



# PIANC

The World Association for Waterborne  
Transport Infrastructure

## GUIDELINES AND RECOMMENDATIONS FOR RIVER INFORMATION SERVICES



**InCom Permanent RIS Working Group Report 246 – 2023**

# **PIANC PERMANENT RIS WG 246**

INLAND NAVIGATION COMMISSION

## **GUIDELINES AND RECOMMENDATIONS FOR RIVER INFORMATION SERVICES**

October 2023

PIANC has Technical Commissions concerned with inland waterways and ports (InCom), coastal and ocean waterways (including ports and harbours) (MarCom), environmental aspects (EnviCom) and sport and pleasure navigation (RecCom).

This report has been produced by an international Working Group convened by the Inland Navigation Commission (InCom). Members of the Working Group represent several countries and are acknowledged experts in their profession.

The objective of this report is to provide information and recommendations on good practice. Conformity is not obligatory and engineering judgement should be used in its application, especially in special circumstances. This report should be seen as an expert guidance and state-of-the-art on this particular subject. PIANC disclaims all responsibility in the event that this report should be presented as an official standard.

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ISBN 978-2-87223-033-4

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# PIANC PERMANENT RIS WORKING GROUP

The 'PIANC Guidelines and Recommendations for River Information Services' (Edition 2023) have been produced in meetings of Working Group 246 (formerly known as WG 125) between September 2019 and December 2022 in Lyon, Vienna, Hamburg, Berlin, Washington DC, Ghent, and online. The contributors to the PIANC RIS Guidelines 2023 are: Gerald Thornberry, Patrick Barger, Daniel McBride, and Brian Tetreault (USA); Jürgen Trögl, Katrin Steindl-Haselbauer, Mario Sattler (Austria); Birgitta Schäfer (Germany); Jan Bukovsky (Czech Republic); Raphaël Le Guillou (CCNR); Alaric Blakeway (France); Alexey Lyashenko (Ukraine); Piotr Durajczyk (Poland); Csaba Kovacs and Robert Rafael (Hungary); Cas Willems, Jeffrey van Gils, and Michael Schreuder (the Netherlands); Yang Shengfa and Zhang Peng (China); Pedro Vila and Alvaro Ortego (Spain); Evgeni Brodsky (Russian Federation); and Piet Creemers, Dierik Vermeir, and Jannes Verstichel (Chair, Vice-Chair and Secretary; Belgium).

We also remember our dearly departed members Lea Kuiters and Igor Gladkykh and cherish the memories we shared with them.

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# 1 MANAGEMENT SUMMARY

River Information Services (RIS) is the concept for information services in inland navigation to support traffic and transport management, including interfaces to other transport modes. The potential for RIS to improve the position of inland navigation within the transport chain was first recognised in the early 2000's by international organisations. PIANC established a Working Group in 2002 that developed the 'Guidelines and recommendations for River Information Services'. In 2004, the first revision of these guidelines was drafted and published, with subsequent updates in 2011 and 2019. This edition continues building upon the original Guidelines and its updates, while extending the scope towards future developments which might impact RIS.

While RIS developments, and these Guidelines, were initially a European story, the overarching concept of facilitating information exchange to support traffic and transport management in inland navigation has found its way throughout the world: River Information Services are in an implementation stage in North and South America, Africa, Europe and Asia. Given the increased traction of RIS beyond its cradle in Europe, these Guidelines have purposely evolved towards worldwide applicability, facilitating competent authorities all over the world in their different stages of exploring, implementing, and extending RIS.

In the coming decade, Inland Navigation and River Information Services face many new challenges and opportunities with respect to climate change, digitalisation, automation, and the multimodal transport arena. Based on these challenges and opportunities this document provides insights, recommendations, and guidelines for River Information Services anywhere in the world. While part of the information is focused on readers that are taking their first steps in (the implementation of) RIS, this report also provides ample insights for experienced readers looking to extend their (knowledge of) RIS and possible future RIS developments.

These Guidelines start with an introduction, including the history of RIS and the PIANC 'Guidelines and Recommendations for River Information Services', and the focus of the 2023 update to the Guidelines. The concept of synchromodality for Inland Waterway Transport is introduced, and relevant trends and developments listed. Moving back to the basics of RIS, the objectives of RIS, RIS stakeholders, and their information needs are defined next, including a mode-agnostic phrasing of some RIS information categories.

A framework for Operational and Technical Services based on the overarching e-Navigation architecture from IMO MSC.1/Circ.1595 is introduced. This framework provides a condensed overview of the different aspects involved in RIS, while also further facilitating the harmonization between inland waterway transportation and maritime sector.

These Guidelines also provide a decomposition of the basic RIS Operational Services into RIS functions. These can be used as a guide for those who have a responsibility to plan and implement RIS Operational Services. In addition to the introduction of novel RIS functions, the scope of several existing RIS functions is also clarified.

The recommendations for the implementation of RIS are of course an essential part of these Guidelines. Both general recommendations and specific recommendations for Operational Services, Technical Services and RIS enabled corridor management are provided. These recommendations should not be interpreted as an exhaustive or prioritised list, but rather as an

overview of many important aspects related to the implementation of RIS and corresponding recommendations. They may provide first insights for readers contemplating RIS implementation, a helpful tool for competent authorities responsible for the implementation of (specific aspects of) RIS, and a reference for experienced readers who are extending RIS.

These Guidelines end with several developments that may affect the planning, implementation, and operation of RIS, as well as annexes that focus on data quality (an important aspect of successful RIS implementations that is often overlooked), synchromodal trends and developments, and details on formal standards supporting RIS Technical Services and globally specified reference data.

This report is not meant to be used as-is for implementation in legislation nor as a reference document for definitions (which was done with the earlier versions of the 'PIANC Guidelines and Recommendations for River Information Services').

## 2 INTRODUCTION

### 2.1 The Evolution of RIS and the PIANC RIS Guidelines

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

The potential of RIS to improve the position of inland navigation within the transport chain was first recognised in early 2000 by international organisations including the United Nations Economic Commission for Europe (UNECE), the Central Commission for the Navigation of the Rhine (CCNR), the Danube Commission, and PIANC, the World Association for Waterborne Transport Infrastructure. PIANC established a Working Group in 2002 that developed the 'Guidelines and Recommendations for River Information Services'. The Guidelines are still an important pillar in the implementation of River Information Services. In 2004, the first revision of these guidelines was drafted and published, and updates were published in 2011 and 2019.

With the support of several EU Member States, the European Commission took the initiative of issuing a directive on RIS, which came into force in 2005. The PIANC RIS Guidelines, revision 2004, are one of the basic regulations<sup>1</sup> of this Directive<sup>2</sup>.

The RIS Directive puts requirements to the EU Member States to implement several basic Operational Services and standardised Technical Services in their parts of the waterway network. In the overall European context, the development and formalisation of RIS were seen as **the** example for other transport modes to move towards a successful implementation of traffic and transport information services. In the domain of inland navigation, it was also recognized as an important step in cross-border information exchange. In 2021 an evaluation of this RIS Directive was made showing its continued relevance in ensuring harmonised and standardised RIS implementations in Europe. However, the evaluation also showed differences in the degree of standardisation and implementation, which were found to be due to a lack of monitoring, a slow implementation of RIS, and a slow update cycle for updating technical

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<sup>1</sup> Commission Regulation (EC) No 414/2007 of 13 March 2007.

<sup>2</sup> Directive 2005/44/EC of the European Parliament and of the Council of 7 September 2005 on 'Harmonised River Information Services (RIS) on Inland Waterways in the Community'.

standards. Combined with the limited links to other transport modes and inefficiencies in data exchange between Member States, it was decided to initiate an impact assessment with the goal of creating a revision of the RIS Directive.

Aside from being an important part of the RIS Directive, the 'PIANC Guidelines and Recommendations for River Information Services' are also the basis for the RIS Guidelines as formally accepted by the CCNR and the European Commission. The document also became a basis for UNECE Resolution No. 57 on 'Guidelines and Recommendations for River Information Services' (TRANS/SC.3/165). CCNR published the RIS Guidelines (update 2011) based on CCNR protocol 2003-I-22.

Since the first initiatives of the European Commission on River Information Services, the overarching concept of facilitating information exchange to support traffic and transport management in inland navigation has found its way throughout the world. Currently, River Information Services are in an implementation stage in North and South America, Africa, Europe and Asia. Given the increased traction of RIS beyond its cradle in Europe, the 'PIANC Guidelines and Recommendations for River Information Services' have purposely evolved towards a worldwide applicability, facilitating competent authorities around the globe in their different stages of exploring, implementing, and extending RIS.

