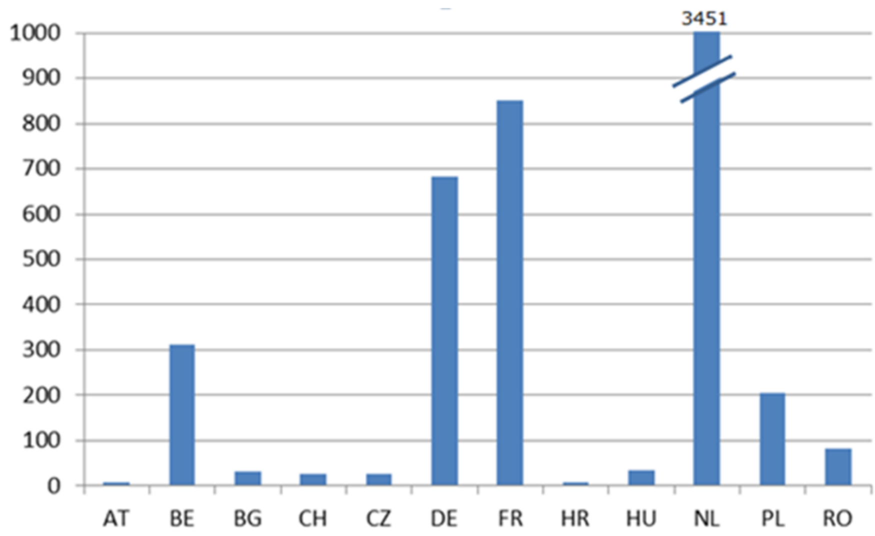


Figure 5: Number of barge operators per country (source: Eurostat)

As part of the barge operator category of actors it is possible to distinguish between the fleet operator (performing the logistics function), the skipper (actually navigating the barge) and the crew (working on the barge). In this document we will use the term 'barge operator' as an overarching term for this.

The barge operator generally needs to deal with three categories of actors:

- Its customers: the shippers and logistics service providers
- Authorities: waterway manager, law enforcement and certification agencies.
- Terminal operators

In terms of market structure there are important differences between the various regions:

<u>Danube / Central and Eastern Europe</u>

Larger companies and operators are predominant on the Danube. On the Danube single ship-owner/operators are exceptional.

<u>Western Europe</u>

In contrast to the Danube most of the dry cargo vessels in Western Europe are owned and operated by families, for example the husband and wife working together, self-employed, possibly with a hired boatman.

Larger companies such as shipping lines also exist in Western Europe and mainly operate larger vessels with hired staff such as push convoys, large container vessels and large motor tankers. If vessels need to operate on a 24/7 basis hired/employed staff is needed to comply with the staff and working time regulations.

Some medium-sized and large companies operate at the logistics and fleet levels, but use the ships of the owner-operators instead of their own vessels, which they used to have in the past. The number of shipping lines operating at all three levels (logistics service provider, fleet operator and owner/operator of barges) is very limited. Examples are Danser and Contargo, intermodal container barge service providers that provide multimodal logistic services, own and operate a number of vessels but also contract a substantial number of private vessel owners/operators to carry out the transport services for container transport on Rhine. Similar situations are seen in tanker shipping, for example Interstream that has 31 own vessels and hires another 110 vessels from private owned vessels.

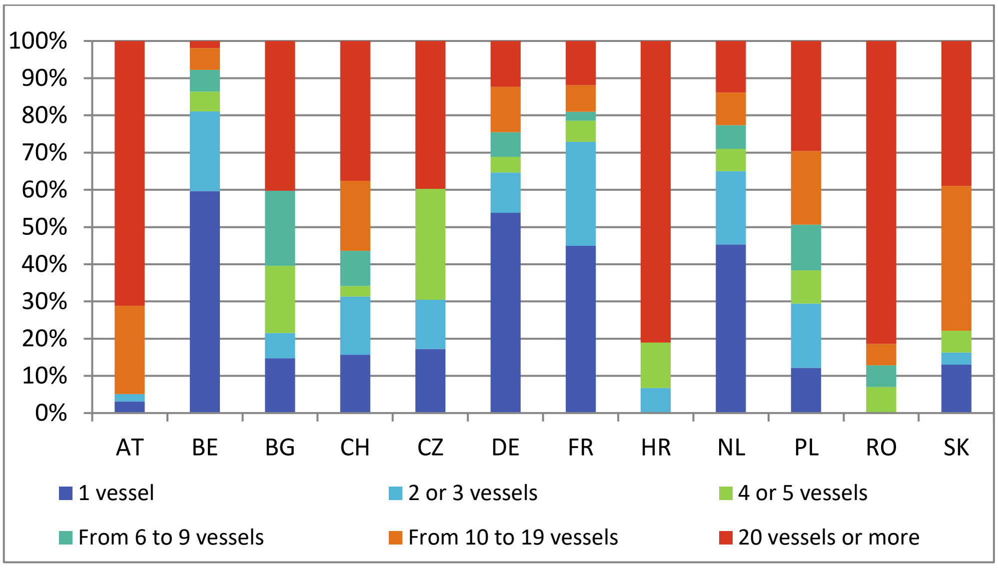


Figure 6: Numbers of vessels per company broken down to different classes per country (2012). Source : Eurostat

The 5 700 IWT enterprises operate a European fleet of approximately 12 800 units with a total load capacity of 16.4 million tonnes. The average year of construction of a dry cargo vessel is 1967 (+/- 50 years old) while in tanker transport the average year of construction is 1976 (+/- 40 years old). In the last decades, the fleet has substantially increased in scale. The new building wave of the past years caused an overcapacity of larger ships that was clearly revealed in 2009 and 2010 when the economic crisis hit major parts of the IWT sector. In 2009, the freight flows declined significantly whereas the fleet was still expanding. The fleet expansion could not be stopped immediately due to new vessels being added to the market that were ordered a few years earlier (before the financial crisis in September 2008).

In 2011 the sector employed approximately 42.200 people – 25.700 in freight transport and 16.500 in passenger transport. The characteristics of the workforce were studied in detail as part of the analysis of costs and benefits of the implementation of the European Agreement on working time in inland waterway transport [9].

Terminal operator

The terminal operator is responsible for the efficient handling of cargo in a terminal. This includes loading and unloading of barges and might also include the transhipment to other modalities or the provisioning of value added logistics services. In hinterland transport some terminal operators also provide logistics services e.g. onward transport by trucks to the cargo's final destination. The terminal needs to synchronize processes in its hub efficiently to remain competitive.

In large ports the terminal operator needs to work with port authorities and waterway managers in relation to the efficient operations of berths and the safe navigation in a port area. The terminal operator needs to synchronize this process with the barge operator: it needs to know when a barge is expected to arrive and might need to assign berth locations and berthing times.

There are approximately 150 inland ports operating in Europe according to figures of the European Federation of Inland Ports [10] :

- France: 20
- Netherlands: 25
- Belgium: 15
- Germany, Luxemburg, Switzerland, Czech Republic: 60 (Rhine/Mosel/Oder/Elbe)
- Hungaria, Austria, Slovakia, Croatia (Upper-Danube): 10
- Romania, Bulgaria, Serbia. Moldova, Ukraine (Lower-Danube): 20

Inland ports differ in size and scope of their operations:

- Most inland ports are relatively small and have only one terminal operator and just a few berths. In addition to this there are some industrial sites along inland waterways with dedicated berths which are not included in this overview.
- There is a small number of very large ports with multiple terminals. Examples include combined maritime and inland ports (Antwerp, Le Havre, Rotterdam, etc.) and large inland ports such as the port of Duisburg and the Haropa ports in Ile-de-France. Given their larger size their operation is also usually more complex, e.g. requiring more advanced scheduling of calls and management of berths.
- Most ports have a specific focus on either a specific type of bulk cargo (depending on the industry in the vicinity) or multimodal container operations.

It is estimated based on this information that in DINA it should be considered that there is a total of +/- 200 actors to be considered in the terminal-category. A small percentage of these have a very complex operation (volume, berths, etc.), it is estimated to be a total of +/- 20 actors. The operation of the remainder is on a smaller scale and more straight forward in terms of planning.

Waterway manager

The waterway manager or fairway authority is responsible for the condition of the infrastructure and the management of traffic flows. This is especially important in capacity constrained areas such as near bridges or locks. The waterway manager needs to work with barge operators to receive up to date information on positions and whether dangerous cargo is on board. Barge operators can receive updates from the waterway manager relating to the condition of the fairway (charts, notices, water levels, etc.) which can be used to plan voyages more efficiently.

The waterway manager needs to work with other authorities too, e.g. the police and other law enforcement agencies. In addition, data from the waterway managers is used in the event of a calamity.

There are approximately 30 waterway managers to be considered in the scope of DINA. These range from nation-wide waterway managers (e.g. Rijkswaterstaat in The Netherlands or Voies Navigables de France) to smaller managers (e.g. EDF for certain locks in areas where they operate hydro-electric power stations).

Law enforcement and Calamity Abatement

In order to enforce regulations on safety law enforcement agencies need to be able to access data on vessels, cargo and crew. Currently barge operators are required to notify the authorities using an (electronic) ship report when they carry dangerous cargo or containers. In addition they need to use an AIS transponder to provide positioning data and a limited set of data on their vessel and planned voyage. This data is used for law enforcement and calamity abatement. It is also used by the waterway manager for traffic management purposes.

Many countries have several agencies involved in law enforcement and calamity abatement. Therefore a total number of 50 - 100 actors is to be considered in this category.

Certification agencies

These authorities perform an (initial) technical inspection of the vessel and issue certificates. These certificates indicate certain capabilities and restrictions which are required for operation.

For crew members (boat masters') certificates are issued indicating their qualifications. Depending on the specific waterway, vessel and cargo different certificates can be needed.

Law enforcement agencies need to be able to inspect these certificates to verifiy that a vessel is operating according to the regulations relating to the particular certificate.

Usually each country has at least one certification agency. As a result an order of magnitude of 30-40 certification agencies is to be considered for DINA.

Overview

The figure below provides a high-level overview of the number of actors to be considered for DINA

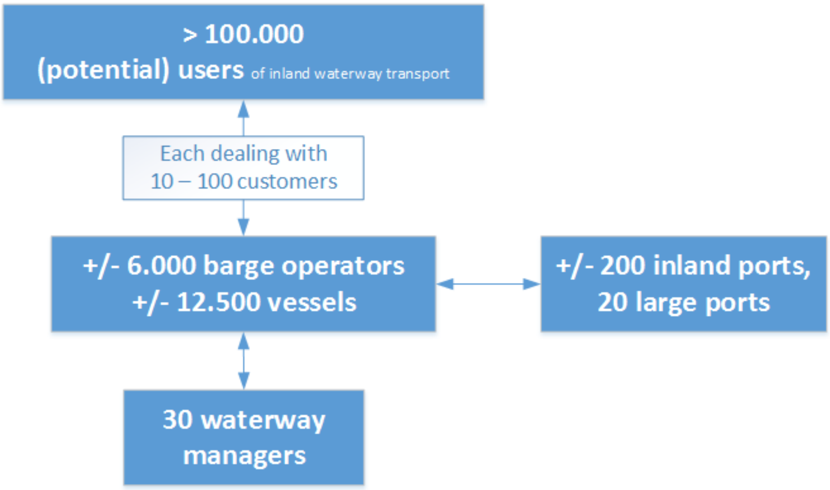


Figure 7: Overview of the number of actors

2.3. Objectives of each category of actors

The DINA taskforce identified objectives for each actor-category and the requirements which result from these objectives.

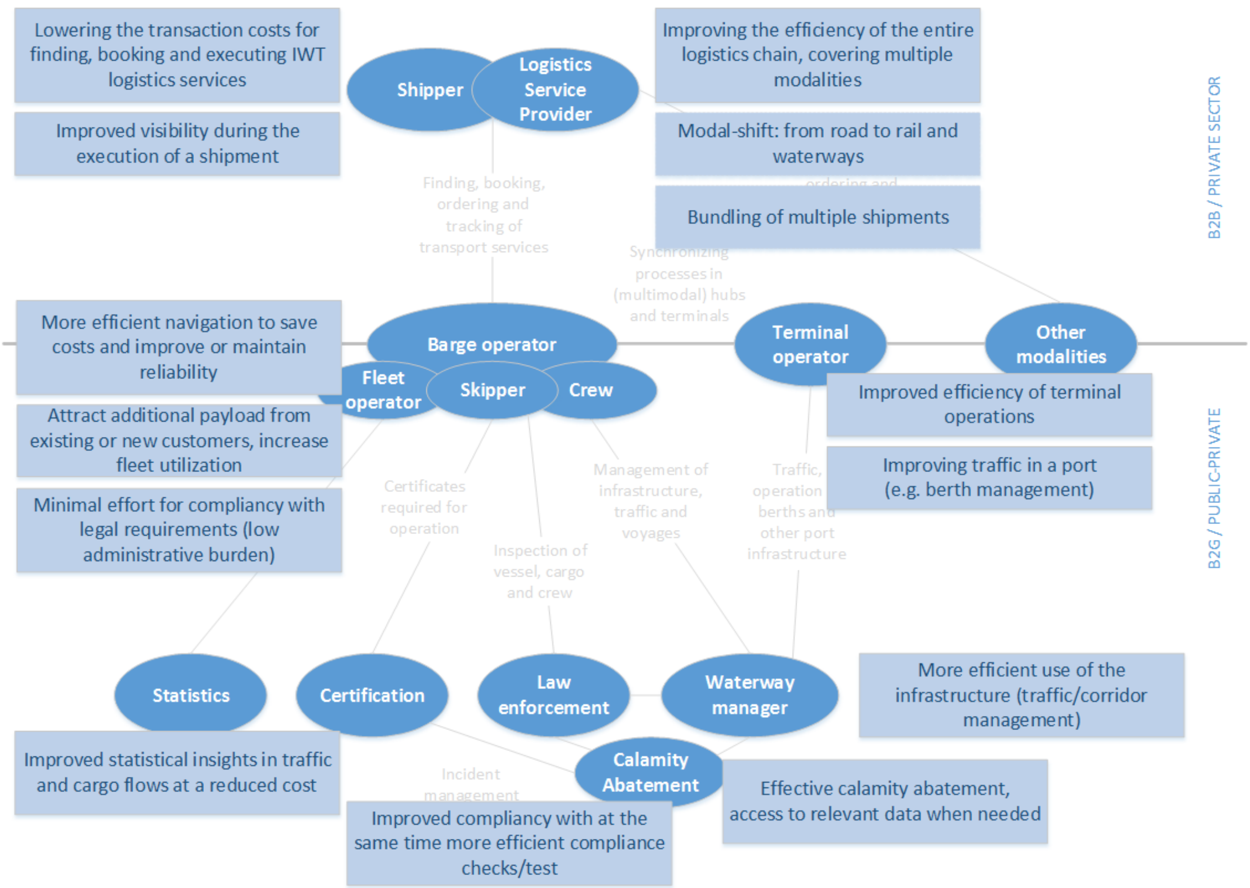


Figure 8: Objectives

2.3.1. Shippers

<u>Objectives</u>

- **Lowering the transactions costs for finding, booking and executing IWT logistics services**: it should be easy to find suitable services, book such a service and execute it. This includes collecting the necessary paperwork or providing the barge operator (and other involved actors) with the right information concerning the shipment and the cargo. Currently many shippers have fixed contracts or long-running business relationships with one or more barge operators. But in multimodal-chains shippers have much greater flexibility in choosing between different modalities, especially for containerized freight. In this case it is important to be able to know what services are available given certain criteria (time, costs, reliability, sustainability).

- **Improved visibility of cargo during the execution of a shipment:** the shipment is usually linked to a logistics process of the shipper, the consignee/receiver or an intermediate logistics actor (e.g. a warehouse or terminal). To make sure these processes can operate efficiently it is important to have sufficient visibility during the execution of a shipment. This can relate to the condition of the cargo (e.g. the temperature of reefer container or dangerous cargo) but it mostly relates to the estimated time of arrival (ETA). Sometimes shippers want to be able to track the location of the vessel and derive the ETA accordingly. But in most cases it is sufficient to know the ETA at the planned destination and to be notified of a delay or early arrival.

IWT considered as a 'black box' by many shippers and logistics service providers

When discussing these objectives with shippers many indicated that IWT is currently considered a 'black box'.

It is difficult for them to get accurate information about available services and capacities – requiring them to contact individual operators or use the services of an intermediate logistics service provider. Usually this is done using phone calls or by sending e-mails. Some larger fleet operators provide online portals providing some functionality.

During the execution of the shipment there is usually no way for shippers to track the status of the cargo. Some organizations use AIS data (e.g. provided through online apps such as MarineTraffic) for tracking vessels. The legality of using AIS data for this purpose is challenged by barge operators stating privacy concerns and liability [11]. Others use dedicated proprietary systems with on-board units or corporate systems of fleet operators.

<u>Requirements</u>

The following requirements apply for shippers:

- **Access to logistics services offered by IWT**: insight in available services, available capacities and constraints.
- **Capabilities for booking logistics services**: digital capabilities for booking a specific service and exchange the required underlying data on the cargo and shipment.
- **Visibility of cargo whereabouts during the execution of services**: the estimated time of arrival of the vessel and (potential) disruptions resulting in an early or late arrival.
- **Synchronization of processes in multimodal hubs** (bookings, visibility, administrative data): also on the side of the shipper things can change, e.g. the cargo is not yet released by the originating deepsea carrier and needs to be dropped from a barge's load list and rescheduled.

2.3.2. Logistics service providers

<u>Objectives</u>

Logistics service providers (LSPs) have in many ways similar objectives when compared to individual shippers. Most LSPs however take a more holistic view, covering multiple shipments and looking at multimodal logistics chains as a whole. Key objectives include:

- **Improving the efficiency of the entire logistics chain, covering multiple modalities**: LSPs try to serve the needs of their customers using different modalities (road, rail and inland waterways).
- **Modal-shift: from road to rail and inland waterways**: rail and (especially) inland waterways can often provide a cost-effective alternative to road transport. In this case there is an incentive for logistics service providers to seek to shift cargo from road to alternative modalities.
- **Bundling of multiple shipments**: by bundling multiple shipments LSPs can achieve greater efficiencies and save costs, e.g. by booking multiple slots on a container vessel or selling slots on a chartered vessel.

<u>Requirements:</u>

The requirements of LSPs are similar to those of shippers. They too need to have access to services offered by barge operators, easy booking facilities, visibility and synchronization capabilities.

The key difference is that LSPs can once again bundle these services into an integrated offering, providing a one-stop-shop for shippers. Sometimes these services are provided 'modal-free' whereby the LSP selects the best modality for a certain shipment at a certain time. In other cases, the LSP bundles multiple shipments providing a costs saving the shipper.

Integrating multiple modalities in a 'synchromodal dashboard'

Several logistics service providers have a so-called 'synchromodal dashboards' or 'control towers' at their disposal. These integrated digital systems combine data on required shipments and real-time data on available logistics services and infrastructure data. In this way such systems control shipments on a certain corridor or through a sea or hinterland hub and deal with disruptions and possibilities for further optimization – e.g. filling empty slots with available cargo.

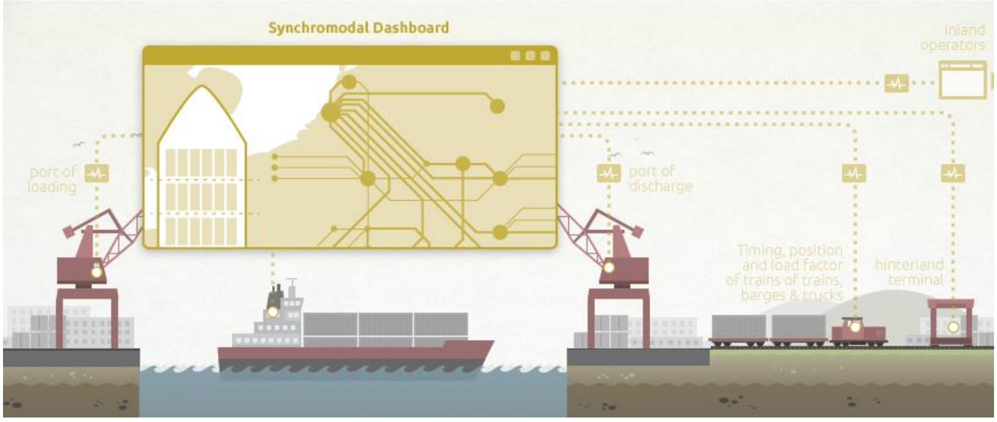


Figure 9: European Gateway Services integrating data of maritime vessels, port and terminal operations and hinterland transport services (barges, road, rail). Developed in the EU-FP7 COMCIS project [12]

2.3.3. Barge operators

Many barge operators face a challenging market characterized by overcapacity and (consequently) low rates [13]. Therefor they have an interest in attracting additional cargo to improve turnover and improve their operational efficiency to lower costs.

At the same time barge operators want to reduce their cost of compliance with legislation. This relates for instance to the administrative burden for filing ship reports with the authorities and other mandatory declarations, e.g. for customers formalities and vessel clearing at border crossings.

Digitalization should also support related developments such as (semi-) autonomous navigation [14] and the introduction of new cleaner/low-emission vessels (e.g. as piloted in the EU H2020 'Prominent' project [15]).

Objectives

- **More efficient navigation to save costs and improve or maintain reliability**: being able to plan a voyage as efficiently as possible, meeting customers' requirements. Cost savings relate to various aspects:
  - Optimal fuel burn: lowering speed when possible and increasing speed to catch up with expected delays later en-route.
  - Optimal operations in ports and terminals: skippers want to be handled there as efficiently as possible with minimal waiting times or empty runs (e.g. between different terminals in a large maritime port).
  - Reduced manning requirements: autonomous navigation or computer-aided navigation can not only enhance safety (e.g. comparable to driving aids in road traffic), they might also reduce manning requirements in the future. This can save costs as digital technologies take over certain navigation and safety related tasks. It should be noted that such approaches are still under development [14] and will require further proving and subsequent changes in legislation.
- **Attract additional payload from existing or new customers, increase fleet utilization:** barge operators are interested to know whether there is additional cargo they could possibly carry on their barge in case they do not operate a full-load. For example, in containerized transport: to have the ability to see if there are additional containers which could potentially be carried from an intermediate port to a final destination [16].
- **Minimal effort for maximum compliance with legal requirements (low administrative burden):** it is important for barge operators to comply with legal requirements with a low administrative burden. In practice this means that they want to minimise the number of (manually filled in) reports (for dangerous cargo, customs, immigration, workers' qualifications) and other paperwork. Ideally authorities re-use data: from each other (e.g. data already filed with another) and from existing registrations (e.g. readily available business data made accessible for authorities under certain conditions).

Requirements

To achieve these objectives barge operators have the following (data) requirements:

- **More detailed traffic information** is needed to plan their voyages as efficiently as possible. This could be done per infrastructure object e.g. waiting times for a lock. Another option is to do this on a corridor level – providing an ETA based on all conditions in a corridor. Key restrictions are currently provided through Notices to Skippers, additional data is expected to be provided through future corridor management data services.
- **Reduced number of declarations to the authorities:** ideally declarations to the authorities should be 'digital only' (no need to provide documents on paper) and 'only once' (data provided to one authority and re-used by many others). Where declarations are needed to comply with legislation this should preferably happen by re-using existing business data, reducing the need for barge operators to register additional data for compliance purposes only.