In the United States of America, the U.S. Army Corps of Engineers (USACE), in cooperation with the U.S. Committee on the Marine Transportation System (CMTS), recognised RIS and incorporated the RIS concept into the national e-Navigation strategy. Under USACE leadership, the implementation of RIS on the U.S. inland waterways network has progressed significantly.

Especially in the last decade the implementation of RIS has gained momentum with the emergence of national and international portals providing RIS information to the Inland Waterway Transport (IWT) community and commercial parties. An important milestone is the 2022 rollout of EuRIS: a single web portal seamlessly combining the River Information Services of 13 European countries. This was an important step in bringing RIS enabled Corridor Management into practice.

Alongside the RIS implementations, there has also been a growing awareness of the importance of standardisation and (intra-modal) harmonisation. The update of RIS terminology from RIS Services and Key Technologies to RIS Operational and Technical services respectively in the 2019 Guidelines was an important step in harmonising RIS with the maritime sector. In Europe, the European Committee for drawing up standards in the field of Inland Navigation (CESNI) created an additional permanent working group on Information Technologies which was tasked to develop and update a European standard for river information services called ES-RIS (European Standard for River Information Services). The first edition of this unified standard, which aims to improve the harmonisation of the terminology but also to coordinate efforts and ensure consistency for all RIS Technical Services at the European level, was released in 2021 with a first update published at the end of 2022. Furthermore, the commitment of CESNI to release a new edition of ES-RIS every two years provides planning certainty that is helpful to all stakeholders. ES-RIS largely refers to the 'PIANC Guidelines and Recommendations for River Information Services', especially for definitions. ES-RIS is envisioned to play a major role in the legal framework of the European Union and the CCNR.

With the early stages of RIS-enabled Corridor Management being implemented, the Permanent INCOM RIS WG felt it was time to expand the focus of RIS towards the connection with other transport modes, laying foundations that will help Inland Waterway Transportation flourish in a synchromodal<sup>3</sup> world.

## **2.2 The PIANC Guidelines and Recommendations for River Information Services – Edition 2023**

In the coming decade, Inland Navigation and River Information Services face many new challenges and opportunities in multiple areas. Climate change is driving a move towards transport decarbonisation. It also has a direct impact on IWT with lengthening periods of draught causing low-water conditions and more intense periods of rainfall causing high-water conditions and floods. All transport modes are making a shift towards digitalisation and automation, increasing the importance of reliable, accurate and precise data and information services. The concepts of 'synchromodality' and the 'physical internet' require a connected, multimodal network where each mode is able to process transport needs and requests, as well as provide feedback on available capacity, timing, etc.

To make the inland waterways a valuable and trusted link within a digitised, multimodal, climate change resilient network, different challenges need to be tackled and opportunities exploited:

- Geographical upscaling (worldwide coverage): River Information Services will need to interconnect different stakeholders within a waterway network. Consequently, transboundary networks will require connecting stakeholders across borders. Corridor management, the cross-border, coordinated management of one or more waterways, has proven to be more efficient than one that is nationally or regionally focused.
- Synchromodal-ready: Once these international waterway networks are able to offer Operational and Technical Services, interconnection with other transport modes will be required. By exchanging knowledge, experiences, ideas, technologies, terminologies, and lessons learnt, these different transport modes can converge to a similar approach and framework. A worldwide elaboration and harmonisation of the above-mentioned services, is a necessity to realize a transparent, global, synchromodal network.
- Future-proof: New technologies will enable new applications in the areas of infrastructure and vessels, including data and information service requirements. At the same time, new technologies will place additional requirements on existing technical and Operational Services. These services must be designed to be scalable and flexible enough to accept potential future expansion of requirements and uses, harmonized over the different transport modes and continents. Furthermore, the data quality requirements for RIS will need to increase in order to meet the needs of these new applications. In the specific case of the path towards autonomous vessels, this may be addressed within the concept and

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<sup>3</sup> See 3.1.

framework of Smart Shipping<sup>4</sup>. RIS developments must be closely aligned with the Smart Shipping concept.

- **Sustainable:** The transition to clean, renewable, and low-carbon fuels will create new information needs on refuelling infrastructure and its availability. New shallow-draught vessel designs, or multiple small vessels sailing as a single entity, are possible examples of ways to overcome issues with extreme water conditions and allow a further penetration of the inland waterway network. However, these may have new information needs. An increased market share for inland waterway transportation may lead to unacceptable sound and light pollution from vessels or inland ports, as well as competition for space with other waterborne activities and nature. Digitalisation and optimisation can play an important role in increasing overall efficiency, enabling a sustainable balance between IWT and all other waterborne stakeholders.

One can conclude the role of RIS is still focused on safety, efficiency, and environmental-friendliness, but faces the opportunities and challenges of upcoming technologies, concepts, and the multimodal transport chain.

Based on these developments this document provides insights, recommendations, and guidelines for River Information Services. While part of the information is focused on readers that are taking their first steps in (the implementation of) RIS, this report also provides ample insights for experienced readers looking to extend their (knowledge of) RIS and possible future avenues for their RIS developments.

## **2.3 Reading Guide for this Document**

The 'PIANC Guidelines and recommendations for River Information Services' – Edition 2023 have been reorganised substantially from the 2019 ones. This reorganisation was necessary due to the changes in content, scope and focus. Below is a brief summary of the contents of the document:

Chapter 2 provides an introduction, including the history of RIS and the PIANC Guidelines, the focus of the 2023 update to the Guidelines, and this reading guide.

Chapter 3 introduces the concept of synchromodality for Inland Waterway Transport and lists relevant synchromodal trends and developments.

Chapter 4 defines the objectives of RIS, RIS stakeholders, and their information needs. The chapter introduces new stakeholders and proposes a mode-agnostic rephrasing of some RIS information categories.

Chapter 5 introduces a framework for Operational and Technical Services, based on the overarching e-Navigation architecture from IMO MSC.1/Circ.1595. This framework provides a condensed overview of the different aspects involved in RIS, while also further facilitating the harmonisation of inland waterway transportation and the maritime sector.

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<sup>4</sup> See the PIANC WG 210 report for more information: <https://www.pianc.org/publications/inland-navigation-commission/wg210>.

Chapter 6 provides a decomposition of the basic RIS Operational Services into RIS functions. It is intended to be used as a guide for those who have a responsibility to plan and implement RIS Operational Services. In addition to the introduction of a few new RIS functions, it clarifies the scope of several existing RIS functions.

Chapter 7 describes recommendations for the implementation of RIS. It contains both general and specific recommendations for Operational Services, Technical Services, and RIS-enabled corridor management. The chapter should not be interpreted as an exhaustive or prioritised list of recommendations, but rather as an overview of all important aspects related to the implementation of RIS and corresponding recommendations. The chapter may provide first insights for readers contemplating RIS implementation, a helpful tool for competent authorities responsible for the implementation of (specific aspects of) RIS, and a reference for experienced readers who are extending RIS.

Chapter 8 considers several developments that may affect the planning, implementation and operation of RIS. The further harmonisation of RIS, S-100 and e-Navigation is an important topic here. Likewise, Cybersecurity is increasingly more important as IWT becomes more digitalised. It should be addressed from an IWT point of view. Mobility data spaces are envisioned to play an important role in connecting the different transport modes.

**Annex 1** focuses on guidelines for data quality (management), an important aspect of successful RIS implementations that is often overlooked.

**Annex 2** contains an overview of relevant synchromodal trends and developments, both from within IWT and from other transport modes.

**Annexes 3** through 7 detail formal standards supporting RIS Technical Services and globally specified reference data.

### **3 SYNCHROMODALITY FOR IWT**

Human activities are continually affected by global factors including anthropogenic climate change, pandemics, and the introduction of disruptive technologies such as automatisisation and digitalisation. Public and private entities alike must make their business processes more resilient and, if possible, take preventive action to minimise the impact of such changes.

Prominent statements regarding climate change have been made by different governmental bodies by elaborating 'green deals' with actions defined in different domains like industry, energy, agriculture, etc. and transport. To be able to meet the goals defined in policy documents (e.g. by the European Commission or the Mannheim declaration published by CCNR) mobility needs to be sustainable, smart and resilient. There is an important role to be fulfilled by Inland Water Transport and River Information Services towards these goals:

- **Sustainable:** Increasing the share of IWT automatically leads to more sustainable transport and, even more so, with the efforts to make IWT itself more sustainable.
- **Smart:** The full potential of data needs to be unleashed. Freight transport needs to be paperless, and automated transport will need to be deployed on a large scale.
- **Resilient:** A fully multimodal transport network for sustainable and smart transport needs to be operational.

In recent years, some new concepts were born in the fields of transport and logistics, looking to optimise the whole transport chain and tackle the challenges defined within the 'green deals'. Of particular note is the concept of the Physical Internet. If we are able to translate the principles of the Digital Internet, i.e. the transport of (data) containers (aka packets) over a network in an optimal and orchestrated way, to a Physical Internet (PI) we could have the same benefits in real life when transporting (goods) containers over a transport network of different transport modes. The principle behind the Physical Internet is based on the idea of synchromodal transport (for which a description is elaborated in Section 3.1). Since the concept of the Physical Internet requires a very highly-automated infrastructure integrated with an intelligent infostructure (digital infrastructure) to orchestrate the whole transport chain, its operational phase is foreseen by some organisations around the year 2040. Although this horizon is quite far away, governmental and private bodies are already preparing themselves to make the transition as smooth as possible.

While private companies are looking towards Industry 4.0 to tackle the upcoming challenges, the governmental bodies are making investments in both digital and automatization initiatives like River Information Services, Intelligent Transport Systems (ITS), e-Navigation (e-Nav), European Rail Traffic Management System (ERTMS), RAILWAY 4.0, etc.

Indeed, preparing RIS for synchromodal transport should enable IWT to meet current and future challenges and opportunities while increasing its role as a reliable link of the transport chain.

This requires a clear description of synchromodality for IWT in order to clarify its different aspects, including necessary nuances.

### 3.1 Description of Synchromodality

The Permanent INCOM RIS WG has elaborated a description of Synchromodality for IWT. It considers synchromodal transport to be:

***“The most efficient and appropriate transport solution in terms of sustainability, transport costs, duration, and their reliability, in which the configuration of the transport chain is not static during transport, but is flexible, being able to adapt the mode of adequate transport according to the conditions in real time of infrastructure and capacity, through collaboration and the exchange of information in real time of all modes of transport, the terminal facilities and the actors involved in the transport logistics chain.”***

It should be noted that this is a description and not a formal definition.

### 3.2 Synchromodal Trends and Developments

A thorough study and analysis of trends and developments towards synchromodality is provided in Annex 2. The main conclusions of this analysis towards the requirements for Synchromodality are provided below:

- Collaboration, trust, and transparency: Commercial companies can be reluctant to cooperate with competitors and to share data. Efforts must be made in communications with all stakeholders to raise the awareness of the importance and benefits of data sharing and collaboration with the incentive of a potential win-win situation. Neutral platforms

providing a safe environment for matching transport needs with transport capacity will be important facilitators. Transparency can ease the acceptance of and increase trust in the complex transport solutions required for synchromodality and avoid greenwashing.

- Sustainability: Transport should be sustainable (ecologically, economically, and socially).
  - A holistic view on economic aspects is needed to balance the internal need for business profitability with the necessity to minimise external costs (e.g. economy of scale leads to increasing weights in road transport, causing damage to road infrastructure, and especially bridges, leading to increased public spending).
  - A shift to environmentally friendly propulsion is needed to reduce the carbon footprint of each means of transport (e.g. hydrogen propulsion using durably created hydrogen fuel). Zero- and low-emission transports, availability of, and information on, charging and refuelling infrastructure will be essential. While IWT is, by its nature, an environmentally-friendly mode of transport due to its energy-efficiency and transport network largely based on natural rivers, it should not delay its transition to zero- and low-emission propulsion.
  - The social impact of (long distance) transport should be considered. The lack of infrastructure (e.g. parking spaces, sanitary installations, etc.) for operators in long distance road transports is a known issue. Long distance transport should be shifted to alternative modes such as IWT and railway transport wherever feasible. Short distance transport could make use of new city logistics.
- Network: The networks of the different transport modes need to be connected via intermodal hubs. Network (or, at the absolute minimum, corridor) management is needed to provide traffic and transport services addressing all parties in the supply chain.
- ICT/ITS technologies: High-quality, standardised, and machine-readable data, available in real-time, is considered a key for multi- and synchromodality. The push towards autonomous transport will require standardised vehicle-to-vehicle and vehicle-to-shore communication and protocols.
- Sophisticated planning and pricing: Sophisticated planning and simulation, including demand mapping and forecast tools, will help solve the complex puzzle of real-time multimodal transport, while also enabling increased sustainability within any single mode. Sophisticated pricing models capturing the dynamic factors determining service pricing will be needed to allow reliable cost estimations. Big data analysis can provide a solid foundation for sophisticated planning and pricing models.
- Physical infrastructure: The location of production sites, ports, terminals, and their connection by transport routes influences the potential for efficiently bundling transport flows and changing modes. The presence of a transport mode at multimodal hubs is a prerequisite for the consideration in transport decisions.
- Awareness and mental shift: The decision for transport modes and routes will move from the cargo owners to independent service providers and platforms for synchromodal transport. Only basic framework conditions such as departure, destination, latest time of arrival, and sustainability requirements will be expected from the customers.

- Legal and political framework: Harmonised transport regulations constitute the basic framework for a functioning synchromodal network. The implementation of an appropriate legal framework in the transport corridors and networks of each mode is crucial, as is the clarification of liability issues.

## 4 RIVER INFORMATION SERVICES, OBJECTIVES, STAKEHOLDERS AND INFORMATION NEEDS

### 4.1 River Information Services and its Objectives

**River Information Services is formally defined as the concept for information services in inland navigation to support traffic and transport management, including the interfaces to other transport modes.<sup>5</sup>**

RIS strengthens inland waterway transport as a sustainable transport mode. It improves the competitiveness of inland navigation and contributes to the overall goal of making inland navigation a safe, secure, efficient, and environment-friendly link in the logistic chain<sup>6</sup>.

The specific objectives of River Information Services are providing information to:

- (1) Make inland navigation a *reliable, plannable, and transparent* transport mode in the multimodal transport chain.
- (2) Contribute to *safety* of traffic and transport by:
  - Reducing traffic and transport incidents and accidents
  - Reducing injuries
  - Reducing fatalities
  - Providing information for law compliance and statistics
- (3) Contribute to *efficiency of traffic and transport* by:
  - Optimising the use of the capacity of waterways and prevention of traffic congestion
  - Optimising the carrying capacity of vessels
  - Enabling just-in-time transport through improved travel time predictability
  - Reduction of travel times and waiting times
  - Reducing the workload and increasing situational awareness of RIS users
  - Reducing transport costs

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<sup>5</sup> Based on the definition in the RIS-directive 2005/44/EC.

<sup>6</sup> In 2011, the European Commission adopted its White paper 'Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System'. The White paper gives a vision for a competitive and resource efficient transport system and defines goals to be reached stepwise in the years 2030 and 2050. Regarding RIS the White Paper calls for the deployment of transport-related information and communication technology to ensure improved and integrated traffic management and to simplify administrative procedures through improved freight logistics, cargo tracking and tracing, and optimised schedules and traffic flows. With respect to the contribution to environmental friendliness it can be stated that RIS contributes to the United Nations Strategic Developments Goals on actions to combat climate change.

- Reducing fuel consumption
- Improving the efficiency of harbours and terminals

(4) Contribute to *environment-friendly* transport by:

- Reducing environmental hazards
- Facilitating smooth flow of traffic
  - Reducing/detecting polluting emissions (in particular CO<sub>2</sub>) and spills due to accidents, illegal actions or normal operations
  - Facilitating the usage of alternative fuels
  - Supporting a modal shift towards IWT

These objectives should be met under the constraints that RIS is supplied in a manner that is **reliable, cost efficient, and legally sound**.

Internal activities between one or more involved companies (Business to Business) are outside the scope of RIS but can be supported by RIS which is open to interfacing with business activities (Business to Government, Government to Business). River Information Services are provided by fairway authorities to:

- other fairway authorities
- waterway users
- related logistic partners
- other RIS stakeholders

Depending on the national allocation of responsibilities, River Information Services are in the jurisdiction of local, regional, or national authorities.

RIS and the RIS systems and applications collect, process, assess, and disseminate (in a harmonised way) fairway, traffic, and transport information. It is essential that, on a high level, this fairway, traffic, and transport information is harmonised worldwide. This is made possible through an internationally-approved framework for RIS as described in these guidelines and, to the extent possible, international standards for technology and data exchange.

The RIS objectives serve RIS stakeholders. Therefore, it is essential to identify these stakeholders and their information needs.

## 4.2 RIS Stakeholders

The inland navigation sector consists of many parties including national authorities, port authorities, vessel owners, skippers, providers of nautical services, customs authorities, international organisations, etc. There are also many other stakeholders which become increasingly important on the path towards a synchromodal-ready IWT such as logistics service providers, operators of multimodal hubs, traffic service providers, etc. Achieving the objectives of RIS very much depends on the information needs of the stakeholders and interactions between these parties across national, organisational, and modal borders. Hence, these Guidelines will describe generic solutions.