- **Ability to synchronize processes with terminal operators to reduce waiting times in ports/terminals**: barge operators want to have a seamless experience in ports and terminals. Terminal calls should be scheduled in such a way that there are as little waiting times as possible. Therefor they require a synchronization between terminal operations and their planned voyage in a port.

Administrative burden today

Barges need to provide an electronic ship report to the fairway authority in case they are carrying dangerous cargo and/or containerized freight. There is a European standard for certain messages including dangerous cargo reporting, however these are only binding where electronic reporting is mandatory by national and international law.

In practice reports other than those for dangerous cargo are often needed as reporting requirements vary among fairway authorities and member states. As a result some reports or some data provided cannot be re-used across countries or is not available requiring additional input or additional reporting activities by the barge operator. There are also instances where additional reports are needed on paper or through VHF radio.

Finally there are also other reporting requirements for other purposes (e.g. customs) requiring similar but slightly different data. This all contributes to the administrative burden for barge operators.

2.3.4. Terminal operators

Terminal operators operate on behalf of shipping lines (in the case of maritime ports) and/or other logistics stakeholders (e.g. forwarders or shippers, in multimodal hinterland hubs).

<u>Objectives</u>

The objectives of the terminal operator are as followed:

- **Improved efficiency of terminal operations:** they want to load and discharge cargo as efficiently as possible with as little crane movements and internal transport as possible. Equipment and personnel should be employed as efficiently as possible.
- **Improving traffic management in a port (e.g. berth management):** terminal operators have an interest in efficient planning of port calls of barges as long as it supports their (the terminals') operational efficiency. For example: a berth shouldn't be occupied when a deep-sea vessel needs to moor there. Or: cargo from a barge that needs to be transhipped to a deep-sea vessel needs to be unloaded first. Several terminal operators have started initiatives to plan such calls with barge operators in a more efficient manner [17].

<u>Requirements</u>

- Ability to synchronize processes with barge operators: receive more accurate ETAs and be able to schedule the handling of barges (where applicable).

2.3.5. Waterway managers

Objectives

The objectives of waterway managers is to support the safe and efficient use of inland waterways. They also have an interest in the increased use of inland waterways as a modality supporting a modal shift.

The key objective for digitalization is to support the **more efficient use of waterways.** Efficiency gains are possible in some cases through more advanced traffic management. Through traffic management on a corridor level increased levels of traffic can be handled, possibly reducing bottlenecks and requiring less investment in physical infrastructure or management (e.g. by planning lock operations more efficiently adding an additional chamber to the lock to ease congestion might be avoided).

Data requirements

A key requirement to plan traffic more efficiently is to have **additional data on planned voyages of barges in a certain corridor**. Currently limited voyage data is available through data in AIS transponders and data in electronic ship reports for some vessels. The waterway manager doesn't have access to the full voyage plan of the vessel, limiting its possibility to accurately predict congestion. For planning operations (e.g. at a lock) an interaction is needed with the barge operator, e.g. providing the skipper with an ETA based on the actual traffic situation in a corridor or planned lock or bridge operations. In a future scenario there could even be an ETA negotiation process, where the skipper / vessel operator provides an ETA, and the lock operator responds with an RTA (requested or required time of arrival).

CoRISMa – RIS Enabled IWT Corridor Management

CoRISMa
TEN-T RIS Enabled Corridor Management

In the European CoRISMa project the concept of 'Corridor management' was introduced and tested. Three levels of Corridor Management were considered: Level 1 covers the corridor-wide information on infrastructure. Level 2 additionally considers current and future traffic flows within the managed corridors. Level 3 offers an additional portfolio of services for logistics users in the transport chain of inland navigation.

RIS COMEX – RIS Corridor Management Execution

RIS COMEX

The successor project RIS COMEX aims to implement the concept of Corridor Management in various European corridors. Corridor Management as a concept aims at improving and linking existing RIS services on a route or network in order to supply RIS not just locally, but on regional, national and international level. The ambition of the project is to facilitate digital services for route planning, voyage planning, transport management and traffic management.

2.3.6. Law enforcement agencies

Objectives

The objective of these agencies is to provide both **efficient and effective law enforcement and calamity abatement**.

On one hand law enforcement agencies have an interest in a low administrative burden: having reliable yet easy-to-use mechanisms in place to capture data required for law enforcement.

On the other hand they need to be able to use this data in an effective manner:

- To identify risks and use this for targeted law enforcement
- To have sufficient data to be able to act in the event of a calamity.

Data requirements

To achieve these objectives law enforcement agencies require sufficient data on **cargo, crew and vessels**.

Some parts of the data are always necessary, e.g. data to be able to identify a certain vessel and to know the category of dangerous cargo. Other parts should be accessible in specific circumstances, e.g. in the event of a calamity or when a targeted inspection is deemed necessary. This can include for instance precise data on the cargo or detailed voyage plans.

e-IWT: supporting the professional qualifications directive and other IWT legislations

The professional qualifications directive aims to lower mobility barriers for professionals working in the inland waterway transport sector. As a next step the social partners and Aquapol and – at the same time – the European parliament and the Council are asking the Commission to consider the possibility of replacing the paper version of Union certificates of qualifcation, service record books and logbooks by digital tools.

Such tools can include electronic professional cards and electronic vessel units, with a view to further modernise the IWT sector and reduce the administrative burden. In addition, digitalization might render documents less prone to being tampered with. Some of the data recorded in the service record book needs to be reported to a centralized database (ECQD), whereas other parts of the data should only be accessible on an as-needed basis during an inspection.

These tools could also be sued for other purposes than the professional qualifications (e.g. the monitoring of working hours).

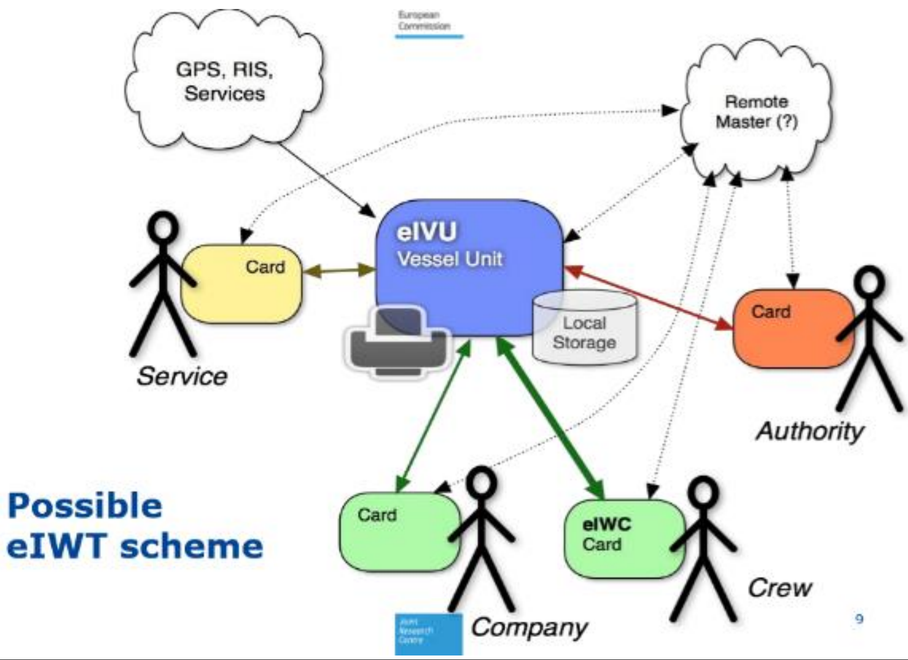


Figure 10: Possible eIWT scheme [6]

2.3.7. Statistics agencies

Objective

Statistics agencies play an important role in collecting data on traffic and cargo flows. Their objective is to **provide improved statistical insights** in traffic and cargo flows **at a reduced cost.**

Data requirements

The corresponding data requirements are twofold:

- They need to have **access to data on traffic and cargo in an easier way**: currently many data is collected through paper or spreadsheet based questionnaires. These are costly to process. Many fairway authorities currently allow for the re-use of ERI (electronic reporting) data for statistics purposes, taking away the need to file separate statistics declarations.
- They need to have **access to a wider set of data**: data of more stakeholders. Because of the high costs questionnaires are often sent to only a limited number of stakeholders reducing the accuracy of the overall statistics.

2.4. Current state of digitalization

There are already various systems and services in place for the digital exchange of data between the various stakeholders. The figure on the next page provides an overview.

We will address the systems and abbreviations mentioned in this figure in the following sub-paragraphs and identify gaps between the stated objectives, generic data requirements and currently implemented technologies.

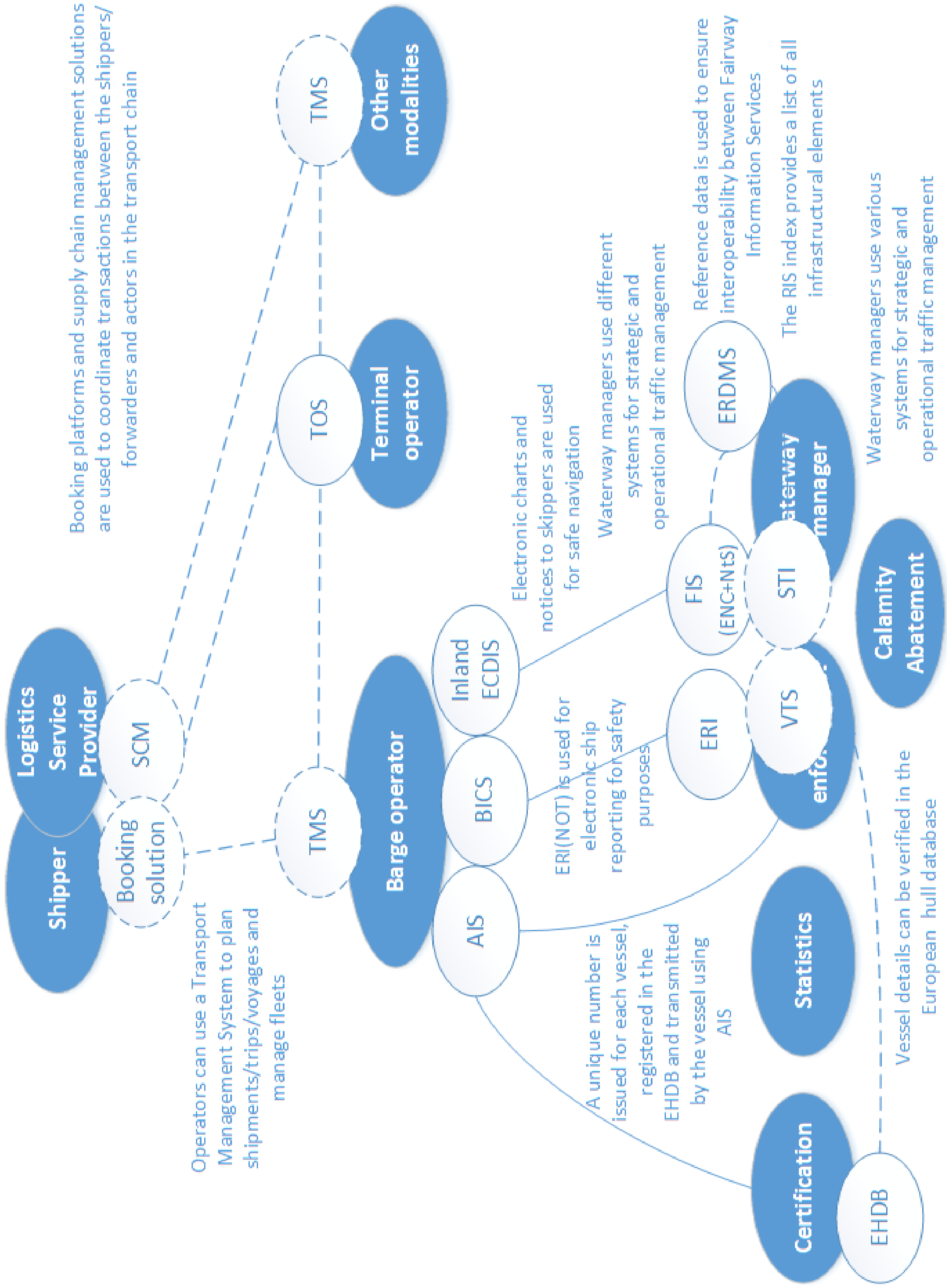


Figure 11: Current state of digitalization - the dotted lines indicate mandatory systems/technologies/data exchanges which are widely implemented and used; the dotted lines indicate systems/technologies/data exchanges used by some actors

2.4.1. Supply chain management solutions (SCM)

Shippers use supply chain management solutions (SCM) to manage the procurement and logistics process of materials needed for production or the production of their customers. Based on sales and production forecasts the objective of such systems is to have a sufficient stock or inventory of raw materials and other procured products to ensure an uninterrupted production. Just in time delivery of raw materials can be attractive to reduce inventories and reduce the associated costs.

SCM systems are linked to (or part of) a company's ERP (Enterprise Resource Planning, for procurement, production planning and sales) and MRP systems (Materials Resource Planning).

SCM systems need to take into account the logistics capabilities of the transport service providers involved. This is especially important for inland waterway transport as it is inherently less flexible than road transport (larger volumes per shipment, bound to the waterways' infrastructure, lower speed) making it more difficult to implement just-in-time deliveries.

Gap: In many cases there is no real-time link between SCM systems of shippers and the various systems used by logistics actors (logistics service providers and transport operators).

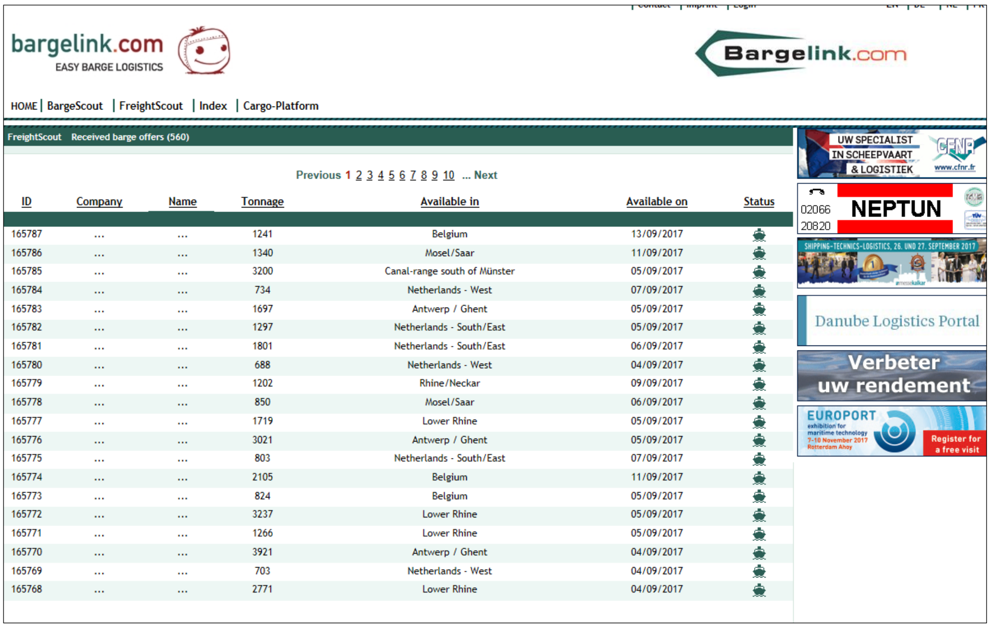
2.4.2. Booking solutions

Large shippers and logistics service providers have developed a range of booking platforms in recent years to support the contracting of logistics services. Such booking solutions can be used both towards customers (shippers) and towards providers of logistics services (trucking companies, barge operators, etc.).

Users can either log-onto an online platform to retrieve bookings or use electronic data exchange (EDI) to exchange bookings. The use of EDI is common for interactions between larger stakeholders. In most cases transactions are dealt with using traditional means of communication (phone, e-mail or fax). This is especially true for SMEs which are very common in inland waterway transport.

In recent years several providers have developed more generic solutions for managing bookings, especially linking these booking solutions to supply chain management software. Examples include GT Nexus (a privately-owned cloud supply chain platform) and INTTRA (electronic transaction platform for maritime shipping). In the inland waterway sector the Bargelink platform was set-up by a number of large shippers; this platform can be accessed by barge operators through a web portal.

Gap: Booking solutions exist but it is difficult for small and medium sized enterprises to use them in a seamless way because of the lack of electronic data exchange capabilities.



ID	Company	Name	Tonnage	Available in	Available on	Status
165787	...	...	1241	Belgium	13/09/2017	
165786	...	...	1340	Mosel/Saar	11/09/2017	
165785	...	...	3200	Canal-range south of Münster	05/09/2017	
165784	...	...	734	Netherlands - West	07/09/2017	
165783	...	...	1697	Antwerp / Ghent	05/09/2017	
165782	...	...	1297	Netherlands - South/East	05/09/2017	
165781	...	...	1801	Netherlands - South/East	06/09/2017	
165780	...	...	688	Netherlands - West	04/09/2017	
165779	...	...	1202	Rhine/Neckar	09/09/2017	
165778	...	...	850	Mosel/Saar	06/09/2017	
165777	...	...	1719	Lower Rhine	05/09/2017	
165776	...	...	3021	Antwerp / Ghent	05/09/2017	
165775	...	...	803	Netherlands - South/East	07/09/2017	
165774	...	...	2105	Belgium	11/09/2017	
165773	...	...	824	Belgium	05/09/2017	
165772	...	...	3237	Lower Rhine	05/09/2017	
165771	...	...	1266	Lower Rhine	05/09/2017	
165770	...	...	3921	Antwerp / Ghent	04/09/2017	
165769	...	...	703	Netherlands - West	04/09/2017	
165768	...	...	2771	Lower Rhine	04/09/2017	

Figure 12: Bargelink platform

2.4.3. Transport Management Systems (TMS)

A transport management system is used by operators to plan and manage shipments. They maintain a record of planned routes and available capacities. They also monitor ongoing shipments to deal with disruptions and provide visibility to customers. Such systems are quite common in road transport. Several systems were developed to cater for the needs of both large and small operators.

Gap: A study by Binnenvaart Vlaanderen shows that many barge operators lack such capabilities [18] . They use less advanced means to manage their shipments such as paper based records or spreadsheets. This limits their ability to digitally exchange data with other stakeholders.

2.4.4. Terminal Operating Systems (TOS)

Terminal operators often have a so called 'TOS' (Terminal Operating System) for managing barge calls, the loading and discharging of cargo and the associated terminal operations. Especially for containerized freight such management system is critical to enable efficient operations.

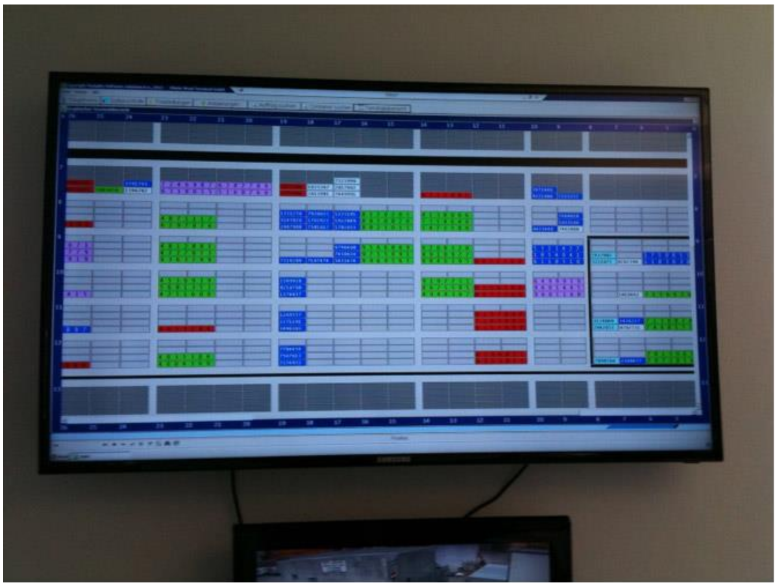


Figure 13: Monitoring module of a Terminal Operating System (source: Modality Software Solutions)

Such systems need to interface with barge operators for two reasons:

- To receive accurate information on the expected loading and discharging of cargo.
- To exchange up-to-date information on the planned and expected arrival time of the barge. The planned time can change because of changes in the terminal planning whereas the expected time can change because of disruptions en-route.

Gap: Some larger ports have started initiatives to facilitate such connections (e.g. the NextLogic initiative and similar initiatives by RheinPorts and PSA Antwerp), sometimes as part of port community systems. In most cases however these interfaces do not exist and data is exchanged manually (by phone or e-mail).

2.4.5. AIS transponder

As part of River Information Services Vessel Tracking and Tracing (VTT) Inland-AIS transponders have been installed on many vessels. AIS transponders emit a digital radio signal providing data on the vessel movements and some key parameters (e.g. the name of the vessel).

The AIS signal can be received by fairway authorities and other vessels and can be used to track vessels and display their location. Additional data can be retrieved by authorized users from databases (e.g. the European Hull Database) and other means (e.g. Electronic Reporting).

The signal can be received by anyone using an AIS-capable antenna and receiver. Several organizations (e.g. MarineTraffic) have used this to develop solutions for tracking vessels and calculating estimated times of arrival. This use is however challenged by barge operators, indicating that such use of AIS-data is not allowed because of the privacy sensitive nature of the data and that barge operators should permit this use on an individual basis (controlled data sharing). There are no known court cases confirming this legal position, but it has been the assumption in many European projects such as CoRISMa when working with positioning data.

Gap: Inland-AIS technically enables the sharing of positioning and tracking data, however the protection of data (privacy and commercially sensitive data) is not yet solved in a transparent way. This limits the re-use possibilities of Inland-AIS as there is no sufficient governance mechanism and technical protection for the use of data for other purposes.

2.4.6. Inland ECDIS

The Inland ECDIS environment consists of on-board equipment to display electronic navigational charts (ENCs). Such charts are provided by fairway authorities, port authorities and/or third party charts providers.

Figure 14: Inland ECDIS

The Inland ECDIS environment assists the skipper to plan his voyage and to execute it efficiently.

In the so called ‘navigation mode’, the Inland ECDIS displays the electronic chart together with the radar images and AIS-data of nearby vessels to be used by the skipper for navigating the ship. Inland ECDIS displays in navigation mode must pass a certification procedure. In ‘information mode’ the system can also display data of other areas of the waterways. It is generally considered that this mode is only to be used for information purposes and not for navigation. In information mode all kinds of chart orientation, rotation, zooming and panning are allowed which are not available when navigating.

There is a potential for feeding the ECDIS system with additional real-time data and to use it as a basis for digital information exchange with other actors. Examples include:

- More frequent retrieval of (updates of) electronic charts, comparable to the way online chart services operate (e.g. Google Maps). Currently data needs to be periodically (monthly, yearly, etc.) downloaded and updated, whereas online mapping-services provide a continuous update of charts – in some cases with offline capabilites when the vehicle drives in areas without coverage.
- Additional (real-time) data on traffic and infrastructure conditions in a corridor (other than Inland-AIS data), such as actual delays and water levels.

Gaps: There is no standardized 'digital backbone' to feed the on-board Inland-ECDIS environment with up-to-date charts and other real-time data on infrastructure and traffic conditions. Charts are mostly updated using file downloads or by distributing charts on removable media (e.g. CDs). If such backbones are available, they are proprietary and linked to the vendor of the system-provider. This makes it difficult to add data from third parties.

There is for instance to no centralized repository of directory-service to retrieve all ENCs, neither are there standardized quality criteria for the ENCs (accuracy, required number of updates, etc.).

Gap: The Inland-ECDIS environment is in many cases not yet digitally connected to other data sources and fed with real-time information such as traffic conditions and water levels. See also 2.4.9 (Fairway Information Services and Notices to skippers).