These Guidelines will not consider how stakeholders are organised, as this may vary in different regions, countries, modes, and organisations.

These Guidelines will focus on general recommendations for the implementation of RIS, taking into account international and national agreements and regulations.

The following categories of stakeholders can be differentiated:

- Consumers of services. Examples include waterway users like skippers, ship owners, lock operators, Vessel Traffic Service (VTS) operators, (multimodal) terminal and port operators, multimodal logistics service providers, traffic service providers, etc.
- Governmental, regulatory, and standardisation bodies. Examples include technical certification authorities, Competent Authorities for traffic management, and port authorities. This category also includes international bodies such as IMO, IALA, IHO, CCNR, UNECE, CESNI, and the European Union.
- Managers in inland navigation. Examples include fleet managers, waterway managers and water managers.
- Information providers. Examples include: waterway authorities and fairway authorities (fairway surveillance, VTS operators, lock operators, etc.)
- Service providers. Examples include RIS providers and rescue and emergency service providers.

The different stakeholder groups have their own *objectives* and requirements on the services, systems, and applications to be provided or used based on their *information needs*.

### 4.3 RIS Information Needs

Table 1 depicts information categories benefitting the potential stakeholders of River Information Services. In light of the reports' focus on synchromodal transport, the high-level information categories have been made mode agnostic wherever possible and sensible. This should make it easier to connect the RIS information needs and categories to information needs and categories from other modes.

Table 1 is organised in different information categories:

- Network & Infrastructure-related information:
  - Waterway-related information
  - Infrastructure-related information
- Vessel-related information:
  - Dynamic vessel information
  - Static vessel information
  - Convoy information
- Voyage & Cargo-related information
  - Voyage-related information
  - Cargo-related information
  - Passenger & Crew-related information
- Traffic-related information
  - Object-related Information
  - Fairway section-related information

An essential requirement from RIS users or service consumers is that the information is provided in a harmonised and standardised way throughout the entire inland waterway network or waterway corridors.

The personal data of RIS users, in particular skippers and crew, must be protected as a matter of ensuring users' trust and often a matter of law. The publication of personal data without consent of the data subject is not acceptable. Similar protections must be ensured for economically sensitive data.

RIS users or service consumers prefer that information they are required to submit should be able to be provided via a single entry of information during (international) voyages.

Information Category		Information need
1st	2nd level	
Network and Infrastructure-related	Waterway-related information	Navigation-based information on fairway and/or navigable water area
		Meteorological information
		Water level-related information
		Information on obstructions and limitations
		Information on navigation rules and regulations
	Infrastructure-related information	Information on land region
		Information on harbours and ports
		Information on terminals
		Information on locks and ship lifts
		Information on bridges
		Information on cables/pipes overhead and other special constructions
		Information on waste reception facilities
		Information on discrepancies between provided data and real-life situation
		Vessel-related
Information on vessel dynamics (i.e. RoT, velocity, CoG, SoG, etc.)		
Event based triggers for vessel position		
Static vessel information	Information on hull data	
	Information on vessel certificates	
Convoy-related information	Overall convoy information	

Voyage and cargo-related	Voyage-related information	Information on origin of voyage
		Information on intermediate discharge locations
		Information on route & voyage planning
		Information on voyage passage points
		Information on destination of voyage
		Information on date/ time of arrivals
		Information on date/time of departures
		Predicted deviation of the original voyage plan (of skipper) at defined points on the route (locks, crossings, berths) and terminals/ports
	Cargo-related data	Information on origin of cargo
		Information on destination of cargo
		Information on cargo details
		Information on loading units
	Passenger & Crew-related information	Information on number of persons (crew, passengers, etc.) on board
Details on persons on board		
Traffic-related	Object-related information	Information on facilities (berth/harbour/terminal)
		Information on bridge and lock chamber planning
		Information on operational status of locks and bridges
		Information on incidents with impact on traffic situation
		Information on actual passage time/duration at locks and bridges
		Information on predicted passage time/duration at locks and bridges
		Information on average passage time/duration for certain categories/certain vessel types
		Fairway section-related information
	Information on sailing time over a certain stretch for certain vessel classes per sailing direction	
	Information on incidents with impact on traffic situation	

Table 1: Information needs and information categories

## 5 FRAMEWORK FOR OPERATIONAL AND TECHNICAL SERVICES

The framework, or overarching architecture, for RIS Operational and Technical services is very similar to IMO's e-Navigation framework. Figure 1 (below) depicts the framework for RIS and is based on the figure that shows the overarching e-Navigation architecture in IMO MSC.1/Circ.1595. The figure is divided into four quadrants. The upper half represents the 'Information Domain', where information is presented to and provided by users. The bottom half represents the 'Data Domain' where the bits and bytes reside that form the technical representation of the information. On the left-hand side of the figure, the Ship-side is depicted with the shipboard users and onboard equipment, while on the right-hand side the Shore-side is visualised.

RIS Operational services provide information to the RIS stakeholders. A RIS Operational Service consists of one or more RIS Functions that provide information to the user by means of one or more Technical Services. A lot of the provided information comes from the shore-based

authorities (e.g. network and infrastructure-related information), but the shipboard environment is also an important information source (e.g. vessel-related information).

The information provided by Operational Services is generated by combining data elements, often from different sources, and applying logic (e.g. information on the estimated time of arrival combines the current location of the vessel with average travel durations on upcoming fairway sections and the expected passage duration at upcoming locks and bridges).

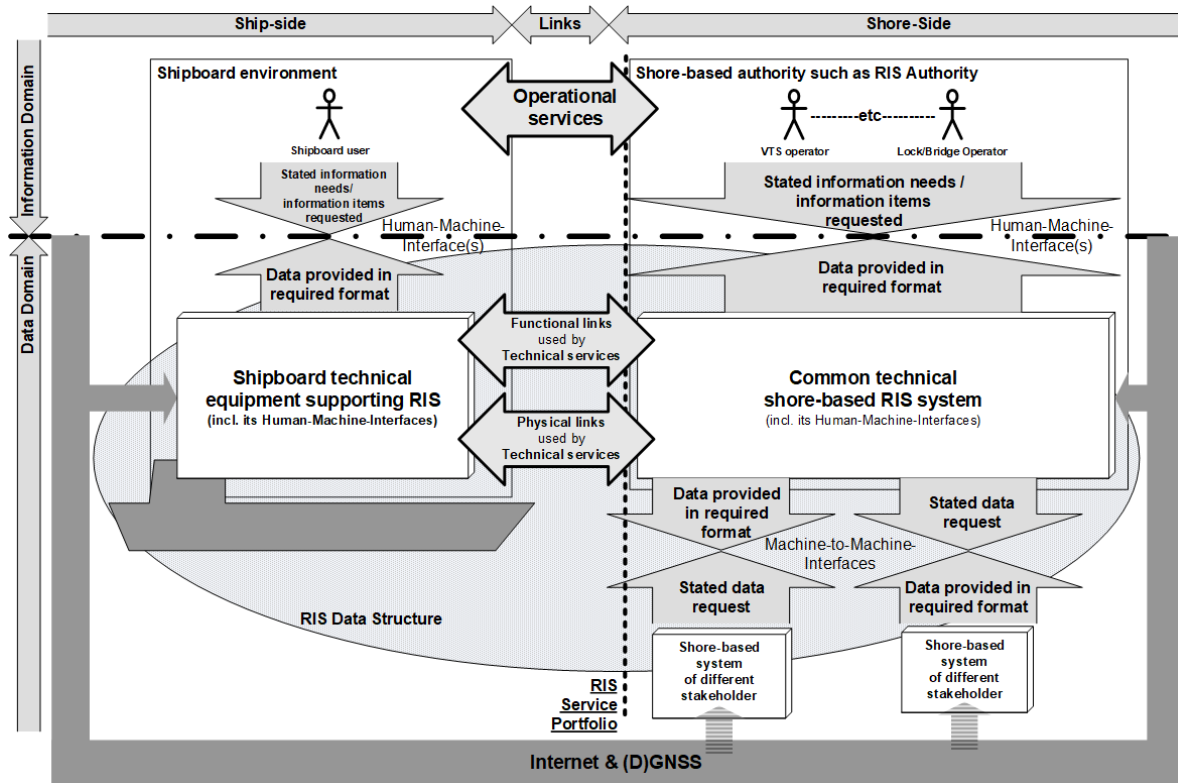


Figure 1: Overarching architecture of RIS (based on Overarching e-Navigation architecture from IMO MSC.1/Circ.1595)

The majority of Operational Services depend on the availability of the internet as a functional link. Technical Services provide a way to get data elements where they need to be using physical links (e.g. VHF radio waves) to establish a functional link (e.g. the Automatic Identification System, or AIS, network). As such, Technical Services and the internet together form the standardized links between shipboard technical equipment and the common technical shore-based RIS systems.

However, there are many other sources of data that can contribute to fulfilling the information needs of the RIS stakeholders, and there are also many shore-side RIS stakeholders with clear data needs that are not shore-based authorities. Using regular machine-to-machine interfaces (e.g. secured Application Programming Interfaces) this data can find its way from and to the shore-based systems of different stakeholders. While some of these machine-to-machine interfaces rely heavily on the specifications of Technical Services (e.g. ERI data exchange with seaports), many of them do not (e.g. endpoints for voyage and route computation).

Through standardisation and harmonisation, a common RIS Data Structure makes it easier to exchange the data elements via both Technical Services and the other machine-to-machine

interfaces, while the RIS Service Portfolio gives a clear view of the available Technical and Operational services in a specific area.

The actual position of vessels and buoys are of paramount importance for RIS. Indeed, Global Navigation Satellite Systems, or GNSS, (including terrestrial augmentation and/or backup systems where relevant) form the foundations on which the RIS Technical and Operational services are built, providing essential input to the majority of the components in the data domain.

Finally, it should be noted that the presented architecture is compliant with evolutions such as automated vessels. Although the Ship-side information domain will be absent for autonomous vessels or located on the Shore-side for remotely operated vessels, all parts of the architecture remain relevant and the data and information exchanged can remain the same.

## 6 RIS OPERATIONAL SERVICES AND FUNCTIONS

In this chapter the RIS Operational Services and underlying functions are elaborated. The explicit mapping of functions to Operational Services is not provided, because in many cases the implementing authority has the liberty to include or exclude specific functions in its Operational Services depending on the needs, geographical environment, network layout, traffic situation, digitalisation level, and other parameters.

### 6.1 RIS Operational Services

An Operational Service provides and uses information. It supports the user in accomplishing the task at hand. On a high level, the RIS Operational Services can be divided into:

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

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

- Tactical Traffic Information (TTI)

TTI is the Operational Service affecting the skipper's<sup>7</sup> or the VTS operator's immediate decisions with respect to navigation in the actual traffic situation and the close geographic surroundings. TTI contains position and specific vessel information of all targets detected by radar and presented on an electronic navigational chart, and is enhanced by external traffic information, such as the information provided by AIS. TTI may be provided on board a vessel or on shore, e.g. in a VTS.

- Strategic Traffic Information (STI)

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<sup>7</sup> Skipper on board or in a remote operation centre, systems controlling an automated vessel, etc.

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

**Traffic Management Information (TM)** are the Operational Services that support traffic management processes in inland navigation:

- VTS – Vessel Traffic Services  
Where VTS is a set of services implemented and provided in agreement with the IALA guidelines on Vessel Traffic Services for inland waterways. VTS is implemented by a Competent Authority, and is designed to improve the safety and efficiency of vessel traffic and to protect the environment.
- Lock and Bridge Management  
Lock and bridge management is the process of planning and operating bridges and locks.
- Traffic Planning Services  
The information process for optimizing the predictability and efficiency of the traffic flow on inland waterways.

**Information to support Calamity Abatement (CAS<sup>8</sup>)** are the Operational Services that facilitate the actions necessary to limit the consequences of a calamity (or accidents and incidents).

**Information to support Transport Logistics (ITL)** are the Operational Services that support transport logistic processes in inland navigation:

- Voyage Planning  
Voyage planning is the process of developing a complete detailed description of the journey of a vessel, from start to finish.
- Transport Management  
Transport management is the process of planning, organising, and executing the efficient movement of goods from one location to another.
- Port and Terminal Management  
Port and Terminal Management is the process of planning, organising, and executing the efficient ship and cargo handling within a port and terminal.
- Cargo and Fleet Management  
Cargo and Fleet Management is the process of planning, organising and executing the efficient handling of cargo and vessels in a transport company.

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<sup>8</sup> Calamity Abatement Support.

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

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

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

*Mainly traffic-related*

**1. Fairway Information Services (FIS)**

**2. Traffic Information Services (TIS)**

- a) Tactical Traffic Information (TTI)
- b) Strategic Traffic Information (STI)

**3. Information to support Traffic Management (TM)**

- a) Vessel Traffic Services (VTS) or local traffic management
- b) Lock and Bridge Management (LBM)
- c) Traffic Planning Services (TP)

**4. Information to support Calamity Abatement (CAS)**

*Mainly transport-related*

**5. Information to support Transport Logistics (ITL)**

- a) Voyage Planning (VP)
- b) Transport Management (TPM)
- c) Port and Terminal Management (PTM)
- d) Cargo and Fleet Management (CFM)

**6. Information to support Law Compliance (ILC)**

**7. Information to support Statistics (ST)**

**8. Information for Waterway Charges and Harbour Dues (CHD)**

*Table 2: RIS Operational Services*

## **6.2 RIS Functions**

In the previous sections and chapters, the high-level information needs of the RIS stakeholders were discussed and mapped on different information categories and the RIS Operational Services. In the current section these information needs are elaborated in more detail and mapped onto RIS functions. These RIS functions offer a framework for providing the information for which a need was identified in the RIS information needs. As such, it should be no surprise that there is a corresponding RIS function for each identified RIS information need.

These RIS functions are defined and presented in Table 3. The table is intended to be used as a guide for those who have a responsibility to implement RIS Operational Services.

Each function in the table provides a function number, the function number is related to the first level information category. As an example: V1 – Provide position information of vessels – has a primary relation to the category of vehicle/vessel-related information.

The table contains one more distinction apart from the one between 1<sup>st</sup> and 2<sup>nd</sup> level information categories and functions: All new RIS functions that were not in the 'PIANC Guidelines and Recommendations for River Information Services' from 2019 are printed in *italics* and marked with an asterisk '\*'.

It should be noted that new RIS functions and updated RIS functions' scopes were added based on information needs that were reported from rapidly evolving fields like corridor management, synchromodality, and smart shipping. As a consequence, a certain mismatch between the RIS functions as described in the table and the actual information needs in these fields could arise in the future. Nevertheless, the Permanent InCom RIS WG feels it is important to elaborate these RIS functions to ensure RIS stays future-proof, and has made every possible effort to describe them on a sufficiently high level to avoid a quick deprecation.

Information Category		Functions		
1 <sup>st</sup> level	2 <sup>nd</sup> level	1 <sup>st</sup> level	2 <sup>nd</sup> level	Function Number
Network & Infrastructure	Network-related information	Provide navigation-based information on fairway and/or navigable water area		<b>F1</b>
			Provide information on bank of waterway, boundaries of the fairway, etc.	
			Provide information on the depth profile of the fairway	
			Provide information on non-navigable or unsurveyed water area	
			Provide information on anchorage areas, mooring facilities and berths	
			Provide information on permanently moored vessel or facility in waterway	
		Provide meteorological information		<b>F2</b>
			Provide continuous weather information	
			Provide predicted weather information*	
			Provide weather warnings	
			Provide actual ice information	
			Provide predicted ice situation	
			Provide information on ice breaking measures*	
		Provide water level-related information		<b>F3</b>
			Provide actual water levels	
			Provide predicted water levels	
			Provide actual discharge information	
			Provide predicted discharge information	
			Provide least sounded actual depths information	
			Provide least sounded predicted depths information	
			Provide information on shallow/critical sections*	
			Provide barrage status	
			Provide information on restrictions caused by high water conditions*	
		Provide information on obstructions and limitations		<b>F4</b>
			Provide information on long-term/permanent obstructions in the fairway	
			Provide information on temporary obstructions (in the fairway/on the route)	
			Provide information on ferries	
		Provide information on navigation rules and regulations		<b>F5</b>
			Provide information on official aids-to-navigation	
			Provide information on the actual status of aids-to-navigation*	
			Provide information traffic signs	
			Provide information on the actual status of light signals	
			Provide information on traffic rules and regulation	
			Provide information on anchorage areas, mooring facilities and berths	
			Provide information on waterway charges, harbour dues and infrastructure charges	