2.4.7. Front-end of electronic reporting: BICS or similar reporting systems

The ERI[2] standard provides standardized electronic messages for Electronic Ship Reporting and various other reporting purposes. The RIS directive requires fairway authorities to use this standard. Other reporting purposes (passenger lists, voyages and berth management) are not covered by the directive and underlying regulations. The standards specify the syntax to be used.

Barge operators use tools such as 'BICS' [3] to create and exchange the required messages according to the ERI standard. Often data needs to be filled-in manually in the BICS tool.

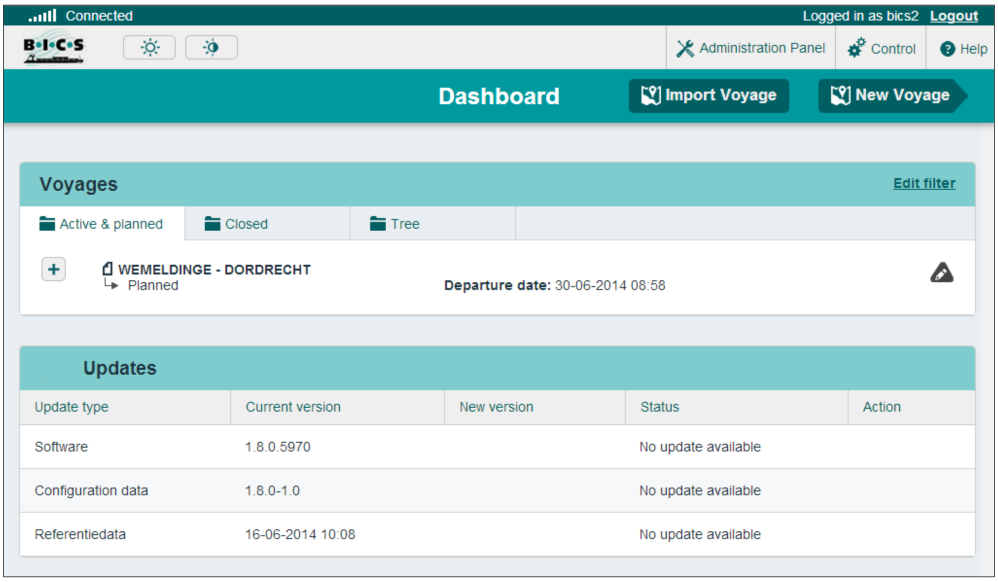


Figure 15: BICS tool

[2] ERI: Electronic Reporting International

[3] BICS was developed by Bureau Telematica Binnenvaart and Rijkswaterstaat (Netherlands) providing skippers with a light-weight environment for electronic reporting.

Gap: Reporting systems are not connected to underlying data sources. As a result skippers need to re-enter data.

Gap: Reporting standards should be worked out for areas beyond the four types of messages covered by the current standard.

2.4.8. Back-end of electronic reporting: Reporting services

Fairway authorities provide back-end systems for electronic reporting. This system receives electronic ship reports from skippers and processes these. The information is subsequently used for other purposes (e.g. Traffic Management Services). Data can be forwarded to another fairway authority if a vessel moves from one jurisdiction to another.

In most cases these services are usable mandatory reporting functions according to legislation currently in force, e.g. when carrying dangerous cargo and/or containerized freight.

In addition, reporting services are not (yet) equipped for other reporting purposes beyond dangerous cargo. This however could be useful for further data exchange with authorities (one mechanism for different purposes) such as cargo information for customs.

Gap: Current reporting services are used for electronic ship reporting (dangerous cargo and containerized goods) only.

2.4.9. Fairway Information Services: Electronic Navigational Charts and Notices to Skippers

Under the RIS directive fairway authorities are required to support Fairway Information Services for the skippers. These services focus on two specific aspects:

- Providing Electronic Navigational Charts (ENCs)
- Providing Notices to Skippers (NtS) on the conditions of the infrastructure

Mandatory RIS standards have been published for formatting ENCs and provide the syntax of Notices to Skippers.

The Notices to Skippers standard provides messages for:

- Fairway and traffic related data about certain fairway sections or objects
- Water level related data (least sounded depth, vertical clearance, barrage status, discharge, regime, predicted water level, least sounded predicted depth or the predicted discharge)
- The current ice situation.
- Weather data (optional)

The data is provided through web portals operated by fairway authorities. In addition to these portals NtS messages can be downloaded in various ways (e.g. using subscriptions). Through various RIS projects these portals have improved in recent years providing a more integrated view on data [33].

Fairway information overview viadonau

7/5/2017 10:25 AM

Waterlevels

7/5/2017 10:15 AM

Water gauge	current value	difference last hour	24h forecast	48h forecast	72h forecast
Achleiten	286	(0)			
Wilhering	315	(0)			
Mauthausen	444	(3)			
Grein	720	(0)			
Kienstock	257	(0)	228	213	207
Duernstein	346	(1)			
Korneuburg	264	(2)			
Wildungsmauer	248	(0)	217	200	194
Thebnerstrassl	242	(-1)			

n/a: above MW = Not available because above mean water level

Shallow sections

7/5/2017 10:25 AM

Shallow section	Area (river-km)		min. depth marked fairway (dm)	min. depth deep channel* (dm)	Forecast min. depth deep channel* (dm)			Area map incl. deep channel	Date of sounding
	from	to			24h	48h	72h		
Furt Weißenkirchen	2014.6	2013.5	33.3	33.3	30.4	28.9	28.3	PDF	6/30/2017
Furt Lobau	1917.5	1916.3	29.6	32.6	29.5	27.8	27.2	PDF	6/8/2017
Furt Zahnetgrund	1916.1	1915.6	30.6	33.6	30.5	28.8	28.2	PDF	6/8/2017
Furt Regelsbrunn	1899.0	1897.8	21.6	30.6	27.5	25.8	25.2	PDF	6/7/2017
Furt Rote Werd	1897.0	1895.4	24.6	31.6	28.5	26.8	26.2	PDF	7/3/2017
Furt Petronell-Witzelsdorf	1893.2	1891.7	29.6	32.6	29.5	27.8	27.2	PDF	5/24/2017
Furt Treuschütt	1888.6	1887.6	24.6	30.6	27.5	25.8	25.2	PDF	6/1/2017
Furt Wendeplatz Theben	1879.8	1879.1	33.0	36.0	n.a.	n.a.	n.a.	PDF	6/1/2017

* **"Deep channel"** refers to that area of the marked fairway which has the width required for a 4-unit convoy travelling downstream. The respective width of the fairwa
wait at a suitable location until it is possible to proceed through a shallow area using the deep channel of the main fairway.
Information on the course of the deep channel is available in the area map for the respective shallow section. The course of the fairway is indicated by buoyage and m
The published minimum fairway depths are calculated on the basis of hourly available water levels at the respective reference gauging station and are thus updated o
At shallow sections in the free-flowing Danube of the Wachau valley and east of Vienna water depths are monitored on a monthly basis. As the riverbed in free-flowing

Current lockstates

7/5/2017

Aschach	left chamber right chamber	available available
Ottensheim	left chamber right chamber	available available

Figure 16: Integrated Fairway information provided in PDF-format (source: Via Donau)

It should also be pointed out that only generic data on the waterway is provided. They show specific fairway conditions (as indicated), but they do to define how waterway conditions will exactly impact the voyage of an individual vessel (e.g. load limitation because of low water levels). As Fairway Information Services generally do not include traffic data, it does not necessarily provide information on congestion either. Thus, possible delays and the expected time of arrival for a specific barge are difficult to calculate.

Gap: Many Fairway Information Services do not provide a digital interface (API, machine readable) for automated retrieval of data, their focus is on providing human-readable data. This makes it difficult to integrate data from Fairway Information Services in digital solutions.

Gap: Fairway Information Services generally do not contain traffic data (e.g. congestion and delays) and do not provide an assessment of the impact of such delays for the individual skipper (e.g. an updated ETA).

In the CoRISMa project additional 'Traffic Information Services' were foreseen to address these gaps.

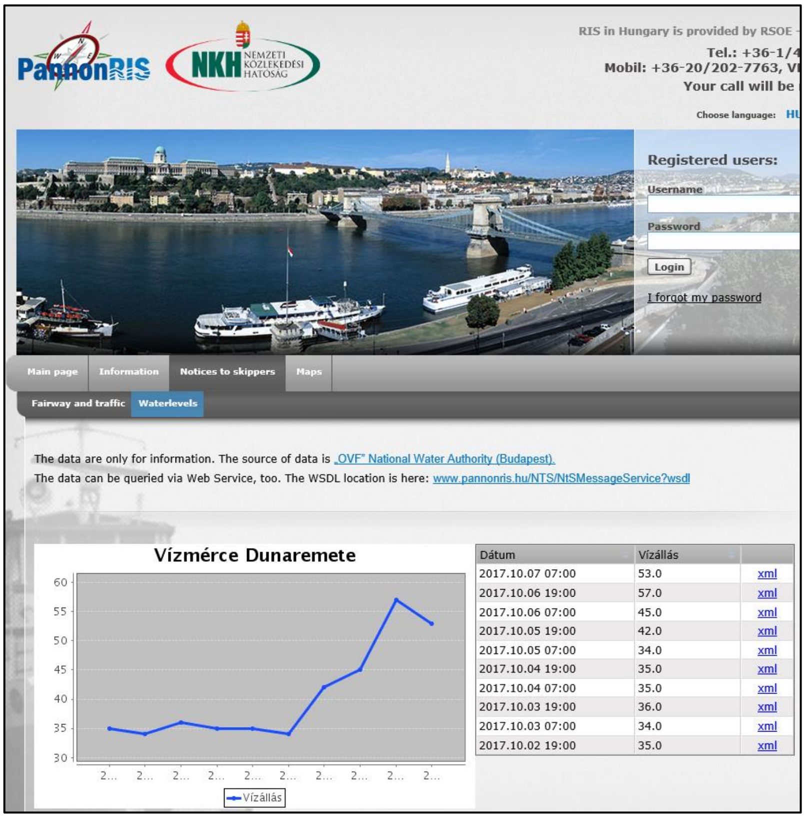


Figure 17: Example: PannonRIS providing water level information in Hungary

2.4.10. Traffic Management Services (VTS, TTI and STI)

Fairway authorities integrate available data (AIS, ERI, static data) in various systems for traffic management. These include VTS (Vessel Traffic Services) and TTI/STI (Tactical/Strategic Traffic Information) systems. VTS is used for local traffic management (e.g on an intersection or in a port) and TTI/STI can be used for managing traffic on a larger stretch of waterways.

Fairway authorities have deployed such systems in various levels of sophistication.

Where these systems are in place they however lack accurate voyage data e.g. on the planned passage of intermediate waypoints as this information is not always shared by barge operators[4]. Also, there is no possibility to digitally signal to skippers that a delay is ahead or that it is recommended to slow down or increase speed (e.g. for planning/optimising lock operations).

This makes it difficult to manage traffic flows in a corridor (in this context: a larger section of fairway). Through several projects (CoRISMa, RIS COMEX) fairway authorities are investigating new approaches to introduce these functionalities by extending the functionalities of existing systems.

Gap: Unable to perform corridor management because of limited availability of machine readable, real time voyage data (skipper → fairway authority) and feedback mechanisms (e.g. updated ETA sent by the fairway authority to the skipper).

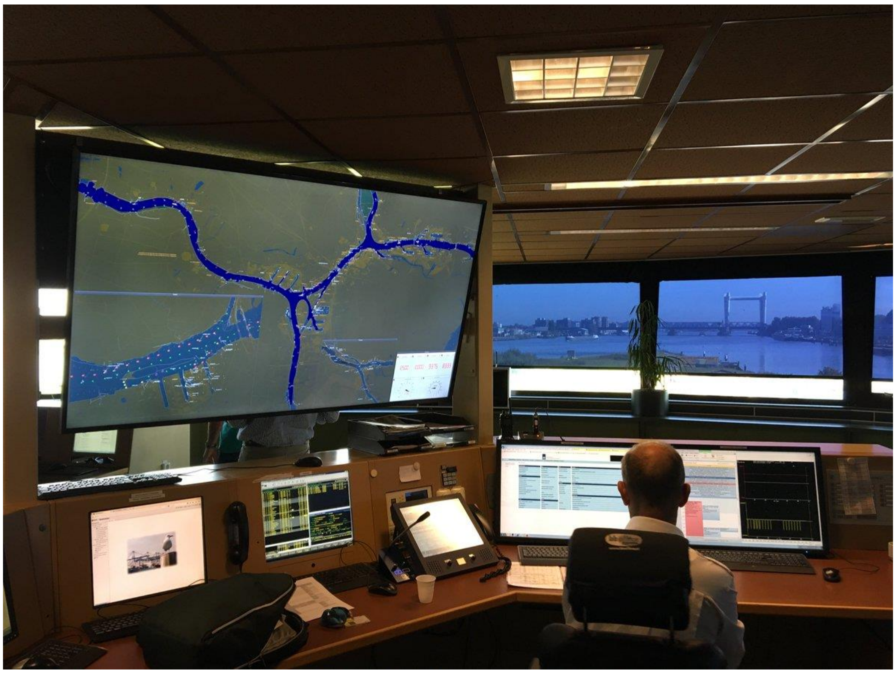


Figure 18: Digitally supported traffic management (source: Rijkswaterstaat)

[4] The ERINOT message contains some functionality in this regard (port of departure, destination and passagepoints). The usage of ERINOT is however not mandatory for all categories of vessels. In the CoRISMa project a dedicated 'ERIINFO' message was tested for the exchange of additional voyage-related data.

2.4.11. Centralized databases (ERDMS and EHDB)

To support the development of River Information Services and to facilitate interoperability two centralized databases have been set-up:

- The European Reference Data Management System (ERDMS) essentially contains two sets of data:
  - Identifiers of infrastructure elements (e.g. locks and bridges). This allows to uniquely identify a piece of infrastructure in different systems. This is the so-called RIS index.
  - Code lists for several, regularly used data elements such as cargo codes, country codes and the code lists for Notices-to-skippers messages. They are based on standards provided by the EU, UN/ECE, ISO, UN/TDED and others.
- The European Hull Database which contains a list of inland vessels registered in the European Union. It includes amongst others the unique identifier of each vessel (ENI) and other related (certification) data.

Both databases are currently being renewed from an IT point of view. The aim is to structure the data in a better way and to enable provide better interfaces for keeping the data up-to-date.

The new directive on professional qualifications for IWT workers will also require a similar centralized registry for crew data and their qualifications: the ECQD (European Crew Qualifications Database).

Gap: The centralized databases currently have only a limited set of interfaces for uploading and using data. Extensions are likely to be needed for more enhanced synchronization and re-use of the data in other applications.

Gap: Data quality is an issue. There are no clear rules on the quality of the e.g. how soon new vessel certificates should be registered in the EHDB or whether infrastructure data needs te be periodically reconfirmed or not.

Although member states are obliged to provide data, not all of them do. Some data elements are already several years old. It woulde be necessary to define clear requirements with regards to data quality and provide (automated) processes to assist authorities to keep their data up-to-date.

Gap: Extensions of the data contained in the centralized databases might considered. This includes not only the already mentioned data on crew qualifications but also other shared data such as translations, code-lists and other reference data used in the various River Information Services implementations (extending the existing ERDMS).

Gap: The centralized databases generally contain static data (infrastructure, hulls, etc.). There is no link available to other data sources providing more dynamic/real-time data, e.g. the actual condition of the infrastructure or the location of a vessel. New mechanisms are likely needed to either incorporate such data in centralized databases or provide a pointer to other data sources where such data is available.

2.5. Summary

Digitalization has focused so-far mostly on the provisioning of River Information Services by fairway authorities and their use by barge operators. Even though this provides a basis, further extensions are needed to address the gaps between the existing systems and the services data requirements of the various stakeholders.

3. ANALYSIS OF PROBLEM DRIVERS

3.1. Introduction

The previous chapter identified the digitalization-related objectives of the various actors. In this chapter we will identify the underlying problem areas and problem drivers.

3.2. Overall problem definition

Shippers and logistics service providers (e.g. forwarders) have a choice of different modalities to cater for their logistics needs. Even though inland waterway transport has a strong position in some markets (e.g. bulk cargo) its position in others is weak or is threatened by developments in other (competing) modes of transport. For example:

- Autonomous driving and truck platooning are expected to reduce the costs of road transport and increase its flexibility [19]
- New rail corridors and the next generation of freight trains are expected to lower technical and organizational barriers for rail freight [20] potentially providing a competitive advantage over inland waterway transport.

Many of these developments are driven by digitalization and different sorts of intelligent transport systems. If nothing happens inland waterway transport risks falling behind.

In addition to this there are new logistics planning concepts being implemented (see section 1.1). Inland waterways need to be an integral part of such planning concepts or risk losing its competitive position in multimodal chains. For example:

- Shippers and logistics service providers use *synchromodal* planning concepts [21] : continuously choosing the right modality and transport service based on actual logistics needs, service availability, cost-, time- and (in some cases) environmental constraints – taking into account real-time conditions of the infrastructure (e.g. delays). Inland waterway transport can only be part of such planning concepts if barge operators are able and willing to share the required data for such concepts.
- In supply chains the vision of the *physical internet [22]* will result in increased bundling of shipments through intelligent hubs. Inland waterway transport can only become part of this vision if barge operators can seamlessly work together with these intelligent hubs and shippers adopting this vision.

Inland waterway transport risks becoming digitally isolated in these new planning concepts, resulting in shippers choosing different modalities for their logistics needs.

Finally barge operators indicate that there is an administrative burden which adds additional costs and inefficiencies to their operations.

The lack of digitalization threatens the overall competitive position of inland waterway transport.

Digitalization is one of the ways to improve the competitiveness of inland waterway transport.

3.3. Three problem areas and their consequences

Based on the discussions in the taskforce and further input received from stakeholders this problem can be further broken down in three areas:

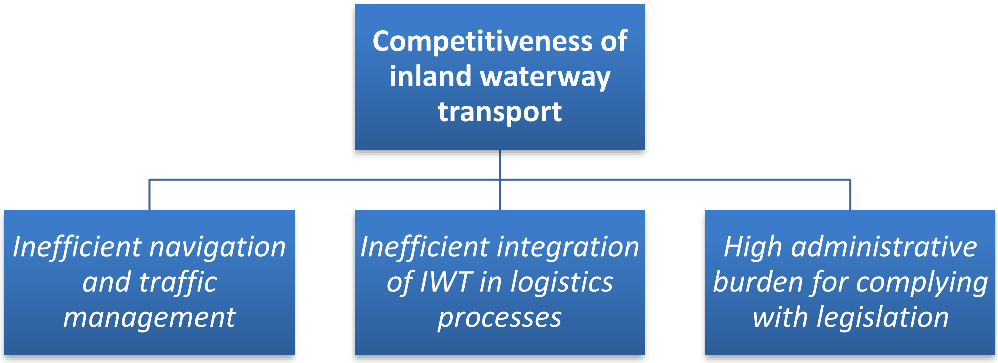


Figure 19: High-level problem tree

3.3.1. Inefficient navigation and traffic management

<u>Operator's perspective: navigation</u>

Barge operators want to plan their voyage as efficiently as possible:

- Serving their customers based on agreed schedules or arrival times
- Providing a reliable level of service, minimizing delays
- Minimizing fuel consumption and environmental emissions

Often a balance needs to be found between these requirements. For example: it might be needed to increase speed (and hence: fuel burn) to meet a certain arrival time requirement. Onboard planning tools are used to plan voyages and achieve this balance. These planning tools are based on the characteristics of the vessel, electronic navigational charts (ENCs) and – in many cases - available generic data on fairway conditions (Notices to Skippers; NtS). There is an interplay between fairway authorities (providing charts and NtS-data) and the barge operator. Currently this is a one-way interchange from fairway authorities to the skipper/barge operator, often supported by an intermediate system of the ICT service provider of the onboard planner.

A key underlying problem for barge operators is the **lack of up-to-date information on traffic conditions**. Barge operators indicate that this limits their possibilities to adapt the voyage plan according to real-time conditions such as:

- Delays at a certain bridge or lock
- Berth allocations in ports and/or updates of terminal calls in a large port with multiple terminals.
- Other traffic conditions

Barge operators indicate that this lack of information leads to:
- Unnecessary delays.
- Reduced quality of service (punctuality/reliability).
- Unnecessary high fuel burn, e.g. to compensate for delays.

Such problems are affecting all barge operators. Nevertheless it is difficult to quantify upfront the exact savings potential. Studies in road transport have however shown that significant gains can be made. For example: truck platooning shows the potential to reduce fuel burn by 10-20% [23]. Similar percentages were shown in projects such as Prominent-IWT and 'VoortVarend Besparen' (a Dutch initiative in 2010 resulting from an inland shipping fuel saving competition).

Autonomous navigation

At the same time there is the future prospect of **(semi-) autonomous navigation**. The key differentiator here is the possibility to reduce manning requirements. Some pilot projects were started in recent years both in maritime [24] and inland navigation [25]. These projects aim to achieve for instance:
- The ability to have fully autonomous vessels, e.g. to provide shuttles between terminals in a large port
- Support skippers with computerized navigation aids to improve both safety and efficiency with fewer crew members on-board.

Technologies used in these pilots include the use of advanced onboard systems (using advanced charts and radar data) and the usage of digital on-shore services (e.g. remote operation of a vessel, as is the case for certain drones).

Overall (semi-) autonomous navigation has the potential to significantly reduce manning requirements. This is obviously the case for fully autonomous vessels, but it might also reduce current barge-specific manning requirements e.g. for vessels operating with dangerous goods. Digital support for skippers might provide opportunities to make navigation safer without additional crew or extend working/operating hours. It should be noted that such developments are still at an early stage. Further testing to ensure safe operation as well as a fitting legal framework will be needed to achieve the desired cost savings.

Traffic management perspective

Fairway authorities experience a similar problem. They need to manage their infrastructure and the traffic that is using it. This includes for instance the operation of bridges and locks and the handling of traffic flows in a safe and efficient manner. Fairway authorities currently rely on positioning data (provided byu an AIS transponder), data received through the mandatory electronic reporting for vessels carrying dangerous or containerized cargo (ERI), VHF-radio (e.g. for the skipper to communicate with the lock operator), video/CCTV and radar. The data in the AIS transponder and the ERI-report contains a limited set of voyage related data.

This data however is not sufficient to:

- Plan ahead for traffic at a critical certain point in the infrastructure, e.g. a bridge or lock.
- Manage and predict traffic volumes on a corridor level with barges passing multiple points in the infrastructure.

Fairway authorities indicate that this results in:

- Additional costs for managing the infrastructure, e.g. not being able to schedule lock operations efficiently
- Non-optimal use of the infrastructure
- The necessity to invest in (expensive) ‘hard’ infrastructure (e.g. additional lock chambers) to ease congestion.

An underlying problem for both perspectives is the fact that skippers do not share the required detailed voyage plans with the fairway authorities. This makes it difficult to realize smart navigation schemes in waterway corridors.

3.3.2. Integration of IWT in logistics processes is limited and sub-optimal

Cargo owners, multimodal terminals and Logistics Service Providers (LSPs) experience high transaction costs when doing business with barge operators. This relates to finding, contracting and booking a suitable IWT transport service compared to other modes of transport. Especially in multimodal (containerized) operations it is important to have a good visibility on services and their availabilities and to be able to manage the service efficiently.