Information Category		Functions			
1st level	2nd level	1st level	2nd level	Function Number	
Network & Infrastructure	Infrastructure-related information	Provide information on land region		<b>F6</b>	
		Provide information on harbours <i>and ports</i>		<b>F7</b>	
			Provide information on harbour area and basin		
			Provide information on category of harbour facility		
			Provide information on port schedule		
			Provide information on terminals		<b>F8</b>
			Provide information on category of terminal		
			Provide information on infrastructure/provided services		
			Provide information on terminal schedule		
			Provide information on locks and ship lifts		<b>F9</b>
			Provide information on construction and facility		
			Provide information on lock operating hours		
			Provide operational status of locks		
			Provide information on bridges		<b>F10</b>
			Provide information on construction		
			Provide information on openable bridge operating hours		
			Provide operational status of openable bridges		
			Provide information on vertical ( <i>bridge</i> ) clearance		
			<i>Provide information on predicted vertical bridge clearance*</i>		
			Provide information on cables/pipes overhead and other special constructions		<b>F11</b>
	Provide information on construction				
	Provide information on vertical clearance				
	Provide information on waste reception facilities		<b>F12</b>		
	<i>Easy feedback on discrepancies between provided data and real-life situation*</i>		<b>F13</b>		

Information Category		Functions		
1st level	2nd level	1st level	2nd level	Function Number
Vessel-related	Dynamic vessel information	Provide position information of vessels		<b>V1</b>
			provide actual position information of vessels	
			provide historic position information of vessels	
		Provide vessel dynamics (i.e. RoT, velocity, CoG, SoG, etc.)		<b>V2</b>
			Provide actual vessel dynamics (i.e. RoT, velocity, CoG, SoG, etc.)	
			Provide historic vessel dynamics (i.e. RoT, velocity, CoG, SoG, etc.)	
		Provide event based triggers for vessel position		<b>V3</b>
			Provide notifications of arrivals at defined (passage) points of the waterway/route	
			Provide notifications of arrivals of departures at defined locations on the waterway/route	
	static vessel information	Provide information on hull data		<b>V4</b>
			Provide full hull data	
			Provide data for the identification of vessels (minimum hull data set)	
			Provide <b>specification</b> information on hull data	
		Provide information on certificates		<b>V5</b>
			Provide community certificate	
			Provide ADN tank certificate	
			Provide ADN dry certificate	
			Provide measurement certificate	
		Provide other certificate		
	Convoy-related	Provide overall convoy data		<b>V6</b>
			Provide information on convoy type	
		Provide information on the hulls of convoy		
		Provide information on the characteristics of a convoy		

Information Category		Functions		
1st level	2nd level	1st level	2nd level	Function Number
Voyage and cargo-related	Voyage-related information	Provide information on origin of voyage		VC1
		Provide information on intermediate discharge locations		VC2
		Route & Voyage planning*		VC14
			Provide route planning service*	
			Provide voyage planning service*	
			Provide re-routing in case of temporary restrictions*	
		Provide information on passage points		VC3
		Provide information on destination of voyage		VC4
		Provide information on data/time of arrivals		VC5
			Provide estimated data/time of arrivals	
			Provide requested data/time of arrivals	
			Provide date/time of actual arrivals	
		Provide information on estimated data/time of departures		VC6
			Provide estimated data/time of departures	
			Provide requested data/time of departures	
			Provide date/time of actual departures	
	Provide information on the predicted deviation of the original voyage plan (of skipper) at defined points on the route (locks, crossings, berths) and terminal/ports		VC7	
	Cargo-related data	Provide information on origin of cargo		VC8
		Provide information on destination of cargo		VC9
		Provide information on cargo details		VC10
			Provide details of cargo sender	
			Provide details of cargo receiver	
			Provide details of non-dangerous cargo	
			Provide details of dangerous cargo	
			Provide port of loading	
			Provide estimated date/time of departure at loading place	
			Provide port of discharge	
			Provide estimated date/time of arrival at discharge place	
		Provide loading unit-related information		VC11
		Provide number of loading units on board		
		Provide information on type of loading units on board		
		Provide information on free loading space*		
	Passenger & Crew	Provide information on number of persons (crew, passengers, etc.) on board		VC12
Provide details on persons on board		VC13		

Information Category		Functions		
1st level	2nd level	1st level	2nd level	Function Number
Traffic-related	Object-related information	Provide facility (berth/harbour/terminal) information		<b>T1</b>
			Number of vessels at facility	
			Provide information on usage of a berth*	
			Provide information on usage of facility infrastructure*	
		Provide information on bridge and lock chamber planning*		<b>T8</b>
			Information on the requested time of arrival (RTA) of a vessel*	
			Information on the sequence of entering the lock/passing the bridge*	
			Information on the planned position of all vessels in the lock chamber*	
			Information on the still available length and/or width in the lock chamber*	
		Provide information on operational status of locks and bridges		<b>T2</b>
			Provide door/bridge status information	
			Chamber/bridge opening availability information	
			Lock chamber water level information	
			Position of vessels in a lock chamber including number of blue cones or passenger vessel or certificate	
			Number of announced vessels approaching the lock/bridge per sailing direction (arriving on short term)	
			Number of vessels waiting for locking per sailing direction	
			Provide information on signal light status*	
		Provide information on incident focused on traffic situation*		<b>T9</b>
			Provide information on incident type, severeness, location, expected duration including influence on infrastructure passage durations incl. waiting times*	
			Provide information on influence on fairway stretch passage durations including waiting times*	
			Provide pro-active alerts*	
			Provide overview of affected vessels*	
			Communication with affected vessels*	
		Provide information on actual passage time duration at locks and bridges		<b>T3</b>
			Actual passage duration	
			Actual lock entry duration*	
			Actual waiting time	
	Actual locking duration			
	Actual lock leaving duration*			

Information Category		Functions		
1st level	2nd level	1st level	2nd level	Function Number
Traffic-related	Object-related information	Provide information on predicted passage time/duration at locks and bridges		T4
			Predicted passage duration	
			Predicted waiting time	
			Predicted locking duration	
			Predicted locking time	
		Provide information on average passage time/duration for certain categories/certain vessel types (at locks and bridges)		T5
			Average passage duration	
			Average waiting time	
		Average locking duration		
	Fairway section-related information	Provide information on traffic density on a certain stretch and/or corridor (for specific vessel classes)		T6
			Actual density	
			Predicted density	
			Average density	
		Provide information on sailing/travel time over a certain stretch for certain vessel classes per sailing direction		T7
Provide information on incident focused on traffic situation*		T10		
		Provide information on incident type, severeness, location, expected duration including influence on infrastructure passage durations incl. waiting times*		
		Provide pro-active alerts*		
	Provide overview of affected vessels*			
	Communication with affected vessels*			

Table 3: RIS Functions

While the scope of most RIS functions is quite clear from their description, discussions with IWT stakeholders have revealed that for some RIS functions a further elaboration of the scope and meaning should be provided. Additionally, the initial scope of other RIS functions may be broadened to better meet new and upcoming information needs.

### 6.2.1 F2 – Provide Meteorological Information

Three 2<sup>nd</sup> level functions have been added or updated:

- **Provide predicted weather information:** With the ever-increasing accuracy of weather information models, weather predictions become a reliable source of useful information for the IWT community. It should however be noted that this should be considered an 'external' function, that is normally not provided by the RIS Authorities/Providers.
- **Provide actual/predicted ice information:** The scope of these functions should include, wherever possible, the expected restrictions that are/will be caused by the actual/predicted ice situation.
- **Provide information on ice breaking measures:** Wherever measures are taken to alleviate the impact of the ice situation, this function can inform the user about their effect.

### 6.2.2 F3 – Provide Water Level-Related Information

Here one new function was added, the function 'Provide regime status' has been renamed, and another functions have been further elaborated:

- **Provide information on shallow/critical sections:** In this new function, the least sounded (shallowest) actual and predicted depths information is used to extract the resulting shallow/critical sections. Providing this information informs all users about these sections and removes some of the need for on-board postprocessing of sounding information to identify critical sections.
- **Provide information on restrictions caused by high water conditions:** High water conditions may cause restrictions. These conditions and their restrictions are often referred to as the 'regime status' in Europe. In the USA they are part of 'waterway action plans'.
- **Provide actual/predicted discharge information:** In areas wishing to support automated vessels, these functions should include information on (critical) cross flows and flow models.

### 6.2.3 F4 – Provide Information on Obstructions and Limitations

The scope of one function is clarified:

- **Provide information on long-term obstructions in the fairway:** This function may include permanent obstructions. Obstructions can also be specified further in the function. For example, if the obstructions are vessels or facilities. So, it is possible for this function to provide information on things that are both obstructions in the waterway and serve a meaningful purpose at the same time.

### 6.2.4 F5 – Provide Information on Navigation Rules and Regulations

One new function was added, and another's scope further clarified:

- **Provide information on the actual status of official aids-to-navigation:** This new function is focussed on two topics: malfunctions and short-term changes to the aids-to-navigation in a specific area. While malfunctions are unexpected, short-term changes are planned and can be promulgated in advance and for as long as they apply.
- **Provide information on the actual status of light signals:** Here the same principle applies as above. Aside from information on which lights are on and off, this function can also provide information about malfunctions and short-term changes of the light signals.