Furthermore there is little visibility on the progress of the transport resulting in logistics inefficiencies in ports and terminals. Terminal operators want to know when a specific barge is going to arrive in order to plan ahead their internal operations. There are currently no standardized and implemented schemes to provide this information[5] making it difficult for them to optimize their processes. As a result this limits the overall use of IWT - particularly in multi-modal chains.

The underlying problem here is the limited integration of barge operators and the booking and cargo management systems/platforms of shippers and logistics service providers to exchange logistics needs, transport capabilities, bookings and status-updates.

Future logistics concepts such as synchromodal transport and the Physical internet all require some form of improved visibility between stakeholders in the logistics chain. Without an improved integration the high transaction costs will remain and the inland waterway sector risks lagging behind adopting new logistics concepts.

[5] The ERINOT standards provides certain functionality through the BERMAN-message but it is not widely used.

Example of impact:

"Barge operators and shipping lines apply Rotterdam and Antwerp congestion surcharges to their customers"

Delays of up to 120 hours have led European barge operator Contargo to impose a congestion surcharge on all operations at the ports of Antwerp and Rotterdam.

The €19.50 per container charge came into effect on Friday and will be levied until 31 August 2017, amid a worsening situation for loading and unloading throughput times at North Europe's major import hubs. This is negatively impacting the attractiveness of IWT as a modality for hinterland transport.

"For weeks now the barges of Contargo's fleet have had to wait increasingly long for unloading and loading," said the operator. "Throughput times of 50 hours, peaking at up to 120 hours, are no longer an exception and, unfortunately, we must now pass on a part of the costs to our customers."

Source: https://theloadstar.co.uk/barge-operators-shipping-lines-apply-rotterdam-antwerp-congestion-surcharges/

Port autorithies and terminal operators are actively trying to reduce congestion by working together with barge operators to introduce new more advanced planning/scheduling schemes and minimum call sizes (a minimum number of containers to be loaded/discharged) to reduce the number of terminal calls.

3.3.3. High administrative burden for complying with legislation

Barge operators need to comply with relevant legislation. This includes both safety related legislation and other legislation (e.g. statistics):

- In many cases this includes filing certain declarations to the authorities, e.g. on voyages with dangerous cargo and containerized freight (ERI). New legislation can sometimes lead to new reporting/declaration requirements.
- Barge operators indicate that they still need to file the same data multiple times to comply with different aspects of legislation and dealing with different jurisdictions in cross-border operations.

The underlying problem here is the existing 'declaration based' reporting and the limited re-use of data by authorities.

Overall this results in a high administrative burden for barge operators. From an authorities perspective there are also high costs to verify compliance with legislation. There is a potential to make this process both more effective and cost-efficient by re-using data that is already there. For instance through more targeted inspections.

This administrative burden relates to both existing and future legislation. If new reporting schemes are necessary for inspection and oversight it is important to re-use existing facilities and data to keep the administrative burden as low as possible.

Example of impact:

20 forms in different formats and languages along the Danube

During a voyage all along the Danube, vessel-, crew-, cargo-, voyage-related information needs to be filled in into more than 20 forms in different ways and in different languages.

On the positive side - recognizing the need for more harmonization – the Hungarian PannonRIS system now allows operators of cruise vessels to send crew and passenger list electronically to the competent authorities 24 hours prior to crossing the border. Border police can use the information to prepare the Schenen border control. In 2016 26% of cruise ships crossing the Schengen border have used this functionalty.

This makes the process smoother and quicker benefiting all actors including the captain/crew of the cruis ships, passengers and the border police. This is an example how a more integrated approach to reporting can reduce the administrative burden.

Although the technical and legal possibility is there for barges carrying cargo to send crew lists electronically to the competent authorities via the PannonRIS website (similarly to cruise ships) this functionality is not used in practice for for freight carrying barges.

3.3.4. Summary of negative consequences

In summary the problem areas result in the following negative consequences for stakeholders:

- High fuel burn for barge operators
- High costs for navigation by barge operators (manning requirements)
- Extended waiting times for barge operators (e.g. vessel and crew idle-time)
- High costs for traffic management for fairway authorities
- High costs for investments in infrastructure to ease congestion
- High administrative burden for barge operators for complying with legislation
- Lost revenue for barge operators as shippers choose other modalities
- High costs for authorities to verify compliance with legislation

As indicated these consequences threaten the overall competitive position of inland waterways, whereas at the same time digitalization is improving the competitive position of other modalities.

3.4. What is driving these problems?

In the previous paragraph we already highlighted several underlying problems where a lack of digitalization is negatively affecting the overall competitiveness of inland waterway transport:

1 Barge operators lack up-to-date information on traffic conditions. This makes it difficult to plan their voyage efficiently and provide their customers with up to date estimated times of arrival (ETAs).
2 Skippers do not share detailed voyage plans with the fairway authorities, making it difficult for fairway authorities to manage traffic in a corridor.
3 There is a limited integration of barge operators with booking and cargo management systems of shippers and logistics service providers. This limits the ability for barge operators to adopt new logistics planning concepts.
4 An administrative burden is caused by 'declaration based' reporting (skippers need to report to the authorities) in combination with a limited re-use of the reported data by the authorities.

Based on our research and discussions with the DINA taskforce it is our understanding that there are certain underlying problem drivers affecting one or more of these problems.

3.4.1. 3.4.1 There are legal and commercial bottlenecks for sharing data

Stakeholders indicate that there are legal and commercial bottlenecks which prohibit them from sharing certain pieces of data with others.

With respect to data on vessels, crew and the location of vessels the following legal restrictions apply:

- **Privacy-legislation**:
  - Underlying regulations prohibit the sharing of data as stored in the **European Hull Database** (EHDB) with third parties. It can only be shared amongst fairway authorities and other actors as specified in the service agreement for users of the EHDB. The EHDB contains the ENI (unique hull) number and other basic data e.g. relating to its operator and the dimensions of the vessel.
  - In many cases skippers and crew live on their barge. This makes the **location** of the barge privacy sensitive. Even though the position of the barge in itself cannot be considered personal data (as specified in the EU Data Protection Directive 95/46/EG), it can be considered as such when linked to other identifying information about persons onboard. Sharing of this data is only allowed with explicit consent of the individual.
  - The same applies to **crews and their qualifications**. The IWT workers' qualifications directive states that personal data may be processed only for the purposes of implementation, enforcement and evaluation of the directive, exchange of information between the authorities and producing statistics. It does not foresee the re-use of this data for other purposes or the (controlled) sharing of this data with third parties.

In general one could state that privacy-sensitive data with third parties is not allowed, unless there is an explicit consent of the person concerned. These restrictions obviously do not apply when the person involved (the skipper or crew member) willingly shares the data him-/herself with others.

- **Commercial sensitivity:**
  - The RIS directive clearly indicates that *"the introduction or RIS should not lead to uncontrolled processing of economically sensitive data relating to market operators*". This relates for example to traffic patterns and individual voyages and calls in terminals. Fairway authorities can collect this data for the purposes of Vessel tracking & tracing (e.g. for safety purposes), but it is not intended to share this data with third parties.
  - In the private sector specific arrangements need to be in place if data is to be shared horizontally among multiple shippers or among multiple barge operators (see for instance the outcomes of the CO3-project [26]) as a consequence of competition laws as data sharing can potentially lead to market abuse or business practices limiting competition.

- **Liability**: based on voyage plans and traffic patterns it is possible for a fairway authority to calculate estimated times of arrivals or to schedule lock operations. Changes (e.g. in lock operations) can occur which can potentially result in delays. Potential providers of such data therefor want to limit their liability or are reluctant to share such data at all.

- **Commercial agreements**: there is a customer-supplier relationship between a barge operator, a shipper and other logistics actors (e.g. a logistics service provider or terminal operator). Overarching treaties regulating such agreements[6] do not always provide provisions on data protection. Nevertheless most customer-supplier specific agreements require a certain level of confidentiality regarding the details of the cargo carried and the specific customer served.

In summary there are certain legal and commercial bottlenecks to data sharing, relating to privacy, liability and commercial sensitivity. In some cases these can be overcome by making specific contractual arrangements (e.g. giving the explicit consent for sharing data). **In any case there needs to be some form of data governance** in place to support such arrangements and technology to support it. This is however lacking at this moment.

3.4.2. River Information Services were developed before continuous and controlled data sharing became an expectation

The architecture for River Information Services was developed step by step in the framework of several research and innovation projects. The RIS architecture is mapped out in the RIS guidelines by PIANC: there are four RIS key technologies and eight RIS services.

[6] In particular the CNMI convention (Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway)

Services support interactions between the various stakeholders in inland waterway transport, starting from the perspective of the fairway authority. Some of these services are enabled through key technologies which where made mandatory under the EU RIS directive and the respective regulations. The interplay of these services and technologies is shown in the following picture:

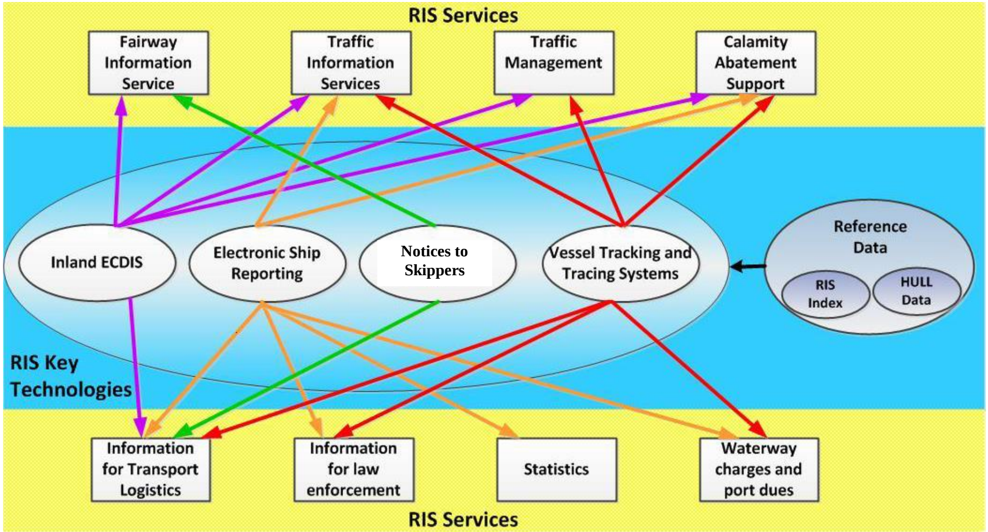


Figure 20: RIS services and key technologies - source: PIANC

When assessing these key technologies three types of interactions can be distinguished:

- **Publishing of (open) data by fairway authorities**: portals and websites where data is published in a (semi-) structured format. Users can access the data in a human-readable format by accessing the website. Often data formats are specified that also allow for the interpretation of the data by machines as well; an example is the ENC-standard for electronic charts and the NtS-standard specifying notices to skippers.
- **Electronic messaging from businesses to authorities**: skippers can report to the authorities by sending an electronic message. In EU members tates, in case reporting is obligatory, the authorities must offer the possibility for the operators to report electronically.
- **Broadcasting of data by skippers**: skippers use AIS technology and dedicated radio frequencies to wirelessly broadcast their position and a limited set of vessel, cargo and voyage related data. Even though this data is for the primary purpose of vessel tracking and tracing and supporting safe navigation the signal can be received by anyone using the right equipment/antennas and is processed in different private systems of logistics actors and commercial data providers (e.g. MarineTraffic).

Currently only AIS provides a continuous stream of information (as long as the beacon is turned on). The other data exchanges are based on periodically uploading or downloading information. There are several aspects which contribute to this:

- **The current set-up is based on the provisioning of digital ('RIS') services by fairway authorities and related governmental agencies**. An extension of such services might be usable for supporting additional interactions between private operators and public bodies; it is however not feasible that they will be used for business-to-business interactions.
- **While the RIS directive and underlying regulations do not enforce the sharing of data in a machine interpretable way**. A review of the implementation of River Information Services [1] already shows that the scope of implementation differs per fairway authority. There is no requirement for providing technical interfaces; some provide such an interface while others don't, with data only being available in a human-readable web portal. The fact that data is not available through a technical (machine interpretable) provides a barrier for re-using (open) data from River Information Services in third party applications, such as (online) route planners.
- **There is no built-in mechanism for controlled data sharing. Data is either shared openly to everyone or not at all**. Examples include:
  - Vessel positions and other vessel data are available in Vessel Tracking & Tracing Systems of the fairway authority but are not shared with third parties.
  - Voyage plans are available in the onboard systems/route planners of the skipper; there are no provisions for sharing this in a controlled way with the fairway authorities.

Example from a related policy domain

Improved EU-wide traffic information services for road users

In 2014 the European Commission launched new initiatives to help provide road users across the EU with more accurate, accessible and up-to-date traffic information related to their journeys (Real-Time Traffic Information). This can include information about expected delays, estimated travel times, information about accidents, road works and road closures, warnings about weather conditions and any other relevant information. Such information can be delivered to drivers through multiple channels: variable message signs, radio traffic message channels, smartphones, navigation devices, etc.

The objective is to make existing information services available to more users, facilitate the sharing of digital data, and foster the availability of more and accurate data. This is done by setting-up national access point for retrieving such data. In addition data standards (DATEX II) are provided for specifying the structure and semantics of the data to be published.

Figure 21: Variable message signs; DATEX II provides the tools for harmonised modelling and exchange of the information displayed

3.4.3. The current IT-setup of barge operators is not yet capable for continuous interaction with third parties

A study by Promotie Binnenvaart Vlaanderen provided a good overview of the current (on-board) IT-setup of barge operators [18].Key outcomes of this were:

- A high penetration of PC, smartphones and tablets
- Reasonably well wireless coverage, but still with limitations on critical spots (e.g. border rivers)
- Use of administrative software for invoicing and bookkeeping.
- High penetration of electronic navigational charts, limited penetration of other tools (e.g. electronic reporting to authorities is used in less than 50% of the vessels, electronic voyage planning in less than 25% of the vessels, fuel saving software in less than 10% of the vessels)
- Communication with customers mostly using telephone and e-mail; very limited use of online platforms and booking tools.

This set-up does not yet support a continuous interaction with third parties such as customers or authorities. A more optimal set-up would require:

- A high level of integration between the various software components (navigation, reporting, logistics transport management, etc.).
- A high quality and reliable internet connection (near 'always on') and/or cloud-based software components which can take over when there is no continuous connection.
- The ability to connect with a range of stakeholders. Such connections require mechanisms for:
  - finding right data provider (e.g. the RIS service of a fairway authority or the data portal of a logistics stakeholder).
  - identification/authentication (to securely connect [34])
  - semantic interoperability (to interpret the data).

At the same time certain secure elements or trusted components might be necessary especially if the environment is to be used for compliance verification. This is currently being explored as part of the e-IWT initiative.

3.4.4. The IWT sector is limited in size and fragmented

As was explained in chapter 2 the IWT sector is limited in size and fragmented across industries and regions. This makes it difficult to achieve economies of scale and provide an attractive market for commercial actors to develop solutions.

Traditionally the market is characterized by:

- A limited number of equipment manufacturers (e.g. for ECDIS), often providing services to various areas of waterborne transport (leisure, inland waterways, maritime)
- Government-led investments in online services as part of River Information Services, partly co-funded by the European Union.
- A limited set of specific software solutions for inland waterway transport. An example is the BICS application which is commonly used for submitting electronic ship reports.

Without standardization and/or public co-funding it is unlikely that commercial software providers will start the development of tailor made solutions for inland waterway transport.

The overall market for logistics services and in other modalities is however significant. There is a potential for inland waterway transport to link-up to developments in other modalities. Key examples include:

- Developments in the area of the acceptance of e-transport documents in road transport[7], which are currently being explored by the Digital Transport & Logistics Forum.
- Development of digital solutions for supply chain management and the management of bookings. This includes booking platforms such as INTTRA and GT Nexus.
- Community platforms used in maritime ports and hinterland hubs.
- Cloud infrastructures for logistics data sharing. Examples include the Maritime Cloud (for data sharing in maritime transport [27]) or ‘data pipelines’ (as used in air transport under the umbrella of IATA).

There is an opportunity to re-use such services and solutions in the inland waterway domain.

3.4.5. There is no overall framework for electronic reporting covering different purposes

The ERI standard provides a syntax for four message types. There is however no overall framework for electronic reporting for other purposes.

In several other domains, e.g. for customs and maritime transport, dedicated ‘single windows’ have been established. Through these ‘single windows’ stakeholders need to submit data only once. The underlying infrastructure ensures that all relevant government agencies are informed about the submitted data.

Single windows vary in scope and set-up. They can include agreements on:

- The semantics (meaning) of data to be submitted
- The syntax (structure) of the data
- The technical protocols to be used, including protocols for identification/authentication and security.
- Governance agreements on the management of the single window infrastructure
- Governance agreements on the usage of the data

The current ERI standard mostly focuses on the syntax and semantics. Several e-government building blocks are technically available (e.g. eID-schemes), but their use is not specified in the IWT domain.

As a result new set-ups are needed each time a new electronic reporting scheme is needed, e.g. for supporting the IWT workers’ qualifications directive.

[7] Most notably the implementation of the e-CMR treaty, e.g. see https://www.iru.org/innovation/e-cmr

In some domains novel approaches have been piloted in recent years extending the single window concept. These approaches are based on (roughly) the following principles:

- A limited number of business-to-government (B2G) declarations. Only the most important events need to be notified to the authorities.
- A 'data-pull' based approach: businesses provide access to a system where additional data can be found. Governments can retrieve data based on an identifier (e.g. a license plate, vessel number or container number).
- Governments specify which data should be available under which conditions. For example: in normal circumstances only dangerous cargo indicators should be available but in the event of a calamity more details need to be made available.
- A risk based approach: law enforcement agencies can 'crawl' ('index') available data and search for anomalies and risk-indicators. Based on these risk-indicators a law enforcement strategy is chosen.

An example of such an approach is the direction taken in the customs domain as piloted in the FP7 CORE project [28]. Similar concepts are being discussed in the Digital Transport & Logistics Forum relating to the acceptance of e-transport documents. See also Appendix 0 .

Example from a related policy area

'Only once' principle in the Digital Single Market

As part of the Digital Single Market initiative the European Union has adopted a new e-government action plan to connect business registers across Europe, to ensure different national systems can work with each other and to ensure businesses and citizens only have to communicate their data once to public administrations, that means governments no longer making multiple requests for the same information when they can use the information they already have. This "only once" initiative will cut red tape and potentially save around €5 billion per year by 2017.

3.5. Summary

The sector is faced with high costs due to inefficient navigation and traffic management, non-optimal integration in logistics processes and a high administrative burden. This is negatively affecting the overall competitiveness of inland waterway transport.

Digitalization can potentially help to improve this competitive position. Nevertheless there are several underlying problem drivers which hinder the development of new digital tools and solutions in the sector:

- The fact that River Information Services were not developed with continuous and controlled data sharing in mind, which is a key requirement for many new digital solutions.
- Legal and commercial bottlenecks for sharing data.
- An IT-setup of barge operators which is not yet capable for continuous interaction with third parties.
- The IWT sector being limited in size and fragmented, making it difficult to achieve economies of scale for new solutions.
- The lack of an overall framework for electronic reporting covering different purposes, making it difficult to address the administrative burden.

4. FRAMEWORK FOR A DIGITAL INLAND WATERWAY AREA

4.1. Introduction

This section presents the framework of a Digital Inland Waterway Area. The objective of this framework is to address the interdependencies between solutions, actors and their digital systems.

We will do this by providing a high-level framework and to identify possible implementation options for this framework.

4.2. High level framework

In chapter 3 we identified the various actors, their objectives and the current systems they use. Based on this we can derive the following high-level framework for DINA:

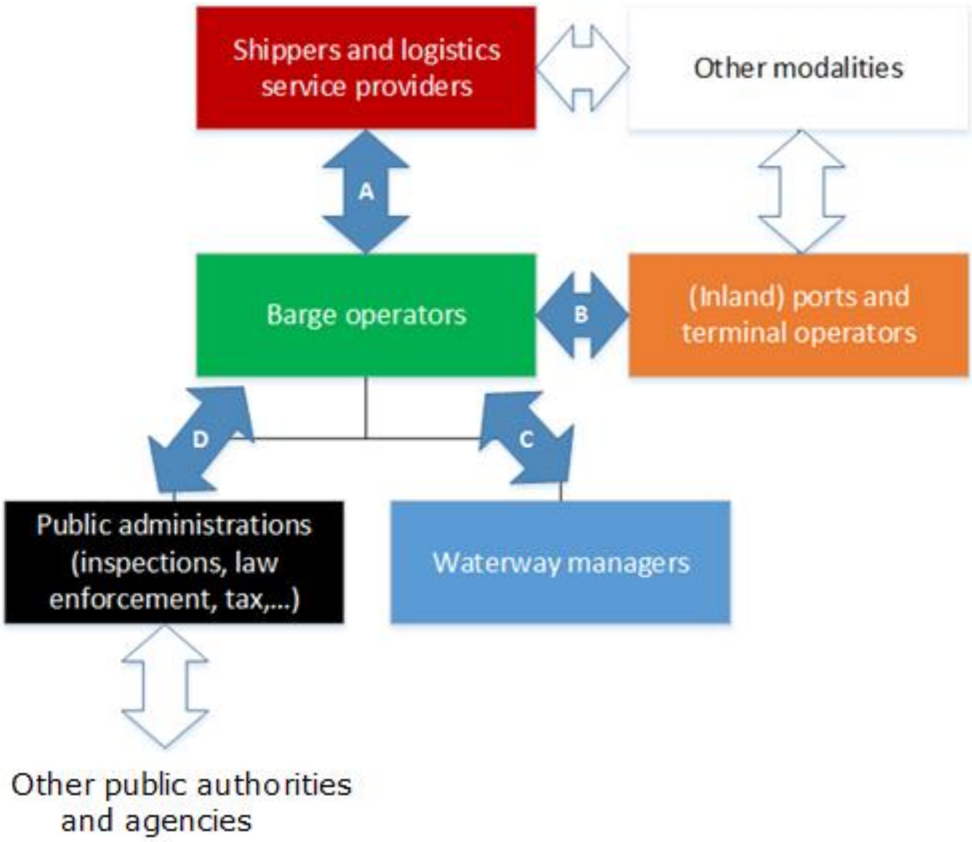


Figure 22: High-level framework

Digitalization in inland waterways should address the four integrations highlighted (in blue) in this framework:

A. **Vertical integration**: process synchronisation between shippers/logistics services providers and barge operators,

B. **Horizontal integration**: process synchronization between barge operators and (inland) ports, hubs and terminals.
C. **Operational integration**: exchanges between barge operators and waterway managers – focused on safe, efficient traffic management and navigation.
D. **Administrative integration:** exchange with inspections agencies, law enforcement, statistics bureaus, etc. to ensure compliance with regulations.

As the high-level framework illustrates, it is all about controlled data sharing between the various stakeholders. As stated in section 2, each of these stakeholders has its own specific objectives but digitalization affects all. This is addressed for the transport and logistics sector in Europe by the Digital Transport and Logistics Forum (DTLF), which provides recommendations to EC DG MOVE on further digitization in all modes of transport. Therefore, DINA should be aligned with the DTLF recommendations.

It should be noted that there are other integrations as well which are outside the scope of the Digital Inland Waterway Area. It is however worthwhile to consider those as they can provide best practices or solutions which could be re-used for implementing the resulting architecture for DINA. These integrations are highlighted with the white arrows and include the integration between shippers and other modalities (similar to the vertical integration in DINA (A)), exchanges between other modalities and multimodal nodes (similar to the operation integration in DINA (C)) and exchange between authorities and other actors (similar to the administrative integration in DINA (D)).

4.2.1. Vertical integration (A)

The vertical integration deals with the exchange of transport orders and associated transport documents. In addition it can serve to provide visibility in various ways:
- visibility on available cargo (shipper → barge operator)
- visibility on available transport services (barge operator → shipper)
- visibility during the execution of the transport (what is the estimated ETA of the cargo, are there any disruptions)

Vertical integration comes in different forms depending on the way actors have organized themselves:
- Some shippers act on their own and contract transport services themselves
- Others use logistics service providers to contract transport services and associated logistics services
- In some cases a skipper is directly contacted by a customer, in other cases bares are part of a larger fleet where a fleet operator interacts with one or more customers. This fleet operator can be the owner of the barges involved but can also have a different commercial relationship (e.g. chartering vessels, or simply ordering an individual transport).

In logistics terms: barge operators currently act as first or second party logistics providers (1PL and 2PL). Increasingly barge operators can also act as a customer to other barge operators and possibly even carriers of other modalities, thus becoming a 3PL (providing outsourced services) or 4PL (outsourced services and supply chain solutions) [29].

It is most likely that services for vertical integration will be provided by 3PL and 4PL operators given the fact that the IWT market is characterized by SMEs operating only one barge (see section 2.2). In many cases these solutions will cover multiple modes of transport. This means that it is important to adhere to standards and solutions which are available in this area and to have functionality in place for individual barge operators to connect to and use such solutions.

Regardless of the way integration is handled, several services are needed for vertical integration:

- *Marketplace services*: publish, search, and find available capacity, schedules, and services.
- *Booking and ordering services:* the ability to share offers with prices and planning data on execution.
- *Visibility and payment triggering services*: progress of the execution relevant to a customer (e.g. pick up time, Estimated Time of Arrival) to allow synchronization with customer's processes and triggering payment at final delivery.

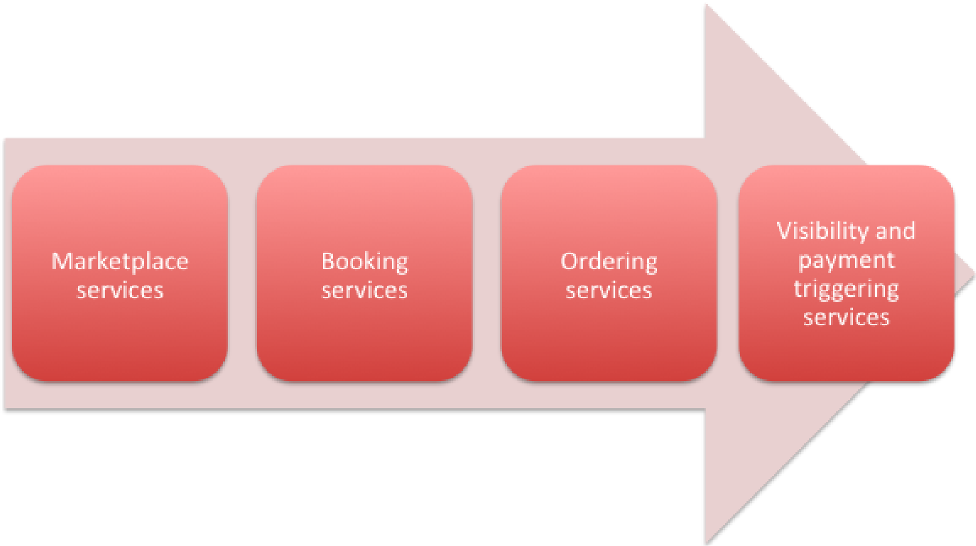


Figure 23: Services needed for vertical integration

Marketplace and *booking services* may result in framework contracts of a barge operation and his customer with pricing details, terms and conditions. *Orders* refer to this framework contract. An order results in a (specific) contract for carriage, which is currently considered a transport document accompanying the goods. This contract of carriage refers to the data of the cargo, the conditions for transport, and has data from a legal perspective. There may also be additional documents required from a regulatory perspective (see 4.2.4 administrative integration).

Visibility needs to be considered from a customer's perspective. This perspective is laid down in a transport order and encompasses for instance the place and time of acceptance/loading and delivery/discharge of cargo agreed between customer and barge operator. A customer might be interested in intermediate locations - because these might cause delays - e.g. border crossing locations. Taking this approach, the AIS position data does not have to be shared between customer and barge operator. Since a barge can carry consignments of different customers the association between barge and cargo is used to generate visibility data relevant to each customer thus supporting controlled data sharing.

To provide adaptability and agility - e.g. to deal with changing customer demands and to be resilient - additional cancellation and re-planning services need to be implemented. Visibility requires the development of ETA prediction which will be discussed in the next section.

4.2.2. Horizontal integration (B)

Process synchronisation with hubs and terminals considers two aspects, namely the ETA of a barge and the loading/discharge actions at a particular hub or terminal. Port of Antwerp, Port of Rotterdam and RheinPorts have already developed solutions addressing this type of process synchronization for their respective ports. Nevertheless, a generalization towards other hubs and terminals is required, especially towards ports in the hinterland to support multimodality.

Horizontal integration includes:

- Accurate *prediction of ETAs*
- Availability of *sufficient data on the loading and discharging of cargo*
- The *planning of operations* in a port relating to terminal operations and (in some cases) transhipments to other modes of transport.

A key requirement for horizontal integration is ETA prediction as this is the basis for deciding the ability for a call. The ETA can be calculated based on the voyage plan of the vessel and the actual traffic conditions. This should then be matched with the expected operations in the terminal (load, discharge, bunkering) which specify the dwell time and thus the quay availability.

But horizontal integration is not just about the vessel and its ETA. Each load and discharge operation is driven by customer goals: a customer order defines the acceptance and delivery location of cargo. Based on these orders, a hub, terminal, or barge operator can make a stowage plan for a particular barge. The stowage plan has to be available to the next hub after actual departure of a barge.

Finally, each terminal/hub has a planning for handling barges - especially the larger terminals in ports such as Antwerp, Rotterdam, and Hamburg. In these maritime ports handling deep-sea vessels and short sea feeders, additional aspects need to be taken into account. Not only has the cargo be physically available it also has to be released by customs and commercially (transport charges for sea transport have to be paid). Customs – and commercial release and physical availability have to be shared amongst various stakeholders in such a port environment. Since shipping lines are also the primary customers of terminals in ports, they will always have priority in handling. To handle barges, there might be a slot planning at a terminal for a barge, but this might change if a (number of) container(s) is not yet released by customs. Barge operators have to be aware of this status information to optimize and coordinate their planning with hubs/terminals. There are currently also different solutions in different ports for planning terminal calls of barges; port of Antwerp for instance has a coordination of barge calls from a terminal perspective (the terminals drive barge plannings) whereas port of Rotterdam is working on a central planning from a barge perspective (barge operators drive the planning and coordinate this with terminals).

ETA prediction service

Calculating an ETA is an important service to enable both vertical and horizontal integration and is – as is shown in the next paragraph – also relevant for operational integration. Two slightly different approaches are possible:

- A customer (shipper/logistics service provider) wanting to know the ETA of its cargo to control its overall logistics operations (supply chains, transhipments, etc.). This is part of vertical integration.
- Terminal operators wanting to know the ETA of a specific barge at a terminal, or fairway authorities wanting to know the ETA of a specific barge at a certain infrastructure point (e.g. a bridge or lock). This is an example of horizontal integration.

In current practice some form of 'barge tracking' is often used using AIS data (regardless of the question whether such use is legally allowed) or with the help of proprietary tracking solutions in combination with distance to a particular location and speed of the barge. Additional to data of locations and speed, including a voyage scheme, the following data is required for an ETA prediction capability:

- Static data on the infrastructure like locations of locks, etc.
- Dynamic data of the infrastructure like depths and stream
- Traffic information: delays and disruptions potentially affecting the voyage
- Planning delays and dwell times in ports, e.g. as a result of container availability in terminals or berth availability
- Weather conditions.

A more accurate ETA can be calculated based on this combination of data. A barge operator should then have the ability to share an ETA with selected stakeholders in a controlled way. This has the added benefit that it will take away privacy concerns for sharing positioning information of individual vessels. In discussions in the IWT sector attention has been given to the controlled sharing of positioning information (e.g. the European Positioning Information Service EPIS prototype piloted in the Platina-2 project).

As will be shown in paragraph 4.3 different options exist for implementing such an algorithm and data sharing service.

4.2.3. Operational integration (C)

Operational integration consists of two aspects:

- optimal navigation (barge operators' perspective)
- optimal use of the infrastructure (fairway authorities' perspective)

<u>Barge perspective</u>

Inland-ECDIS has played an important role in supporting this integration as part of the current RIS setup: it provides electronic maps (ENCs) which can be used by skippers in on-board equipment to accurately plan their voyage. Even though the initial key focus is on safe navigation several providers of ECDIS equipment are providing added functionality to plan a voyage according to the infrastructure and vessel characteristics. Additional functionality is possible by integrating notices to skippers (NtS) in the ECDIS environment.

But further enhancements are possible: based on ETA predictions it might be possible to adapt the voyage plan according to the actual traffic pattern: the ETA prediction can show whether the skipper can meet its customer's requirements and he can adapt his voyage accordingly potentially saving fuel. This would require the sharing of the voyage plan with an ETA prediction algorithm provided either by the skippers' onboard systems (requiring those systems to have the necessary underlying data on traffic and conditions of the infrastructure) or by a third party (commercial provider and/or the fairway authority).

Further extensions are possible towards (semi-) autonomous navigation for instance by integrating more sensor and radar data, providing added digital support for skippers.

<u>Fairway authorities' perspective</u>

Fairway authorities have additional data available: based on positioning data (AIS) and (for some barges) electronic ship reports there is a more enhanced traffic picture. Based on this it is possible to show the current traffic information and to some extent predict the expected traffic information.

Experiments in CoRISMa and the ongoing COMEX project have shown that additional data is needed to accurately predict the traffic status to such a detailed level that it becomes possible to plan traffic (e.g. lock planning). This requires not only ETA production but also an exchange with the barge operator (e.g. to indicate the expected passage of a lock based on a planned schedule).

4.2.4. Administrative integration (D)

Administrative integration is based on agreed rules and conventions:

- To register basic data on vessels and crew certificates and share these details with relevant authorities.
- To verify whether the operation of barges complies with safety regulations (laws, implementing regulations, requirements based on vessel or cargo characteristics).
- Additional administrative requirements, e.g. relating to immigration (passenger lists), secure, safe and legitimate trade (customs) and statistics.

The administrative integration therefor requires:

- Public registries capturing basic data on vessels and crew certificates.
- Periodic data exchange between the barge operator and public authorities on actual operations given certain legal requirements.
- Providing access to data to other authorities based on specific requirements, e.g. for calamity abatement or law enforcement (police).

On a European level some building blocks of administrative integration have been realized through the EHDB (European Hull Database) or will be by the proposed ECQD (European IWT Workers' Qualifications Database), both for capturing basic data. The ERINOT standard is available for data exchange between barge operators and the authorities for dangerous cargo declarations. This standard is supported by tools such as BICS. There are provisions in place in the RIS directive and underlying regulations for data sharing between authorities for law enforcement and calamity abatement. On a member state level local solutions exist (like for example the Hungarian example for the electronic submission of passenger and crew lists to the border police).

But there are other aspects which are not yet covered:

- The EHDB is not yet used in full for all purposes and data quality remains an issue.
- The ECQD is not yet available and it is intended initially to include only limited static data in the database.
- The ERINOT standard is only mandatory for certain vessels and provides only high-level data on the cargo itself (which might not be sufficient in the event of a calamity). There are not yet mechanisms in place for other (future) uses one could think of, e.g. the exchange of crew data, statistics data or cargo data for customs purposes.
- Local solutions are not necessarily interoperable between member states.

4.3. Implementation considerations

The question is: how to implement the four integrations mentioned in the previous paragraph. For each of the integration different aspects need to be considered which we will describe in this paragraph:

- Public versus private implementation
- Shared solutions versus components
- Open standards
- Local versus cloud

4.3.1. Public versus private implementation

This relates to the question which organization will provide a solution for a particular integration: a public authority (e.g. the European Commission or a national authority) or a private organization (e.g. a commercial software provider or a business community).

River Information Services were to a large extent developed in the public domain with fairway authorities providing Fairway Information Services and other related (online) tools. Many developments were co-funded by the European Commission. A small number of parties developed solutions for on-board use such as ECDIS-tools, AIS-transponders and tools for electronic reporting (e.g. BICS). These tools are highly standardized as they need to adhere to the specification adopted in the RIS implementing regulations and maintained by the RIS expert groups.

Other solutions are mainly developed in the private domain. These include Terminal Operating Systems (TOS) used by terminal operators and control towers/dashboards used by shippers and logistics service providers for supply chain management, visibility and bookings.

4.3.2. Shared solutions (platform) versus individual components

For some of the four integrations a specific component can be developed by one or more actors. By using open standards, it can be ensured that these components are interoperable amongst each other. This is for instance the case with reporting software. Each barge operator can select its own provider of reporting software, as long as it works with the ERI standard. We consider this to be an individual component: a digital (software and/or hardware) application which uses standards to communicate with other solutions.

For the IWT sector we need to take into account that the sector is quite small. This makes it unlikely that there will be a lot of vendors providing components specific for IWT as the number of potential customers is relatively low (when compared to other mass-markets). In addition, in some cases the sector also needs to link into existing solutions, e.g. multimodal solutions already in use by logistics service providers or other modalities.

Given these characteristics it is possible to purposely develop or strive for shared solutions: one solution used by many different barge operators. Such an approach is already commonplace in ports where port community system are used by all actors in the port, providing efficiency and economies of scale.

Shared solutions are typically platforms, enabled by cloud technology (see also 4.3.4). An example of a possible choice is providing a shared platform for reporting or providing individual software components for reporting. In this case the platform is used by multiple end-users, each with their own log-in to the system.

4.3.3. Open standards

It should be considered for each integration to what extent open standards need to be developed or adopted. This section describes the advantage of having open standards, identifies the topics of open standards and provides recommendations on their development in the context of DINA.

Open standards are those specifications that are (1) adopted by a recognized standardization body with a formalize adoption and maintenance procedure and (2) available for free (or against low costs covering administrative processes) to all interested parties [30]. ISO, UN/CEFACT and CEN are well-known and recognized standardization bodies for maintaining formal standards. Other standards are maintained by industry bodies such as W3C (which maintains many internet-related standards) and OASIS (which maintains certain standards for electronic business). The current RIS standards do not have such a formal body. The standards are maintained through the RIS expert groups and discussed in dedicated workshops held during the bi-yearly RIS week. The standards related to the four RIS key technologies have been adopted in the form of EU regulations, providing a solid legal basis. The downside of this is that updating the standards requires amendment of the regulation.

Open standards have various advantages, namely:

- *Complexity reduction* – complexity is specified by the open standard and needs no further discussion.

- *Cost reduction* – one specification requires one implementation, thus reducing interoperability costs.
- *Technology neutral* – the standard is independent of any implementation and thus technology neutral
- *Vendor neutral* – the standard is provided in such a way that it is independent from any solution of a vendor.
- *Market adoption* – having an open standard enables faster adoption of a solution by the market.
- *Vendor distinction* – vendors will be able to distinguish themselves by the functionality of the standard they provide and how they provide it. Aspects as 'completeness' of an implementation, 'ease of use', 'performance', and 'costs' play a role.
- *Open environment* – all stakeholders are able to share data according the standard.
- *Increased number of solutions* – having an open standard contributes to the development of solutions and services by providers.
- *Vendor of choice* – each stakeholder is able to select its appropriate solution and still able to share data with others.

Open standards are feasible at different levels[8]. At least at the following three levels, agreement needs to be reached:

- *Communication* – agreement on protocols and technology for data sharing, e.g. Internet protocols combined with mobile networks (4/5G).
- *Syntax* – structuring the data for sharing between two computer systems. XML and EDIFACT are the most commonly used syntaxes in trade and logistics.
- *Technical paradigm* – there are different technical paradigms for data exchange. Common approaches include:
  - A *messaging based paradigm* - as is the case in many EDIFACT-based systems.
  - A *web services* based paradigm in which systems provide a specified API[9] which can be accessed to query and update data.
  - A *linked data paradigm* in which data is published in a controlled way, organizations get notified of updates (events) and can crawl ('index') and analyze data. Such an approach is sometimes called a data pipeline.

  Increasingly organizations choose webservices and linked data / event driven paradigms, whilst re-using concepts from existing messaging based paradigms.
- *Semantics/data dictionaries* – semantics specifies the meaning of data and so controls its processing. Semantics can be represented in a syntax (e.g. an XML Schema Definition or XSD (see ISO standards) or an EDIFACT message structures like developed by WCO and UN/CEFACT) and/or a data model (e.g. the WCO data model for Business-to-Government data sharing). These data models are based on dictionaries like the United Nations Trade Data Elements Directory (UNTDED). They may also have data groups in common, e.g. dangerous goods specifications, but not all data values of these groups are identical for all modalities. A semantic model and/or dictionary for terminology shared amongst stakeholders in inland waterways; ERINOT contains a number of terms, ERDMS a set of code lists that are valid. Both are components of a dictionary. Note that harmonization of data

[8] See for instance https://en.wikipedia.org/wiki/Conceptual_interoperability

[9] Application Programming Interface – a technical interface for digital communication with a software component.

dictionaries still needs to be done; different modalities each have their data dictionary and IT systems utilized by stakeholders are built upon these dictionaries. Terminology of inland waterways is (partly) aligned with that of sea transport, since messages like ERINOT are based on agreed components also utilized in sea transport.

Maritime Cloud

The Maritime Cloud [27] as developed in the EU-FP7 EfficienSea 2 project uses a 'pull' approach for data provisioning. It implements a web services and linked data paradigm. To enable such datasharing the project developed registries for identifying actors and services. Based on these registries it is possible to locate data sources and authorize access to a certain datasource.

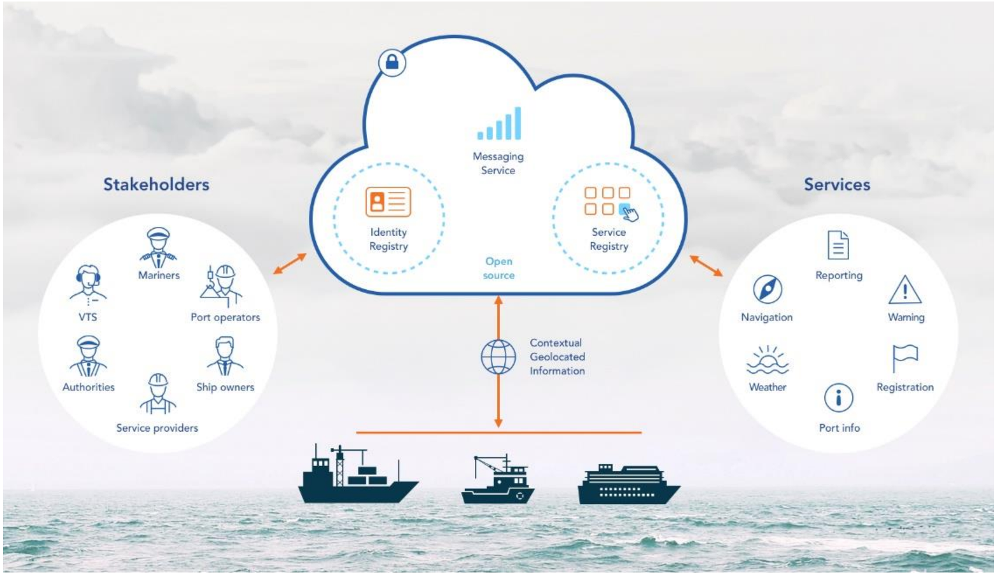


Figure 24: Maritime cloud

4.3.4. Local deployment versus cloud-based deployment

Finally, it should be noted that increasingly there is a choice between deploying a solution locally or in a cloud-based environment. There is a clear trend of moving both data and application functationality to the cloud for business applications. This means that all computational logic is provided through a central (online) platform and the user only needs a simple device to access it. In this way it saves costs not only for implementing the solution but also for maintaining it.

In the IWT domain the on-board services have been traditionally deployed locally given their integration with the vessel and given the lack of communication capabilities (e.g. low network coverage). Various other services such as Fairway Information Services are already provided as on-line 'cloud' services.

In this respect, there are three trends to be observed:

- Cloud computing provides a (private) cloud for storing and operating all cargo related applications that are continuously accessible via communication networks. Since network coverage is improving significantly and roaming charges have been eliminated within the EU, cloud computing can be applied (note that there are still locations with no network coverage that will have to be addressed). The roll-out of 4G and 5G networks in the years to come is expected to provide always-on and much more reliable data connections.
- The introduction of new (disruptive) blockchain technology for trusted data sharing between all relevant stakeholders. This technology replaces the need to share data via a centralized (community) system and distribute the data to trusted nodes to create a resilient data infrastructure. This is for instance the case when deploying blockchain technologies or distributed ledgers [31] . These can be used to register transactions (transport orders, arrivals in a port, members of crew coming onboard, etc.) in a secure way without the need for a centralized repository. Whereas the technology stems from digital currencies, its TRL (Technology Readiness Level) is relative low for logistics applications. Nevertheless, such technology can be considered for future applications, e.g. for registering data from an Electronic Service Record Book for implementing e-IWT.
- Autonomous barging requires development of on-board applications that can be controlled remotely (for instance to monitor autonomous sailing of (deep sea) vessels from a remote-control room). As such, a barge becomes a sailing computer with computational power and storage on which applications can be installed which is linked to a cloud based environment. A similar trend is visible in the automotive domain where for instance Tesla cars (partly) rely on cloud services for implementing autonomous navigation.

4.4. DINA architecture

Based on these four implementation considerations (public vs. private implementation, shared solutions vs. components, open standards and local vs. cloud-based deployment) we will describe the future DINA architecture, realizing the various facets of integration mentioned in paragraph 4.2 taking into account the various characteristics of the sector.

The DINA architecture consists of the following key elements:

- An **extension of River Information Services**: providing additional (real-time) data, making them more interoperable and making the more useable for barge operators using new **on-board e-IWT tools** and apps.
- A **data platform for barge operators**: allowing them to control their own data and operations. This should allow barge operators to share data in a controlled way with other stakeholders such as public authorities (for reporting purposes), (inland) ports and terminals.
- An **integration with booking and transport management platforms of shippers and logistics service providers**. This should provide better visibility and a better integration of IWT in the full logistics chain covering multiple modalities.

We will describe these elements in the following paragraphs.

4.4.1. Future River Information Services and on-board tools

The diagram below positions various future River Information Services and on-board tools. River Information Services will continue to play an important role in the future Digital Inland Waterway Area. To implement integration C (Operational Integration) an extension and upgrade of the existing River Information Services is required.