### 6.2.5 F8 – Provide Information on Terminals/Berths

The scope of one function is elaborated:

- **Provide information on infrastructure/provided services:** This function can include information on available mooring facilities (e.g. for automated vessels), shore power, potable water, the availability of infrastructure for bunkering of alternative fuels, etc., but also connections to other transport modes.

### 6.2.6 F9 – Provide Information on Locks and Ship Lifts

Two functions are further elaborated:

- **Provide information on lock operating hours:** This function provides information on both the regular operating hours of locks and short-term changes of lock operating hours.
- **Provide information on construction:** Information on the construction of a lock should include basic information like the number of lock basins and their dimensions, the type of the lock basin doors, shape of the lock basins (especially if not rectangular), etc., but also more advanced information like the location of bollards and supported mooring systems (especially those fit for automated (remote operated) vessels).

### 6.2.7 F10 – Provide Information on Bridges

One function has been added and two are further elaborated:

- **Provide information on predicted vertical bridge clearance:** This new function provides predictions on vertical bridge clearance, preferably with clear indicators on the time-validity of the predictions and the uncertainty of their values. It is advised to clearly inform the consumers of this function about the informative and non-binding nature of this service to avoid liability claims in case of accidents caused by information that was made available via this function.
- **Provide information on operable bridge operation hours:** This function provides information on both the regular operating hours of operable bridges and short-term changes of operable bridge operating hours, whatever the reason for the change.
- **Provide information on construction:** Wherever possible and relevant, this function should include the shape of the navigable bridge opening spans (or equivalent information) in a machine-readable format. This is especially valuable information to support automated vessels and vessels with a large air draught.

### 6.2.8 F13 – Easy Feedback on Discrepancies Between Provided Data and Real-Life Situation

This new 1<sup>st</sup> level function has a reversed direction of information flow: it should allow users of the waterway to provide feedback to the RIS Authorities/Providers about discrepancies between the provided RIS data and the real-life situation, enabling a quick reaction and, where relevant, amendment of the information made available via the implemented RIS. Examples are reports about damage to the waterway or infrastructure.

### 6.2.9 V6 – Provide Overall Convoy Data

One 2<sup>nd</sup> level function's scope is elaborated further.

- **Provide information on the characteristics of a convoy:** An important characteristic of a convoy is the configuration of the hulls in the convoy/tow. Indeed, there are multiple ways in which, for example, a convoy with one pusher and three barges can be sailing. Providing the overall dimensions of a convoy often doesn't suffice to determine the convoy's

configuration. The relative position of each barge in the convoy can be very valuable information in lock planning (determining remaining available free space) and for automated vessels (sailing characteristics of the convoy).

#### 6.2.10 VC3 – Provide Information on Passage Points

If the necessary data is available, this 1<sup>st</sup> level function should also include information on the actual passage times (timestamp) of vessels at a passage point.

#### 6.2.11 VC11 – Provide Loading Unit-Related Information

This 1<sup>st</sup> level function is not limited to containers. Information on other types of loading units, e.g. tanks for liquid bulk, can also be provided via this function. One 2<sup>nd</sup> level function is added and the scope of the existing 2<sup>nd</sup> functions is elaborated:

- **Provide information on free loading space:** This new function provides information on free loading space (tonnage/containers/tanks/pallets/etc., including supported type(s) of cargo, etc.) for a voyage. It may even include information on room for high and heavy loads. The underlying information should be provided by the skippers or fleet operators, making this an external function.
- **Provide number of loading units on board:** This function provides information on the number of loading units on board. This can be the number of separate tanks for liquid bulk, containers, etc.
- **Provide information on type of loading units on board:** The type of loading units can be the sizes and properties of containers (20 feet, 45 feet, reefer, etc.), the properties of tanks (volume, allowed product types, etc.) and other relevant information on any type of loading unit.

#### 6.2.12 VC14 – Provide Route and Voyage Planning

This new 1<sup>st</sup> level function provides access to a route and voyage planning engine. For route planning this function can provide information on the expected/optimal itinerary from origin to destination (including optional via-points), taking into account vessel dimensions. For voyage planning the itinerary information is extended with timing information (estimated times of arrival) taking into account lock and bridge operating times, tidal windows, temporary obstructions, etc. and (voyage specific) vessel characteristics. If possible, the voyage planning engine should take into account all available dynamic information. Examples are actual and predicted ice information, shallow/critical sections, vertical bridge clearance, passage times, required time of arrival at locks/operable bridges, etc. and incidents that have an influence on the traffic situation.

#### 6.2.13 T1 – Provide Facility (Harbour/Terminal/Berth) Information

This 1<sup>st</sup> level function has been updated to include harbours. It should be noted that many of the 2<sup>nd</sup> level functions can apply to both public and private infrastructure. Several partially overlapping 2<sup>nd</sup> level berth functions have been merged into a single function with a clearly

defined scope, new functions have been added and some functions are further elaborated to give them a clearly defined scope.

- **Number of vessels at facility:** The function was made more general (facility instead of berth) to allow the inclusion of terminals and harbours.
- **Provide information on usage of a berth:** This function bundles several 2<sup>nd</sup> level functions from the previous guidelines. The function may include the following information: location of vessels at a berth; actual, planned and predicted berth space reservations/occupations, including their (expected) duration. It should be noted that (some of) the provided information may need to be anonymised for non-authorised users.
- **Provide information on usage of facility infrastructure:** The scope is similar to the function above, but this function focusses on the available infrastructure (e.g. shore power, bunkering facilities for alternative fuels, etc.).

#### 6.2.14 T2 – Provide Information on Operational Status of Locks and Bridges

The 1<sup>st</sup> level and 2<sup>nd</sup> level functions have been updated to include bridge information, matching the corresponding RIS information need. One 2<sup>nd</sup> level function is added, and the 2<sup>nd</sup> level function on 'The still available length and/or width' is moved to the new 1<sup>st</sup> level function T8 – 'Provide information on bridge and lock chamber planning'. Moreover, for three other 2<sup>nd</sup> level functions the in-line elaboration of the scope has been moved here.

- **Provide information on signal light status:** This function provides information on the actual signal light status (green, red, other, unknown) which is extremely important information for automated vessels which are not always able to register the actual status of signal lights via their onboard sensors (e.g. due to sunlight) and may also benefit skippers in difficult weather conditions (e.g. fog).
- **Provide door/bridge status information:** Door status should be made available for each of the lock's chamber doors. The same goes for the movable part of the bridge. Examples of statuses are: open, closing, closed, opening, malfunction, unknown.
- **Chamber/bridge opening availability information:** Provides information on whether the chamber or bridge opening is available for navigation. Possible statuses are: available, vessels entering, vessels leaving, locking in process, not in operation, restricted operation, unknown.
- **Lock chamber water level information:** The following water level statuses could be provided: low, levelling up, high, levelling down, unknown.

#### 6.2.15 T3 – Provide Information on Actual Passage Time Duration at Locks and Bridges

This 1<sup>st</sup> level function provides information that can be used to feed statistical models used by voyage computation engines to improve ETA predictions. The information can also be made available (possibly after anonymisation) to external parties for statistical purposes. Two 2<sup>nd</sup> level functions are added, and the function 'Sequence of entering the lock/passing the bridge' is

moved to the new 1<sup>st</sup> level function T8 – ‘Provide information on bridge and lock chamber planning’.

- **Actual lock entry duration:** This function provides information on how long vessels take to enter the lock chamber.
- **Actual lock leaving duration:** This function provides information on how long vessels take to leave the lock chamber.

#### 6.2.16 T7 – Provide Information on Sailing/Travel Time over a Certain Stretch for Certain Vessel Classes per Sailing Direction

This 1<sup>st</sup> level function may include, amongst others, information on the estimated time of arrival at a specific waypoint considering the predicted traffic situation. For that use case it can be seen as a complementary function with VC3.

#### 6.2.17 T8 – Provide Information on Bridge and Lock Chamber Planning

This new 1<sup>st</sup> level function can be seen as an extension to the existing T2 & T3 functions and describes a lot of information that is currently exchanged via VHF, making it available for developments in Smart Shipping and automated vessels.