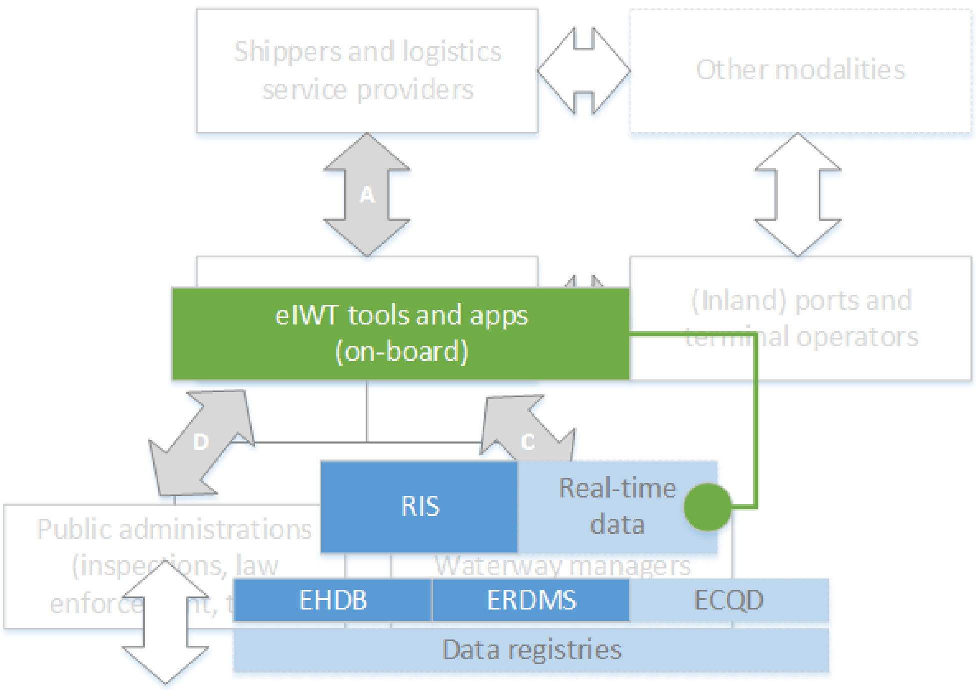


Figure 25: River Information Services and on-boaard tools

This extension will be geared towards:

- Improved integration of existing River Information Services along corridors.
- More real-time data shared between infrastructure managers to barge operators. Such real-time data exchange can include for instance up-to-date traffic information and other conditions of the infrastructure going beyond the existing notices to skippers.

Real-time data can be included in a future on-board environment which we refer to as 'eIWT tools and apps': a digital on-board platform which can be used by the skipper to view data coming from different sources and use new apps to plan his voyage and support navigation. Such a platform can be seen as an add-on or future evolution of the existing AIS/ECDIS environment, extending the current ECDIS Information mode. Later on such an environment might also serve future requirements for autonomous navigation.

River Information Services continue to be provided by fairway authorities in their respective areas. To support the interoperability of the various solutions the position of the shared European databases should be strengthened:

- The European Hull Database provides a registry of all vessels, their unique numbers, certificates and key characteristics.
- The European Reference Data Management System provides frequently used code list and a registry of infrastructure elements (locks, bridges, etc.) and their unique identifiers. Charts are not included in this system but could form a further future extension.
- A future European Crew Qualification Database (ECQD) will provide a registry of crew members and their certificates. Note that in the R&D environment, blockchain technology is already applied in comparable contexts (e.g. to share certificates between universities) and could thus also be applied in this context as well – it is a candidate technology for future versions of the ECQD [31].

The EHDB and ERDMS are currently available (a technical update is currently ongoing). Data quality remains an important consideration. The ECQ will be added in due course to support the IWT workers' qualifications directive.

In addition to the ongoing efforts it is recommended to add a so called 'data registry' to these European databases. This should contain links to real-time data for each entry in the aforementioned databases. For instance: infrastructure elements in the ERDMS could contain a pointer to an online database of a fairway authority providing real-time data on the condition of that particular piece of infrastructure.

In this way the 'data registry' acts as a yellow-pages directory. This in turn allows for the seamless retrieval of real-time conditions of a particular lock, cargo and voyage data of a certain vessel or details on a certain crew member in a service record book.

Considering the implementation options we can state the following:

Public versus private implementation	Extensions of the RIS set-up will be developed in the public domain. eIWT on-board tools will be provided by the private sector, but standardization is necessary to provide an economy of scale (as was the case for ECDIS, AIS, etc.). This requires a public-private collaboration.
Shared solutions versus individual components	The various databases are likely to be provided as a European shared solution as is the data registry. The actual real-time data can be stored in systems and services offered by the various actors.
Open standards	Standards should be provided specifying the interface for real-time data to be implemented by the various RIS providers. This should also enable standardization of the eIWT on-board tools as they will have a similar connection: regardless of the area they operate in there should be one 'connector' to retrieve and update data.
Local versus cloud-based deployment	Given the nature of these solutions it is likely that most functionality will be based on cloud technologies. Some local components are likely to remain as part of the e-IWT setup (e.g. inland-ECDIS and AIS) on-board.

4.4.2. Data platform for barge operators – crew, vessel, voyages and cargo

Only implementing the suggested extensions of the current River Information Services and extending the on-board environment is not enough to fully implement integration C (operational integration), neither is it sufficient to implement integration B (administrative integration):

- To optimize traffic management from a fairway authority's perspective it is needed to have more data of the voyage plan of an individual barge.
- Public authorities require additional data on the cargo, vessel and the crew for law enforcement, statistics, etc. – currently resulting in a high administrative burden.

This results in additional data requirements towards the barge operator. For the envisioned horizontal integration (integration D; with terminal operators) a similar requirement applies: the terminal operator wants to know the ETA of the barge operator.

To support these requirements it is envisioned that there will be a data platform for barge operators which acts as a sort of 'control tower' for their operations: an environment in which the barge operator can maintain its data on the vessel, voyage, cargo and crew, and at the same time interface with its customers.

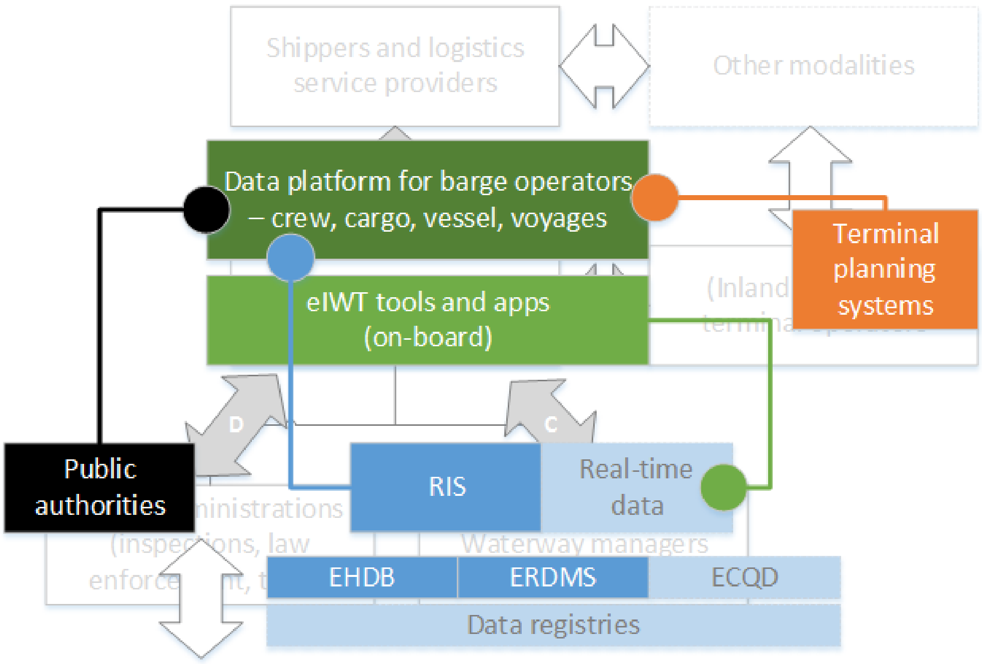


Figure 26: Data platform for barge operators

Te data platform basically acts as the digital backbone of a barge operator and/or his booking agency. It not only maintains the data, but it can also support added value services such as:

- Order management
- Supporting voyage planning
- Cargo management
- Crew/human resource management
- Financial management/invoicing

Towards other actors the platform can act as a data source with the barge operator/booking agency controlling who gets access to this data source under which conditions. The circles in the figure indicate these interfaces:

- An interface for public authorities (inspections, law enforcements, tax, statistics): by 'piggy backing' on the existing data such an interface can potentially greatly reduce the need for barge operators to actively declare/submit data to authorities (integration B; administrative integration).
- An interface for fairway authorities to view voyage plans – when needed for traffic management/corridor management (integration C; operational integration).
- An interface for terminal operators to view estimated times of arrival and to share planning data in ports and terminals (integration D; horizontal integration).

These interfaces could in our view best be provided as part of the platform and made available for others to use.

In view of the implementation considerations, we can state:

Public versus private implementation	Given the nature of the platform it is likely to be developed in the private domain. Public authorities however have a vested interest in their development. It should be considered how public policy could stimulate private development. The aforementioned instruments for developing platforms and standards can also be applied for developing solutions (e.g. a Public-Private Partnership based on financial instruments).
Shared solutions versus individual components	Whilst it is technically possible to implement it as a component based solution for an individual barge operator, it is likely that this is only feasible for the (few) very large fleet operators. For other barge operators it would make more sense to join a shared solution.
Open standards	It is crucial to specify the key requirements for the specified interfaces. Especially when these interfaces are needed to fulfil legal requirements it is important to specify the required data elements and their semantics, the quality of the data and the conditions for accessing the data (data governance). Data provisioning using a 'pull' or 'piggy backing' mechanism is proposed to reduce the administrative burden.
Local versus cloud-based deployment	It is most suited to deploy the platform in a cloud environment, providing continuous access to all relevant users independent of the connectivity of the individual barge.

A strategy for developing such a platform could be based on the principle of defining public requirements, i.e. requirements for data availability as part of implementing the IWT workers' qualifications directive / electronic service record book. This provides barge operators with a choice to procure a solution to just meet the public requirements (e.g. comparable to the existing BICS tool for electronic reporting) or a more enhanced solutions which also supports interactions with private entities and their own business processes.

The data platform for barge operators has a significant interdependency with the foreseen e-IWT onboard tools: it acts as the data backbone of these tools and is likely to feed data to many new apps and services provided through such tools.

4.4.3. Booking and transport management platforms

For implementing the integration A (vertical integration) connections are required with booking and transport management solutions. It is important to consider that solutions for supply chain management, booking and transport management are often driven by customers of a barge operator (as is the case for Bargelink, see section 2.4.2). As was stated in paragraph 4.2.1 only operators of large fleets are likely to offer such capabilities to their customers – in fact acting as a logistics service provider.

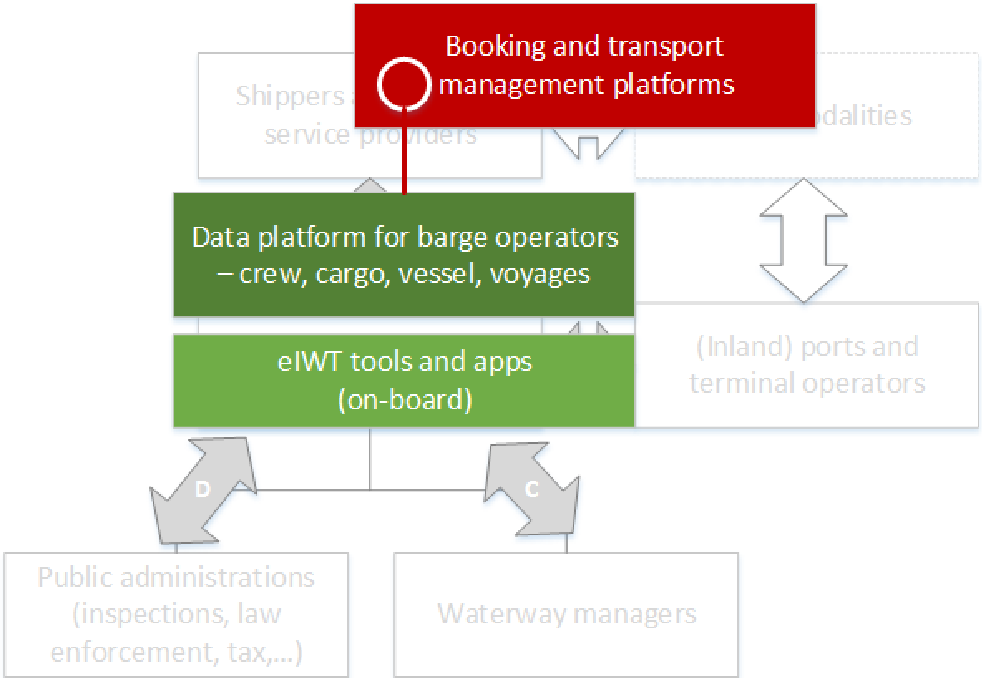


Figure 27: Booking and transport management platforms

For most barge operators this means that they need to connect to systems provided by their customers, using the interfaces provided by such systems.

Public versus private implementation	These solutions are typically developed in the private domain.
Shared solutions versus individual components	Both shared solutions (e.g. global platforms such as INTTRA and GT Nexus) and components (individual supply chain management or booking software suites) are possible. There is however a tendency here towards shared solutions to provide economies of scale.
Open standards	It is unlikely that standards will be driven by the IWT sector as the software tools are used across different modes of transport. Standardization can make it easier to connect to solutions of different vendors. A high level of standardization of the platform for barge operators can also facilitate adoption.
Local versus cloud-based deployment	Both local and cloud based deployments are possible. Most shared solutions are cloud based.

4.5. Summary

Within the DINA framework there are four key integrations to be considered:

- Vertical integration between barge operators and customers
- Horizontal integration between barge operators and ports/terminal operators
- Operational integration between barge operators and fairway authorities
- Administrative integration between barge operators and other authorities (law enforcement, tax, statistics, etc.).

To support these integrations an architecture needs to consist of:

- Platforms providing functionality should implement open standards for the services they provide.
- Extended River Information Services, including shared databases on a European level for vessels, infrastructure elements and crew.
- Data registries to register locations where real-time data can be found on registered entities (vessels, infrastructure – e.g. traffic, and crew).
- A new on-board digital environment – e-IWT tools – to support new digital apps and services for barges, extending the current AIS/ECDIS set-up.
- A platform for barge operators to manage data on their vessel, voyages and crew. This data environment should provide interfaces to selected stakeholders to share data in a controlled way with third parties, including authorities and ports/terminals.

The following picture shows the proposed architecture to realize these integrations.

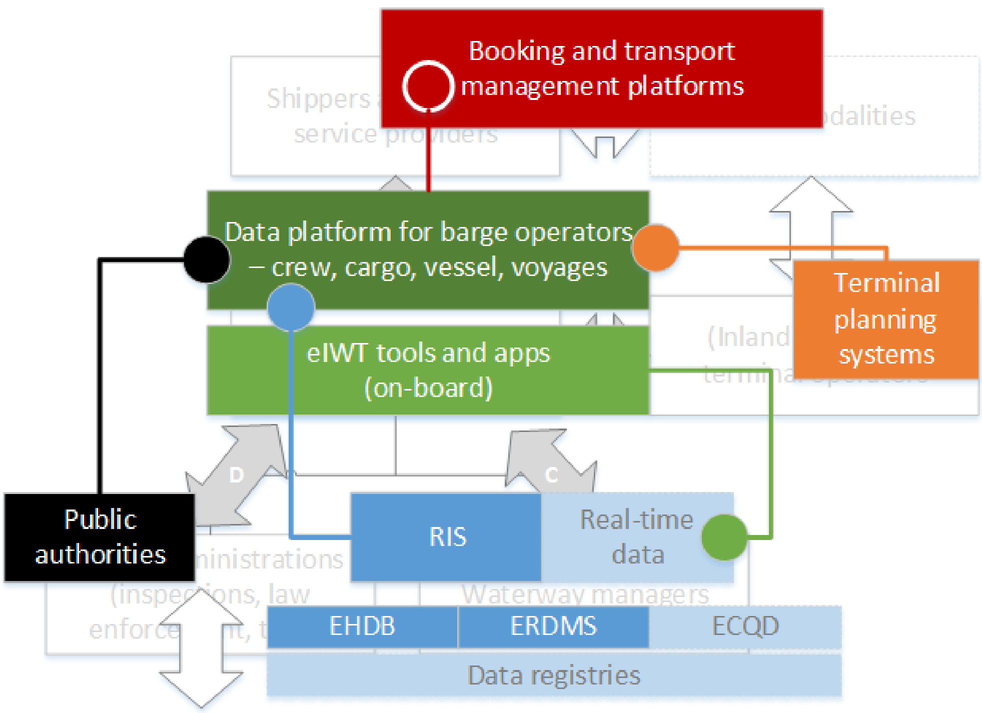


Figure 28: Overview of the full DINA architecture

5. IMPLEMENTING DINA

5.1. Introduction

In the previous chapter we have shown the possible future architecture for the Digital Inland Waterway Area. In this chapter we will focus on the roadmap and implementation strategy for DINA.

5.2. Addressing the underlying problem drivers

Any implementation strategy should make sure that all of the underlying problem drivers are properly addressed. Some of the underlying problem drivers are directly addressed by design choices in the proposed DINA architecture. For instance:

- It is proposed to introduce real-time data features to support continuous data sharing.
- The proposed platform for barge operators provides an opportunity to improve business-to-government data exchange and reduce the administrative burden.

Others depend on the roadmap and implementation strategy for DINA, for example:

- Which (if any) legal measures are feasible to take away bottlenecks for data sharing? Or is it sufficient to provide data governance tools to barge operators for controlled data sharing?
- How to overcome difficulties caused by the limited market size and market fragmentation? How to govern the implementation?

In the following table we specify this for the various problem drivers:

Problem driver	**Addressed in the architecture**	**Implication for the implementation roadmap**
River Information Services were not developed with continuous and controlled data sharing in mind.	New features proposed (e.g. data registries) to enable real-time data sharing on the infrastructure, vessel, cargo and crew.	• Standardization • Governance • Legislation (updating of the RIS directive)
Legal and commercial bottlenecks for sharing data.	Controlled data sharing is proposed through a platform for barge operators. This enabled the barge operator to control who can access his data.	• Governance • (Potentially) legislation
IT-setup of barge operators which is not yet capable for continuous interaction with third parties.	New on-board e-IWT tools are proposed to be used with a cloud-based platform for barge operators.	• Standardization • Public-private collaboration needed

The IWT sector being limited in size and fragmented, making it difficult to achieve economies of scale for new solutions.	It is proposed to work with shared solutions and cloud based approaches, providing the required scalability.	• Standardization • Public-private collaboration needed
The lack of an overall framework for electronic reporting covering different purposes, making it difficult to address the administrative burden.	The architecture supports new reporting mechanisms and facilitates the re-use of data.	• Future reporting requirements and administrative formalities should be transformed in electronic way

5.3. Building blocks and timeline

In the figure below we identify the key building blocks of the proposed DINA roadmap and the associated timeline. These building blocks include the gradual implementation of the DINA architecture and take into account the implications mentioned in the previous paragraph.

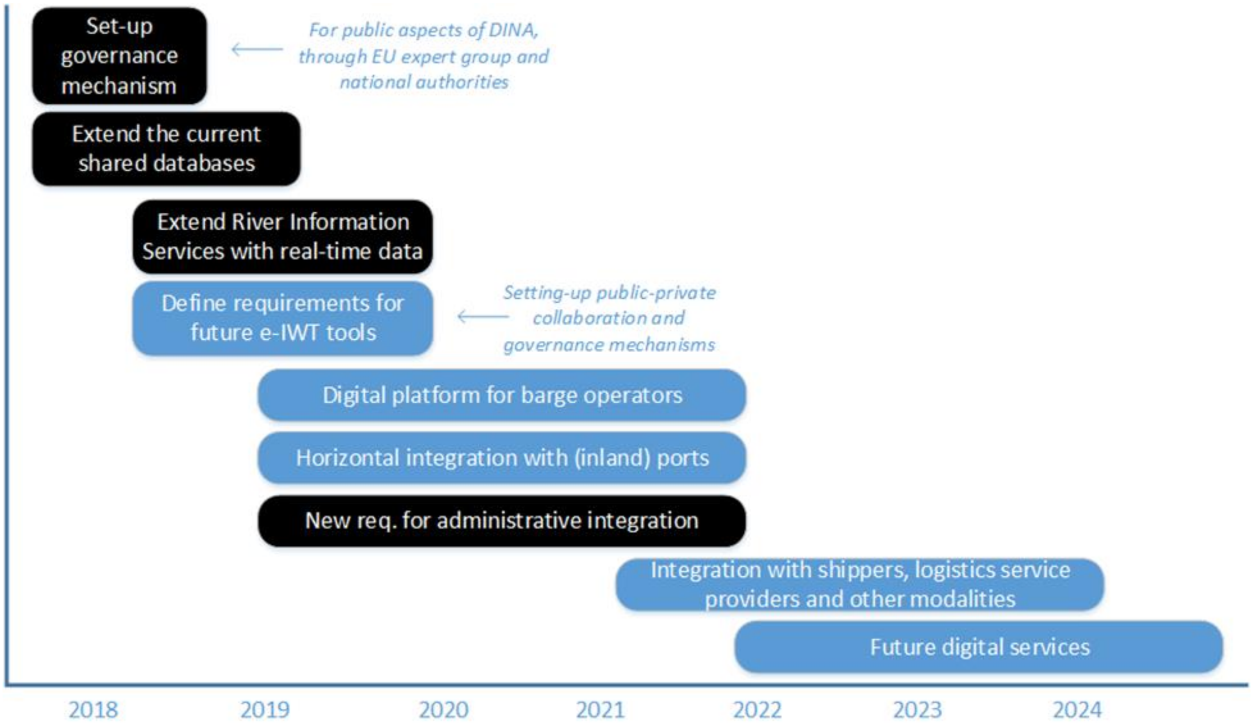


Figure 29: Building blocks and timeline - blue: public/private collaboration, black: public initiative

In the next sections we will describe the building blocks in more detail.

5.4. Short term building blocks

Short term actions focus on:
- The ongoing improvement of River Information Services, the associated services on a corridor level and the shared European databases.
- Ensuring a proper governance for the future standards to be adopted in DINA, as well as the governance of the shared components.

5.4.1. Set-up a governance mechanism for the public aspects of DINA

A key short-term building block is to arrange the governance of public aspects of DINA such as standards and shared components.

Many of the current developments in River Information Services stem from different collaborative projects with the RIS expert groups playing a vital role in maintaining the underlying standards. With the growing use of River Information Services, the need for interoperability and the extension with new components (e.g. the various shared databases) and functionalities (e.g. corridor management) it is important to formalize the governance of the public aspects of DINA. Key aspects on the short term include:
- The governance of semantic standards (ERINOT, Notices-to-skippers, ENC)
- Ensuring technical interoperability of the implementation
- Governance of the shared European databases (EHDB, ERDMS, ECQD)

In the medium term governance should also include aspects such as:
- Alignment with standards used in other modalities
- Certain architectural aspects relating to real-time data sharing
- Public requirements for the on-board equipment (e-IWT)

It is recommended to choose a governance-mechanism based on ‘open standard’ principles (see section 4.3.3). This could be done by means of setting up a separate entity, by using a formalized expert group, by using the facilities of a standardization body or combinations thereof. National authorities can play a vital role as well. It is recommended to build on the best practices from the existing RIS community where possible.

Possible options in this context could include:

- Setting up a DINA expert group to provide formal recommendations
- Formalizing the standardization process and body for maintaining the RIS standards and future standards under DINA. This could be done by evolving existing RIS expert groups and/or linking these standardization developments to other bodies such as CESNI.
- Maintaining a link with other initiatives focusing on the governance and adoption of digitalization in transport and logistics, most notably the Digital Transport & Logistics Forum.

5.4.2. Extend the current shared databases

As mentioned the technical reconfiguration of the European Hull Database (EHDB) and European Reference Data Management System (ERDMS) is ongoing. In addition an ECQD will be needed to support the IWT workers' qualifications directive.

The Directive 2016/1629/EU on the technical requirements for inland waterway vessels imposes the mandatory use of the EHDB. The Directive on the Recognition of professional qualifications in inland navigations foresees the realization and use of the ECQD. These legal frameworks provide for the mandatory use of these databases but do not provide for the more specific usage conditions and provisions for data quality.

It is recommended to take the necessary further steps to enforce the full mandatory use of these databases, thereby including aspects such as:

- Data quality (completeness, correctness, etc.)
- Mandatory use in other applications (single source of truth, no duplication of data)
- Accessibility of the data (e.g. through specified technical interfaces)
- Procedures for signalling and correcting errors

In addition, it is recommended to provide a data registry with pointers to locations where additional 'real-time' data can be found. For instance in third party systems.

In future iterations (e.g. future iterations of the ECQD) the usages of new technologies such as blockchains if further transactions need to be recorded in these databases (e.g. the electronic service record book). See also section 4.4.1.

5.4.3. Extending River Information Services with real-time data

River Information Services have driven digitalization in the IWT sector in the past decade. Supported by the RIS directive and several joint projects fairway authorities and skippers have successfully implemented several RIS core technologies and services. Under DINA it is proposed to extend those, most notably by strengthening the shared databases and facilitating real-time data exchange. This can be realized by extending River Information Services with APIs (technical interfaces) for real-time data.

New digital services rely on the availability of data. Especially services for voyage planning and traffic management rely on infrastructure and traffic data which is currently published through River Information Services (most notably ECDIS charts and Notices to Skippers).

Most of these services are currently provided through web portals. These portals can be accessed using a web browser and provide data in a human readable format. Some of the data can also be downloaded and/or sent via e-mail. Only some RIS providers provide an additional technical interface. As a result, new systems (e.g. corridor management systems) require a significant implementation effort to connect with the various underlying databases.

It is recommended to make it mandatory to provide technical interfaces (APIs) for providing machine readable real-time data and to provide an open standard for such an interface. This should be part of a revision of the RIS directive and/or underlying implementing regulations. It is then the responsibility of the providers of River Information Services (the fairway authorities in the member states) to implement these interfaces.

The RIS COMEX implementation project is a potential 'landing spot' for this action since similar interfaces will be needed to develop the services (on a corridor level) foreseen in this project.

5.5. Medium term building blocks

Many aspects of DINA are related to developments in the private domain and other modes of transport. In addition: several aspects of DINA require digitalization initiatives in the private domain, e.g. the horizontal integration with inland ports or the marketing of new on-board equipment.

Medium term building blocks should therefor focus on public-private collaboration. This could potentially be accelerated through publicly (co-) funded acceleration and innovation programmes, in addition to the ongoing development and management of the required standards.

5.5.1. Define the requirements for the future e-IWT onboard tools

Skippers currently predominantly use three categories of tools:
- Web-portals to view fairway information and notices to skippers
- ECDIS for displaying electronic charts and to support navigation; ideally including an overlay with NtS-data. This is often linked to the AIS-transponder and the on-board radar.
- Software tools for Electronic Ship Reporting (e.g. BICS).

It is expected that this set-up will evolve in the future as new functionalities will be required and become available. These 'e-IWT onboard tools' are likely to include:
- Support for more efficient navigation, maybe even for (semi-) autonomous navigation
- Apps and services to communicate with external stakeholders
- The collection of vessel data (draft, fuel consumption, etc.)
- Capabilities for electronic identification and authentication
- Working with the platform for barge operators as a data backbone

The availability of connectivity is a key boundary condition: barge operators indicate that currently there is not sufficient wireless coverage on several waterway stretches. This has resulted in initiatives such as 'Binnenvaartnet' providing WiFi-hotspots in several port areas [32] . Possible solutions can be found in the development of 5G mobile communication, satellite based communication and/or new Internet-of-Things networks (using communication technologies such as LoRa and narrowband LTE). Such developments should be considered.

It is recommended to start an initiative with solution providers and end-users to define the requirements for the future on-board reference infrastructure, taking into account existing investments and future requirements. Such an initiative could already start early-on, but results are to be expected in the medium term.

5.5.2. Work with service providers to develop a data platform for barge operators

As indicated in the previous chapter it is proposed to have an architecture integrating improved River Information Services with a new data environment for barge operators. This should in turn support additional integrations with several stakeholders.

- It is important to develop this environment with commercial platform providers. These could be technology providers, providers of logistics solutions, providers of on-board equipment and combinations thereof. Aspects of such a collaboration include:
- Standardizing the public requirements for the proposed data platform for barge operators (relating to the interfaces of such a system).
- The maintenance of IWT-specific standards used, especially when considering the semantics of data exchange.
- The use of one or more data registries, providing a 'yellow pages' directory for finding (real-time) data sources.
- Recommendations for technical standards and standards for data governance to be used.

It is recommended to adapt the RIS directive and underlying regulations to include this development, most notably with regards to the public requirements for the proposed data platform for barge operators. This provides the market with two options: developing a dedicated solutions for complying with these requirements or providing a solution which can also meet other requirements in the private domain. It is likely that they will choose this second option given the opportunity to reduce the administrative burden and meet demands of both authorities and customers/ logistics partners with one solution.

5.5.3. Horizontal integration with (inland) ports and others

The proposed DINA architecture allows for the sharing of the necessary data on infrastructure, traffic conditions and voyage plans to allow for a more accurate prediction of ETAs. In addition the proposed data platform for barge operators allows for the controlled sharing of these ETAs with other stakeholders (e.g. terminal operators or customers).

There is however still some ambiguity on the responsibility for providing an algorithm and digital service to actually calculate such an ETA. In principle it should be possible for the barge operator (or a digital service provider operating on behalf of the barge operator) to do so. There are already voyage planning tools available which provide such functionality and which might be extended using the additional data made available through DINA.

For some uses a more advanced interaction might be necessary between stakeholders. This includes:

- Exchanges between barge operators and fairway authorities when planning traffic in a corridor or at a certain point in the infrastructure (e.g. lock planning). In this case the voyage plan of an individual skipper can be influenced by the fairway authority. This is a scenario considered as part of corridor management in the COMEX project.
- Exchange between barge operators and ports/terminals relating to berth management. Operational changes in terminals (e.g. the (non-) availability of cargo) can lead to changes both on the side of the barge operator and on the side of the terminal. An exchange of alignment of plans might be needed, influencing he ETA at a terminal. This scenario is currently being implemented as part of systems introduced by PSA Antwerp, Port of Rotterdam (NextLogic) and RheinPorts.

It is recommended to develop more standardized patterns for ETA prediction based on the outcomes of these projects. One option is to provide an ETA predictor as a public service as part of River Information Services, providing a key enabler for many improvements (navigation, traffic management, etc.). In the DINA taskforce it was noted that liability is a potential issue since most fairway authorities do not want to be held responsible for inaccurate ETA predictions.

5.5.4 *Define new requirements for administrative integration*

Reducing the administrative burden depends on defining new requirements for administrative integration. In the DINA architecture it is proposed to introduce a ‘data pull’ approach where authorities can retrieve data from the data platform for barge operators when required. This limits the number of declarations by a barge operator, reducing the administrative burden.

In order to achieve this it is important to define the detailed requirements for the data to be provided, as well as the quality of the data and the access conditions (data governance). These are likely to be specific for inland waterway transport and can be seen as an extension of existing reporting requirements (e.g. to report dangerous cargo).

In addition more generic requirements apply, e.g. relating to key priorities in the Digital Single Market initiative. Here it is stated that public services should ‘digital by default’. This means that public administrations should deliver services digitally (including machine readable information) as the preferred option. Specific requirements include:

- *Once only principle*: public administrations should ensure that and businesses need to supply the same information only once to the authorities;
- *Cross-border by default*: public administrations should make relevant digital public services available across borders and prevent further fragmentation;
- *Interoperability by default*: public services should be designed to work seamlessly across the Single Market and across organisational silos, relying on the free movement of data and digital services;
- *Trustworthiness & Security*: All initiatives should comply with relevant information security regulations and adopt schemes such as eID for electronic identification and authentication.

It is recommended to update the legal reporting requirements accordingly.

5.6. Longer term building blocks

The medium term actions are focused on setting-up the required public-private collaboration, providing a platform for development and starting the broad roll-out. This platform (DINA) should then provide an environment for future digital developments. These are likely to be in the area of integration with other modalities and digital services for e-navigation/autonomous navigation.

5.6.1. Integration with shippers, logistics service providers and other modalities

As mentioned in the previous chapter there are already several providers of booking platforms, supply chain management solutions and transport management tools. Their development is mostly driven by commercial (ICT) service providers and/or large shippers and logistics service providers using these solutions.

It is important to work with those providers to see how barge operators can easily connect to such platforms, given the future data platform for barge operators. Ideally standardized interfaces should be provided to such a system. It is therefore recommended to involve providers of such systems when defining the requirements of this data platform.

In addition to working with these providers it is important to consider the outcomes of the Digital Transport & Logistics Forum. The DTLF is considering new ways to accept electronic transport documents and exchange data across modes of transport. Discussions include the harmonization of standards in the various modalities, the inclusion of existing generic standards, the general approach towards standardization and the requirements for cloud platforms implementing these standards.

In both cases it is important to adapt solutions from other modalities where possible and influence their development where needed to ensure that specific requirements of inland waterway transport are met.

5.6.2. Future digital services

DINA should be considered as a platform for the development of new apps and services. Members of the DINA taskforce have identified several potential future services beyond those addressed in this report such as:

- The reporting of emissions
- Supporting customs and immigration procedures (e.g. for passenger ships leaving and entering the Schengen zone).
- Managing empty return containers
- Etc. etc.

It is important to stimulate the development of these and the already suggested services (e.g. enhance voyage planning) through dedicated innovation instruments (e.g. CEF, H2020). In this way it is possible not only to speed-up the development of new apps and services but also to accelerate the development and adoption of the underlying DINA architecture.

In this way DINA can also serve as a platform to introduce new navigation concepts, especially relating to (semi-) autonomous navigation. Even though this development is still in the early stages there are some pilots in the field of maritime transport and it is part of the innovation roadmaps of other modalities (road and rail). In all modalities we see a combination of advanced on-board equipment (sensors, radars, computers) and the use of data services. DINA can potentially play an important role in the development of the required data services.

5.7. Implementation costs

5.7.1. Baseline

DINA is an overall concept touching many different actors, systems and technologies. It will be the platform for many different applications, each with its own business cases (integration with inland ports vs. autonomous navigation vs. electronic reporting, etc.) which is the topic of a more detailed policy impact assessment.

Nevertheless we can make a high-level assessment of the required implementation costs by looking at the various components of DINA and the size of the market:

- Barges need to be equipped with a **new digital on-board infrastructure**. This infrastructure should serve multifunctional data processing, provide internet communication capabilities, etc. It should enable skippers to run new digital apps and interact with customers, authorities and other actors in the transport network (e.g. terminal operators).
- New **(cloud based) transport management solutions for barge operators** will be needed providing a data platform for all their operations and interactions. These solutions manage data regarding the vessel, cargo, crew and voyages and are the basis for interactions with other stakeholders. The solutions should connect to:
  - Booking platforms and control towers of shippers and logistics service providers, e.g. to share logistics capabilities and provide visibility.
  - Digital tools used by inland ports and terminal operators, e.g. to provide estimated times of arrival.
- Various **new applications will be needed for individual skippers**, using the digital on-board infrastructure and online transport management solutions:
  - Apps to provide access to this data to government/law enforcements agencies (workers qualifications, dangerous cargo)
  - Apps to provide access to this data to fairway managers (voyage plans)
  - Apps for smart navigation (beyond ECDIS information mode), ultimately enabling autonomous navigation.
- Many of these **inland ports and terminals** currently lack the required apps and digital infrastructures.
  - Existing terminal operating systems and planning systems in large terminals need to be modified to support enhanced berth planning and other communication with barge operators.
  - Smaller inland terminals currently lack equipment and apps to digitally communicate with barge operators and should be provided with those.
  - Fairway authorities need to adapt and extend their existing River Information Services, integrating with the new capabilities of barge operators and extending the functionality towards corridor management. The investment can differ, depending on the size and scope of activities of the authority involved (e.g. length of the waterways and levels of traffic).
- **Inspection and law enforcement agencies need to adapt and extend their existing capabilities** in a similar way. They need digital infrastructures and tools to access and assess data of barge operators.

5.7.2. Cost assessment

Based on the previous assessment of what will be needed we can assess the required investment. Here we distinguish between the investment in technology (setting-up the required software and digital platforms) and the organizational implementation. We assume these costs to be 75% of the required investment in technology – e.g. education and training, process adaption, etc.

Barges / skippers

Description	**Number**	**Cost / unit**	**Total cost**
New cloud platforms for managing data of barges (crew, vessel, cargo, voyages)			€ 15.000.000
On-board multifunctional digital infrastructure (‘eIWT tools’)	12.500	€ 2.000	€ 25.000.000
Apps for compliance / law enforcement	12.500	€ 500	€ 6.250.000
Apps for smart navigation	12.500	€ 500	€ 6.250.000
Apps for communicating with terminals	12.500	€ 500	€ 6.250.000
Total investment in technology			€ 43.750.000
Design, set-up, and organization implementation (75%)			€ 32.812.500
Total required investment			**€ 76.562.500**

Shippers / logistics service providers

Description	**Number**	**Cost / unit**	**Total cost**
Integration with booking platforms and visibility tools of customers			€ 15.000.000
Total investment in technology			€ 15.000.000
Design, set-up, and organization implementation (75%)			€ 11.250.000
Total required investment			**€ 26.250.000**

Terminals and ports

Description	**Number**	**Cost / unit**	**Total cost**

Equipment and apps for small terminals and inland ports	180	€ 5.000	€ 900.000
Digital platforms for large terminals (e.g. Duisburg, maritime ports, inland hubs)	20	€ 2.500.000	€ 50.000.000
Total investment in technology			€ 50.900.000
Design, set-up, and organization implementation (75%)			€ 38.175.000
Total required investment			**€ 89.075.000**

<u>Authorities</u>

Description	**Number**	**Cost / unit**	**Total cost**
Adaptation of existing River Information Services, extension towards corridor management. Including shared European facilities.	30	€ 500.000	€ 15.000.000
Dashboards and digital infrastructure for law enforcement and inspection agencies	30	€ 500.000	€ 15.000.000
Total investment in technology			€ 30.000.000
Design, set-up, and organization implementation (75%)			€ 22.500.000
Total required investment			**€ 52.500.000**

5.7.3. *Total investment required*

Based on this assessment an investment in the order of magnitude of € 300 - 325 million euros is expected to be required for digitalizing Europe's inland waterway sector:

- +/- 70 – 80 million € for digitalizing barges
- +/- 20 – 30 million € for improving the integration of IWT in logistics processes of shippers and logistics service providers.
- +/- 90 million € for digitalizing (inland) ports and terminals
- +/- 50 million € for digitalization of public authorities (fairway managers, inspection agencies, law enforcement)

Once realized further yearly expenditures are expected for maintenance and governance:

- Maintenance of digital tools, e.g. as a result of service level agreements and license fees – approximately 20% of the initial technology investment - +/- 35 million €/year.
- Governance of the required standards and the coordination of the implementation – approximately 5% of the initial technology investment - +/- 7 million €/year.

5.7.4. *Policy implications*

It is clear that in order to realize the proposed building blocks a combination needs to be found between:

- Publicly funded shared components on a European level
- Investments in national implementations by the member states
- Investments by barge operators, ports, terminal operators and logistics actors in the required tools and software

Covering the required design, set-up and organization costs through a shared public-private innovation programme might be an opportunity to lower the investment barrier for actors to invest in setting-up DINA. In addition co-funding of the required technology-investments (e.g. e-IWT on-board tools) might lower the barrier for barge operators.

5.8. Summary

Implementing DINA will require short, medium and long-term building blocks. These will not only need to take into account the DINA architecture but also key aspects of the underlying problem drivers such as the limited market size.

A short-term focus should be on the continued implementation and extension of River Information Services, standardization and the implementation of the shared European databases.

The medium-term focus should be on initiating joint public-private initiatives for developing the future e-IWT onboard tools, the data platform for barge operators and the integration with other stakeholders.

This should enable a long-term focus on further integration with other modalities and the usage of DINA as a platform for new applications such as (semi-) autonomous navigation.

To cover the costs of implementing DINA a combination needs to be found between public and private initiatives. This can include covering the required design, set-up and organizational costs through a shared public-private innovation programme and/or co-funding the required technology-investments of barge operators.

6. CONCLUSION

6.1. Digitalization to improve the competitiveness of inland waterway transport

In this report we provided an overview of the possible Digital Inland Waterway Area by means of introducing an architecture that can provide controlled data sharing amongst all actors related to inland waterway transport.

Having such an environment can enable innovations in many different aspects, all focused on improving the competitiveness of inland waterway transport. Some of these aspects have a very specific business case (e.g. lowering the administrative burden) others have further reaching implication (e.g. autonomous navigation). It is however clear that digitalization is needed to avoid IWT lagging behind other modalities.

The research shows that there are only few legal bottlenecks to enable such an environment: privacy related legislation and competition related legislation (both are unlikely to change). This means that a lot is possible within the broader framework of the free flow of data and data economy as pursued in the Digital Single Market strategy.

- A key element is the provisioning of tools for barge operators to enable controlled data sharing (barge operator remains in control).
- Implementing key principles such as ‘once-only’ and ‘digital by default’ can potentially reduce the administrative burden.

6.2. Focus needed on standardization and shared innovation

In the implementation roadmap a clear focus is on standardization and shared innovation:

- Standardization is needed to provide the necessary economies of scale. It is also needed to enable interoperability with other modalities. A governance scheme is needed to cover the existing standards for River Information Services, future additional standards used in DINA and to ensure the alignment with other standards. This strongly relates to the work currently carried out by the Digital Transport & Logistics Forum.
- Shared innovation will be needed to further define and implement certain components of DINA. This includes most notably the future e-IWT onboard tools, a data platform for barge operators and various kinds of digital services and integrations using these.

6.3. Combination of individual and shared business cases

There is not a single overarching business case for DINA as a whole. Instead it is a combination of individual and shared business cases. Further assessment of policy impact will be needed to assess costs and benefits of these combinations and identify a fitting financing scheme for realizing DINA. Such a scheme should combine:

- Publicly funded shared components on a European level
- Investments by member states in national implementations
- Investments by barge operators and logistics actors in the required tools and software

Covering the required design, set-up and organization costs through a shared public-private innovation programme might lower the investment barrier for many actors.

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APPENDIX A

Projects, studies and technologies considered

This appendix provides an overview of projects, studies and technologies considered for this report by the taskforce. Note that this is not an exhaustive list as members of the taskforce have considered additional country or domain specific technologies and studies. Where applicable a link to such studies is included in the overview of literature references.

A.1 Projects considered

RISING
The RISING project was funded under the FP7 framework programme. The objective of this project was to identify possible future River Information Services. The project looked at aspect such as business cases and architecture. The results of the project became part of several national and international RIS-implementation projects. RISING was concluded in 2012.

CoRISMa
The CoRISMa project, funded as part of the TEN-T programme, focused on the interconnection of various national RIS systems in a corridor with the aim to provide a 'one stop shop' for users of such services. The concept of corridor management was explored in this project. The project concluded that various 'levels' of corridor management were possible. Participating countries included Austria, Belgium, Germany, Luxembourg and the Netherlands. The project was completed in 2015.

RIS COMEX
Based on the experience and results of its predecessor project CoRISMa, the new project is about to continue the pan-European expansion of River Information Services for inland navigation following the Corridor approach. The project has 15 partners from 13 countries. They will introduce jointly defined services on the following corridors: Danube, Rhine, Elbe, Mosel, Amsterdam-Antwerp-Liege, Amsterdam-Antwerp-Brussels and Dunkirk-Scheldt. The project started in 2017 and is funded under the CEF.

Prominent H2020
PROMINENT is a project funded in the Horizon 2020 programme. It addresses the key needs for technological development, as well as the barriers to innovation and greening in the European inland navigation sector. PROMINENT is ultimately aimed at providing solutions which make inland navigation as competitive as road transport in terms of air pollutant emissions by 2020 and beyond. In parallel PROMINENT aims to further decrease the energy consumption and carbon footprint of IWT, an area where IWT has already a strong advantage compared to road transport. DINA is influenced by PROMINENT because of the strong need for additional data exchange e.g. on emissions and waterway conditions needed for greener transport. The project is ongoing.

EfficienSea
The EfficienSea project was a flagship project in the Baltic Sea Region. Key areas of research included e-navigation, vessel traffic data and risk management. Even though

the focus in the project was on maritime applications, several aspects were considered for re-use in inland waterway transport given the traditional link between technologies in the maritime and IWT domains (e.g. AIS). The project was completed in 2013.

Maritime Cloud
The MaritimeCloud is jointly developed by the EU funded EfficienSea2 project (the successor of EfficienSea) and Sea Traffic Management project (CEF funded). The Maritime Cloud aims to introduce new data exchange capabilities in maritime transport both for e-navigation and administrative purposes. Where relevant architectural concepts were re-used to define the DINA architecture.

A.2 Studies considered

Inland ports and IWT
The European Federation of Inland Ports published a position paper on the role of inland ports in relation to the digitalization of inland waterway transport. Aspects included the exchange of data between operators of inland terminals, barge operators and other modalities.

Platina-2
The Platina-2 project delivered a series of reports focusing on implementing the Naiades-2 policies. Key deliverables considered for the Digital Inland Waterway Area included deliverables on the uptake of River Information Services in the member states and deliverables on the future extension of River Information Services.

eIWT
The European Commission Joint Research Center studied in 2016/2017 the potential concept of electronic tools for inland waterway transport. These studies were driven by the need to provide digital support for implementing the IWT workers' qualifications directive. Several aspects such as a database for qualifications and the future toolkit for on-board use were considered in the DINA architecture.

Binnenvaart Vlaanderen – ICT use in IWT
In 2015 Binnenvaart Vlaanderen studied the use of ICT by barge operators. This provided valuable findings relating to aspects such as network connectivity, the adoption of digital tools (e.g. tablets) and the use of planning systems. It underlines the need for easy-to-adopt tools and services for barge operators.

Digital Single Market Policy mid-term review
In May 2017 the European Commission published the Mid-Term review of the Digital Single Market initiative. Key recommendations are the initiative to spur the European data economy by clarifying rules on the cross-border flow of non-personal based data, focus on growing cybersecurity challenges and the promotion of fairness and responsibility of online platforms (mostly in the consumer domain). Intelligent transport such as connected cars is considered a domain for further investment. The Digital Inland Waterway Area fits in the DSM policy providing an architecture for secure and trusted data sharing in the IWT domain, enabling new data driven innovations supporting the competitiveness of IWT as a modality.

E-Navigation for Inland Waterways 2017 by PIANC

A PIANC working groups has investigated the possibilities for extending navigation capabilities using digital tools under the umbrella of e-navigation. Key aspects include the possible use of ECDIS information mode and further digital services to support navigation. The development of such services is encouraged as part of DINA.

Digital Transport & Logistics Forum

The European Commission has launched the Digital Transport & Logistics Forum to aid the implementation of e-freight solutions. Aspects include the acceptance of e-transport documents and the sharing of data in corridors. The preliminary outcomes were considered in DINA to ensure alignment with these developments. A technical annex is included in this report to highlight this alignment.

INE Vision on digitalization

Inland Navigation Europe has provided a vision document / position paper on digitalization. The paper identifies three key lines for digitalization:

- Digital government: having a single point of entry to government administrations, digital certificates in declarations (vs. paper) and oordinated targeting and controls by government agents.
- Digital hubs & corridors: exchange of data between transport modes (national & international), multi-modal orchestration of transport movements, enable Tracking & Tracing
- Paperless supply chain: re-use of data along the supply chain (Commercial, transport, government), trusted data access by private and public supply chain actors, multi-modal voyage planning
  The DINA architecture is defined in such a way that it can enable the development of such services, e.g. through the proposed digital data platform for barge operators enabling them to share data in a controlled way with other stakeholders.

A.3 Technologies considered

PIANC RIS Guidelines 2011

The PIANC RIS Guidelines provide a full overview of RIS core technologies and possible RIS services. Some of these services were implemented as part of the European RIS directive, others were piloted as part of innovation projects. An overview of relevant technologies and services is included in this report. Examples include ECDIS, NtS and AIS.

National RIS implementations

Various countries have implemented RIS in different ways providing various portals and digital services for stakeholders. Examples include the VisuRIS portal developed in Flanders and the Danube FIS portal and DORIS website. Such implementations were considered for the current state of the art and future extensions towards real-time data.

Cloud platforms for logistics

Shippers and logistics service providers have developed various cloud platforms for sharing cargo and service related data. Several technological concepts are used but most platforms rely on some form of controlled data sharing technologies. Based on the data gathered through these platforms new services and apps can be developed.

Examples of cloud platforms considered are BRUCloud (air cargo), Ericsson Integration Backbone (air cargo and other modalities), IBM Shipping Information Pipeline, MSC Cloud (maritime).

Such concepts were re-used when considering the proposed data platform for barge operators and the integration with existing logistics platforms. A key consideration was introduced whether services should be developed stand-alone/locally or as part of a shared service (which is the case in many of the aforementioned cloud platforms).

Aquapol

Aquapol is a cooperation of law enforcement authorities. They gather data on vessels and risks to enable risk-based law enforcement. In this way they can target specific vessels and share data with other law enforcement agencies.

It was discussed with Aquapol how such a database could become part of the future DINA and how this would influence reporting requirements and the administrative burden.

Blockchain

The use of so-called distributed ledgers or blockchains removes the need for having a shared database in a community. Data is being shared on a peer-to-peer basis and advanced algorithms ensure that nobody can tamper with the data. It is a promising technology for registering transactions and events. This makes it a possible candidate technology for future extensions of the shared European databases (e.g. EHDB and ECQD), reducing the need for having centralized IT-governance.

5G

Data connectivity currently is a clear issue for many barge operators, especially since many rivers run along country borders (where wireless coverage typically is an issue). Europe is investing heavily in the development of 5G as the next generation wireless communication. This will not only provide faster connections, but it will also focus on the specific needs of verticals such as transport, manufacturing and health. It is to be expected that the introduction of 5G technology will greatly improve coverage, throughput and reliability of wireless data communication. As such it can be an enabler for future concepts such as autonomous navigation with an on-shore control.

Semantic web technologies

Traditional data exchange technologies focus on the use of EDI and XML as data syntax. Standards such as ERINOT come with a message implementation guideline which describe which fields need to be filled with what data. New semantic web technologies combine data and the meaning (semantics) of the data in one computer interpretable structure. This makes it much easier to achieve interoperability and lowers the implementation burden. Semantic web technologies are considered an enabler for the future data platform for barge operators, the controlled data sharing and the integration with (data of) other modalities in DINA.

APPENDIX B: DINA TASKFORCE

The project assembled a taskforce to provide input on requirements for digitalization and to ensure alignment with ongoing (or previous) initiatives.

The following persons were members of the taskforce based on their specific knowledge, background or expertise:

- Mr. A. Blakeway - Voies Navigables de France
- Mr. W. Brunet - Generaldirektion Wasserstraßen und Schifffahrt
- Mrs. M. Chaffart - ETF-Europe
- Mr. P. Durajczyk - Inland Navigation Office in Szczecin
- Mr. S. Daniels - HPC Hamburg
- Mr. A. Glowacki - Evonik
- Mr. R. Hemeleers - INE
- Ms. V. Ivanus - Bruckner Invest Romania
- Mr. H. van Laar - Bureau Telematica Binnenvaart
- Ms. L. Kuiters - Rijkswaterstaat
- Mr. G. Pauli - CCNR
- Mr. M. Nijdam - Port of Rotterdam
- Mr. R. Rafael - ProDanube
- Mr. D. Savelkoul - Autena
- Mr. M. Stefanoff - PSA Antwerp
- Mr. D. Vermeir - Alsic
- Mr. T. Wagner - Generaldirektion Wasserstraßen und Schifffahrt
- Mr. S. Wiech - HPC Hamburg
- Mr. C. Willems - Individual expert

The taskforce met three times:

- April 18 2016 in Brussels, focusing on the general context of DINA
- June 22 2016 during the TEN-T Days in Rotterdam, focusing on possible value added services
- November 22 2016 during the RIS week in Hasselt (Belgium), focusing on architectural concepts and the underlying problem analysis

DINA was presented during the common issue day during the November 2016 RIS week in Hasselt. During the RIS week in May 2017 in Belgrade the architecture and concept of DINA was presented.

APPENDIX C: Open systems for e-freight (DTLF)

C.1 Introduction

The EC DG MOVE Digital Transport and Logistics Forum studies the acceptance of e-transport documents and data exchange in corridors. There is a specific focus on the use of standards and on the introduction and use of digital platforms for e-freight.

In this appendix we will highlight some of the preliminary outcomes and aspects of the discussion within the DTLF relevant to the DINA architecture.

Aspects relevant for DINA include:

- Standardization of the various interfaces requires a conceptual modelling approach to construct an open system for interoperability of barge operators and skippers with their environment. The method for developing these standards needs to be developed in joint collaboration with EC DG MOVE DTLF.
- There are sufficient platforms in the private sector offering different types of functionality. There are two actions required for DINA:
  - Specification of platform services. By specifying relevant services of those platforms for the inland waterways for an open infrastructure, platform service providers can develop functionality for inland waterways and limited functionality is required in the public sector.
  - Specification of protocols for federation of platforms. Protocols between different platform service providers are required to construct an open environment, by which a barge operator, skipper, or customer only needs to register once and is able to do business with any other partner. A type of Internet for Barging is created based on different suppliers of platforms.

C. 2 Standards and their implementation

The main conclusion is that the current methodology for development and implementation of standards for replacing business documents with electronic messages leads to closed (community) solutions with the following properties:

- the private sector, logistics enterprises and IT systems and solution providers, is not able to develop an open interoperability environment by itself; IT systems and solution providers address the problems arising from different implementation guides;
- the public-sector acts as dominant player, in some occasions develops systems with private sector functionality (e.g. for inland waterways), and
- there is still a focus on supporting existing procedures by replacing documents with electronic versions, both in the public and private sector and supported by standardization bodies.

Many of these problems stem from ‘power’, both at business level and standardisation bodies. They lead to enforcing particular standards, both by private enterprises and the public sector. The current approach is hindering innovation and interoperability costs (e.g. maintenance and implementation costs) are too high.

There are already (many) innovative solutions for sharing data, e.g. Application Programming Interface management platforms, and innovative business models like Uber4Freight operating as two-sided platforms (see the document on platform functionality produced for Subgroup 2 of the DTLF). The logistics sector has to have the means and technology to be able to meet these challenges. An innovative approach to standards has to be taken and implemented to support business innovation. To reach this objective, the following recommendations are given:

- Innovative approach to interoperability - conceptual interoperability (level 6). Interoperability is currently at level 4 of the LCIM (see before), which prevents dynamic chain composition in logistics networks (level 5). Conceptual interoperability (level 6) supporting existing open and defacto standards needs to be developed. Conceptual interoperability should utilize standards as a means to share data, where the actual data that is shared reflect value exchange between various stakeholders. Value exchange is driven by Key Performance Indicators (KPIs) or Quality of Service (QoS), where external drivers can influence QoS of a particular stakeholder (e.g. accidents or incidents).

  The following figure shows a first concept of steps to reach conceptual interoperability:

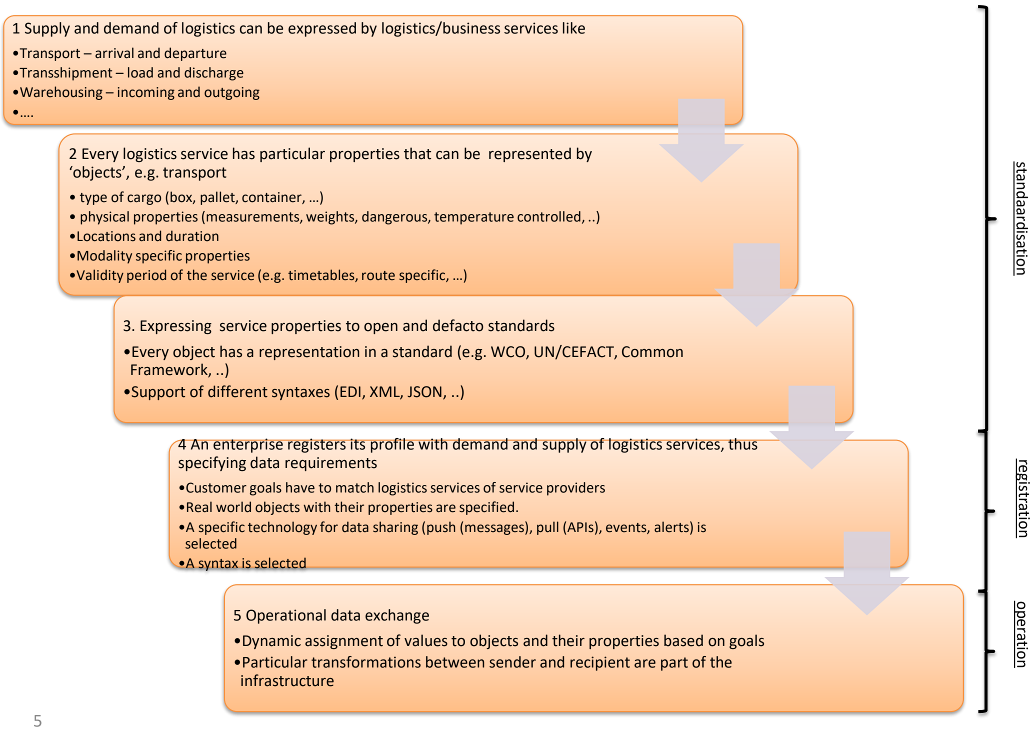

Figure 30: Achieving conceptual interoperabililty

1. Value modelling – supply and logistics is expressed in terms of the logistics services and goals of LSPs and their customers. Transport, transhipment, and warehousing are examples of these logistics services.
2. Service properties – a specification of the logistics service properties. These are mostly expressed as the type of cargo that can be handled, the duration of the service, etc. A logistics service also has a validity period, e.g. a timetable with daily freight train scheduled across a particular corridor, where the corridor expresses the locations. The service definitions of the Common Framework can be used to support the specification of services and their properties.
3. Standard representation - logistics services and their properties are expressed in open (and defacto) standards. If for instance a transport service can have a property 'container', that latter property can be represented (as a concept with its properties like container size and type) by its relevant structure in the WCO data model and UN/CEFACT standards. There may be differences in properties of concepts in different standards, which requires further harmonization of those standards.
4. Registration – each LSP registers its services by selecting a service type and giving them values. These result in for instance transport services along particular corridors with given timetables, flight schedules, and voyage schemes. Customer goals have the same properties as the required services, but don't have to be registered. Customer goals are input to marketplace services or a search for logistics services (see platform functionality). Registration might also include the standard representation, the syntax, and the technology used for data sharing. However, connection services for a platform infrastructure do not require this; a syntax can be used locally to connect to a platform (see platform functionality). Technologies can also be different, resulting in the necessary transformation, e.g. between a pull (API) and push (messaging) approach by providing an API upon messages or generating events out of web services.
5. Operational data sharing - actual sharing of data between stakeholders utilizing a particular technology at the local connection to a platform and maybe over the infrastructure. The data that is available from a customer' perspective is entered and matched with requirements formulated by logistics services of LSPs.
6. Integrated systems approach. An integrated systems approach of standards for logistics interoperability, platform functionality, and roles of the various stakeholders with respect to development, implementation, and deployment. The role of disruptive technology like blockchain technology should be explored as potential solution for interoperability, but the roles will still have to be identified.
7. Standardisation bodies need to be included to harmonize and further develop the innovative approach and method. Each stakeholder needs to agree on its particular role.
8. Collaboration between public and private sector. Conceptual interoperability for logistics requires collaboration of all relevant stakeholders: authorities, logistics enterprises and IT service and solution providers. IT service and solution providers for instance need to assure that the solution is technical feasible. Logistics enterprises have to see a clear business case for this innovative approach and its capabilities for business innovations. The latter mostly refers to business innovation by data sharing. Logistics information services are already identified to address this issue (see platform functionality).
9. Initial development. Subgroup 2 of the DTLF could already work on further development and application of the proposed approach to the chosen corridor.

Subgroup 1 could develop the approach further by modelling electronic Waybills like eCMR, representing a particular state of logistics.
The current structure of the logistics sector, investments in current (legacy) systems, and business models of individual stakeholders are considered as important barriers to such an innovative approach. Early adopters have to be identified that are willing to consider their role and business model to be able to innovate and deal with new entrants. EC DG Move Digital Transport and Logistics Forum can develop this systems approach based on conceptual interoperability based on the two use cases mentioned, namely the Scan-Med corridor and the electronic Waybills.

C.3 Platform functionality

Platform functionality is expressed by the services those platforms provide to their customers. These will be called Platform Services and can be classified in accordance to the three layered architectural model of TOGAF, supported by Archimate. The classification is:

- **Technical Services**: services provided by technical components like communication, data storage, and Application Programming Interface (API) management. At this level, syntactic correctness and data types are validated.
- **Application Services**: services of IT applications for data sharing like a registry of users with their capabilities, transaction support services and services for dynamic planning of logistics chains. Application services utilize underlying Technical Services.
- **Logistics information Services**: services to support logistics processes like visibility, agility, resilience, marketplace services and booking services. These are relevant end-user services. Logistics Services utilize application services.
- **Supporting Services**: these services support the operation of a platform like monitoring, billing identification and authentication, and connection services.

  The next figure presents an overview of potential services according their layered classification.

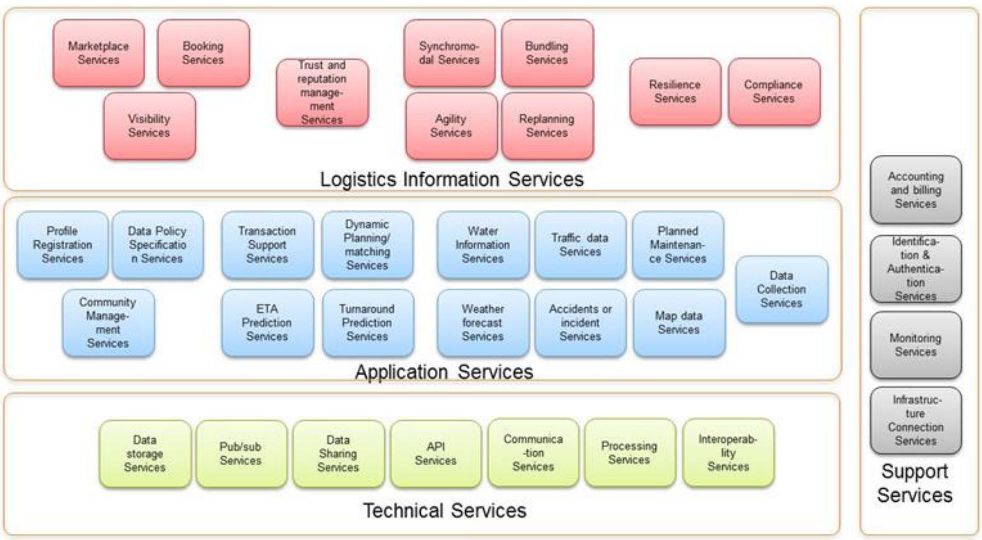

Figure 31: Services

Based on these services, the following types of platform providers can be distinguished:

1. Integration Platform Providers (horizontal platforms): these platforms provide Technical Services like Data Sharing with messages and/or alerting based on a publish/subscribe mechanism (Pub/Sub Service), Interoperability Services (data transformation) – and Communication Services. They will have their own Identification and Authentication -, Monitoring - , and Accounting and Billing Services.
2. Logistics Platform Providers (vertical platforms): these types of platforms provide one or more Logistics Information Services. These types of platforms are called vertical platforms, since they provide one (or more) Logistics Information Services and all required services of the other categories. The following distinction is made:
    a. Logistics Marketplaces are examples of two-sided platforms.
    b. Booking and visibility platforms: these platforms provide capabilities of booking transport for particular legs (e.g. sea transport), particular type of cargo and provide visibility of individual bookings.
    c. Visibility Platforms: these platforms only provide visibility services for particular shipments or objects like a container, barge, or a railway wagon.
    d. Registry Platforms: it concerns platforms specifically focussing on user registration with their capabilities.
    Logistics marketplaces and bookings – and visibility platforms mainly support matching one goal with one capability resulting in one transport leg, although algorithms have been developed for composing a chain of several transport legs for one goal ((dynamic) chain composition). These algorithms are not yet provided by (commercial) platforms. We also see the developement of ETA Prediction Services by specific platforms.
3. Platform Deployment Providers: providing Technical Services with an underlying technical platform for developing and deploying particular Logistics Information Services. These deployment providers mainly focus on particular user communities like in a port or airport.
4. Platform Component (Providers): either open source software components or Commercial Of The Shelve (COTS) software solutions. Various implementation partners are able to develop a horizontal or vertical platform based on these components. The following sub-categories are identified

a. Integration components: API management platforms and/or Enterprise Service Busses (ESB). Open source components utilize for instance standard protocols for Data Sharing like the defacto standard for Message Queueing.
b. FiWare: the Public Private Partnership (PPP) Future Internet (a collaboration of the EU software industry, end-users and the European Commission) led by ATOS Research developed a set of open source components (FiWare) that can be used to develop a platform.
c. CEF Building Blocks: the Europese Commissie has developed the so-called Connecting European Facilities (CEF) building blocks for interoperability interoperability between enterprises and citizens with EU authorities. eDelivery is an example of such a building block for reliable and secure data transfer with messaging according the electronic business Messaging Service (ebMS) standard. eIDAS provides a mechanism to enterprises and citizens for utilizing one identification mechanism for all EU authorities.
d. Bundling Components: these software components provide the capability to develop and deploy bundling of cargo flows and transport capacity. They are also called ‘Cross Chain Collaboration Centers’.

e. (Dynamic) chain composition algorithms: these algorithms require available capacity and LSP services to be able to (dynamically) compose a transport chain. They lack sufficient data to provide for instance Synchromodality Services.

These platforms may have identical functionality, but they are not necessarily interoperable. For instance, they support particular message implementation guides that are not supported by other platforms. Interoperability amongst these platforms is established on a bilateral basis, it also includes roaming agreements and potentially the re-use of identification schemes.

APPENDIX D: GLOSSARY

5G	Fifth generation standard for cellular (wireless) communication; focusing on improved speeds, more reliable connections and better support for all sorts of wireless data applications
AIS	Automatic Identification System; digital radio-beacon used on vessels to broadcast data on their position, heading and vessel-characteristics
ATA	Actual Time of Arrival
BICS	Binnenvaart Informatieen CommunicatieSysteem - tool for electronic reporting
CCNR	Central Commission for the Navigation of the Rhine
CEF	Connecting Europe Facility; European funding scheme for infrastructure investments
CESNI	Comité européen pour l'élaboration de standards dans le domaine de la navigation intérieure; standardization body initiated by the CCNR
Cloud	Software and data storage deployed using online service managed, by a service provider, instead of deploying it on-premises in a data center
COMCIS	Collaborative Information Services for Container Management - European FP7 research project
COMEX	RIS Corridor Management Execution - CEF funded project
CORE	Consistently Optimised REsilient ecosystem - FP7 research project on supply chains and information exchange
CoRISMa	RIS enabled Inland waterway Transport Corrdidor Management - innovation project
Corridor management	Traffic management in a transport corridor
DATEX II	Standardized information model for road traffic and travel information in Europe
DINA	Digital Inland Waterway Area
DMN	Digital Multimodal Nodes
DSM	Digital Single Market strategy of the European Commission
DTLF	Digtal Transport & Logistics Forum of the European Commission
ECDIS	Electronic Chart Display Information System; used to support navigation
ECQD	European Crew Qualifications Database; currently being set-up as a shared European database to register skills certificates
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport

EHDB	European Hull Database; a shared European database containing unique identifiers and basic characteristcs of all vessels
e-IWT	Electronic toolkit for Inland Waterway transport
ENC	Electronic Nautical Chart
ERDMS	European Reference Data management system; shared database containing codelists and unique identifies of infrastructure objects
ERI	Electronic Reporting International; standard for electronic reporting
ERP	Enterprise Resource Planning; software for financial and operational planning of organizations
ETA	Estimated Time of Arrival
FIS	Fairway Information Service; online information portal for providing information on fairway conditions
FP7	7th Framework Programme; European programme for innovation and R&D, succeeded by Horizon 2020
H2020	Horizon 2020; European programme for innovation and R&D
IoT	Internet of Things; technological trend regarding the connection of all sorts of devices and sensors to the internet, not just traditional computers and handheld devices
ISO	International Standards Organization; formal standardization body
IVU	In-vessel unit; part of the e-IWT concept
IWC	IWT workers card; digital card containing worker qualifications - part of the e-IWT concept
IWT	Inland Waterway Transport
LSP	Logistics Service Provider ; a company providing logistics services such as planning, coordination, transport and warehousing.
MRP	Materials Resource Planning; supply chain management concept relating to expected amount of required materials
Multimodality	The usage of multiple modalities (waterways, road and/or rail) for arranging transport
NAIADES	European Action Programme aimed at moving more freight transport onto inland waterways
NtS	Notices-to-skippers; RIS technology to inform skippers about fairway conditions (e.g. blockages)
Physical Internet	Future logistics concept based on extensive use of digital technologies, smart hubs and self-organization
PIANC	Permanent International Association of Navigation Congresses; world association for waterborne transport infrastructure
RIS	River Information Services
SCM	Supply Chain Management
SME	Small and Medium-sized Enterprises
STI	Strategic Traffic Information; possible RIS service

Synchromodality	Logistics concepts whereby logistics choices are made based upon real-time data of cargo destinations, infrastructure conditions in multiple modalities and availability of logistics services.
TEN-T	Trans-European Transport Network
TMS	Transport Management System; software used by a transport operator to plan and monitor his operations
TOGAF	The Open Group Architecture Framework; framework used for the designing and managing information technology based on the principles of Enterprise Architecture.
TOS	Terminal Operating System; software used by a terminal operator to plan and monitor his operations
TTI	Tactical Traffic Information; possible RIS service
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business; organization focusing on trade faciliation procedures and electronic business
UN/ECE	United Nations Economic Commission for Europe; organization to encourage economic cooperation
UN/TDED	United Nations Trade Data Element Directory; ISO standardized information model for trade documents
VHF	Very High Frequency radio; voice communication between vessels and on-shore actors using wireless equipment
VTS	Vessel Traffic Services; possible RIS service
VTT	Vessel Tracking and Tracing; possible RIS service based on AIS (positioning) data
XML	Extensible Markup Language; technology providing a syntax/structure for electronic data exchange

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