- **Information on the requested time of arrival of a vessel:** This function provides information on when a vessel should be present at the lock in order to adhere to the current planning. Using this information vessels can adjust their speed, reducing fuel consumption and perceived waiting time at the lock. Furthermore, it is an important tool in enabling the lock operators to increase the planning horizon of the lock, benefitting overall efficiency of the infrastructure.
- **Information on the sequence of entering the lock/passing the bridge:** This function provides information on the sequence in which vessels should enter the lock or pass the operable bridge. For locks it is strongly related with the function below.
- **Information on the planned position of all vessels in the lock chamber:** This function provides information of the vessel placement in planned lockages. It includes the assigned position of all vessels in the planned lockage and information on the hazard level and vessel type of all vessels (e.g. passenger vessels, recreational vessels). It should be noted that (some of) the provided information may need to be anonymised for or not made available to non-authorized users.
- **Information on the still available length and/or width in the lock chamber:** This function provides information on the remaining capacity in the lock chamber, it can be used to determine if/which additional vessels could still be added to a planned lockage.

#### 6.2.18 T9 & T10 – Provide Information on Incidents Focused on Traffic Situation (Object & Fairway-Related)

These new 1<sup>st</sup> level functions bundle information related to incidents that may influence the traffic situation. T9 comprises incidents related to objects, while T10 comprises those related to

the fairway itself. Each have two general 2<sup>nd</sup> level functions and two functions that are strongly related to VTS.

- **Provide information on incident type, severeness, location, expected duration including influence on infrastructure passage durations, including waiting times**
- **Provide information on influence on fairway stretch passage durations, including waiting times**
- **Provide pro-active alerts:** This VTS oriented function allows sending pro-active alerts in case the VTS operator (or equivalent) notices an emerging dangerous situation.
- **Provide overview of affected vessels:** This function provides information on the vessels that are affected by an incident, enabling swift and effective communication and the deployment of specific measures to alleviate the negative effects of the incident.
- **Communication with affected vessels:** VHF can be used to communicate with affected vessels, but usage of (specific inland) AIS messages is also possible.

## 7 RECOMMENDATIONS FOR THE IMPLEMENTATION OF RIS

This chapter contains recommendations for the implementation of RIS. These recommendations should be considered as a helpful tool for the competent authorities responsible for the implementation of (specific aspects of) RIS. Special attention is paid to recommendations on Data Quality, Operational & Technical Services and Corridor Management.

A holistic approach is necessary for the development of RIS to ensure that the needs of all stakeholder groups are considered, without emphasis on a specific group. Governmental organizations can play a crucial role here, as it is presumably the best party to play an independent role. There is a need for a win-win situation: e.g. a harmonised approach in service delivery and information exchange, between RIS authorities, logistics sector, skippers, ports, customs, etc. In this way, the implementation of RIS supporting transport management will help inland navigation become a more efficient and cost-effective transport mode.

### 7.1 Legal Considerations

1. Before implementing RIS it is essential to consider the legal framework and implications related to the implementation and operation of RIS Operational and Technical Services.
2. The legal considerations should be outlined upfront to identify any actions needing to be addressed while providing RIS services, such as the need for amendment of the shipping legislation, the preparation and execution of administrative agreements, the need for additional rules and regulations on the use of the Operational Services, liabilities associated with the provision and use of information, etc.
3. A RIS authority should consider the legal consequences of the different RIS Operational and Technical Services.
4. Legal considerations should include the following aspects:

- Tasks and responsibilities of the RIS authorities.
  - Regulations of data exchange at national and, if applicable, international level, especially when considering corridor management.
    - Such regulations may remove the need for multilateral agreements for each specific data exchange.
    - In light of synchronomodality, regulations for data exchange between transport modes should also be considered.
  - Rules and regulations for data storage and data exchange, especially data privacy regulations<sup>9</sup>.
  - Regulations enabling, or even obligating, digital information sharing (getting rid of paper and stamps).
  - Avoid or remove overlapping and conflicting regulations
5. When including standards for Operational and Technical Services in legislation, there should be no room for misinterpreting these standards. A cooperation between legal and technical experts should be considered.
  6. Clear definitions of RIS-specific terms should be elaborated to avoid misunderstandings and provide clarity. Both the PIANC RIS definitions reports included in earlier versions of these Guidelines and the website [www.risdefinitions.org](http://www.risdefinitions.org) (a collaboration between the CCNR and PIANC) are contributions in this sense.

## 7.2 Training Considerations

The successful operation of RIS depends upon competent and experienced RIS stakeholders. Training and education are essential for the efficient and safe use of RIS.

1. Training courses should be developed and taught on the use of Operational and Technical Services taking into consideration the education level and experiences of stakeholder groups.
2. Especially for users aboard vessels, courses should be developed for e-learning.
3. For certain Operational Services (e.g. Traffic Management Information) and Technical Services (e.g. AIS and ENC's) simulation systems should be considered for RIS operators and the education of users on board vessels.
4. Attention should be paid to cybersecurity and cyber-resilience.
5. Courses that are available should be adapted to local conditions.

## 7.3 Technical Considerations

1. Services should be accessible through machine-to-machine interfaces (e.g. web services).
2. Multiple harmonised means should be used to provide services to a wide range of users with different needs. In addition to website publication, the use of smartphone apps or transmission via AIS ASM (Application Specific Messages) could be considered.

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<sup>9</sup> For example, the General Data Protection Regulation in Europe, the Law on the Protection of Personal Information of the People 's Republic of China, Personal Information Protection Act in South Korea, United States Privacy Legislation.

3. RIS providers and RIS users should be required or encouraged to use only certified equipment and software or equipment that fulfils relevant technical standards.
4. Common RIS services should be published at a single point of access.
5. If sensitive RIS data is restricted on a user account level, it should be ensured that one user account is valid anywhere in the connected waterway network.
6. RIS providers of a connected waterway network should harmonise the process for user authentication and registration to ensure the same quality and protection levels in all countries.
7. To ease the automated interpretation of RIS information, data encoded to a common standard should be used wherever possible.
8. The same reference data should be used to ensure interoperability of different RIS Operational Services, especially for geographic reference data.

## **7.4 Data Quality Considerations**

High-quality data is the key to a successful RIS implementation.

1. RIS authorities should be deliberate in their cycle of data quality measurement, assessment, and improvement so that their data sets, and the processes which make them, enable high-quality RIS Operational and Technical Services.
2. Before high-quality data may be produced, or its quality measured, the technical requirements for data content, syntax, feature types, attributes, and many other parameters should first be specified in detail in a Data Product Specification, forming the blueprint for data quality.
3. Data Quality Elements should be used to describe how well a data set meets the criteria set forth in its Data Product Specification, or other user requirements, and provide quantitative and qualitative quality measurements.
4. While it is not within the purview of these Guidelines to recommend the implementation of any standard or methodology over another, the data quality considerations in these guidelines are mostly derived from two standards published by the International Organization for Standardization (ISO), the eminence of which is acknowledged by the multiple citations within Annex 1:
  - a. ISO 8000 – Data Quality
  - b. ISO 19100 – Geographic Information
5. More information on data quality considerations is provided in Annex 1.

## **7.5 Operational Services**

### **7.5.1 General**

1. RIS Operational Services should be provided by waterway authorities that are competent for implementing RIS.
2. Interfaces for access to RIS Operational Services should be provided for all RIS stakeholders and should include interfaces to stakeholders in other transport modes.

3. Information provided through RIS should come from reliable sources and should always be validated and approved by the Competent Authority.
4. RIS providers shall always keep data protection in mind (including privacy and commercially-sensitive data) and ensure that sensitive data is only accessible to authorised users.
5. User authentication and registration should be harmonised on the complete waterway network.
6. User accounts should be valid for accessing Operational Services anywhere in the connected waterway network.
7. Wherever RIS includes the submission of electronic reports from vessels, it should strive to ensure that the information needs to be reported only once (the 'single window' concept) and is made available to other RIS users with an authorised need for the information.
8. Information provided through RIS should include an indication of the quality of the information. Depending on the type of information, this quality can be expressed in terms of accuracy, reliability, age, completeness, conformity to standards, etc. The user should be informed at least on:
  - Availability and reliability of the information
  - Accuracy, correctness and age of the information
  - Completeness of the information
9. A list of all available Operational Services should be provided including information on how they can be accessed. This list should be comprised of local, regional, national, or international Operational Services, considering RIS across borders, on a corridor, or on the entire network of inland waterways.
10. The publication of RIS information should take into consideration the languages spoken by the RIS stakeholders.
11. A user reference group should be established to create sustainable contact with stakeholders such as representatives of service and logistics providers.
12. A clear and realistic roadmap for the implementation and maintenance of Operational Services should be maintained.

### **7.5.2 Fairway Information Services (FIS)**

1. Fairway information contains static and dynamic as well as urgent information regarding the fairway. Static and dynamic information should be communicated and updated on a regularly scheduled basis.
2. Fairway information should be provided at a national level, or in case of trans-national waterways, at corridor or international level by implementing and operating a single point of access for FIS information.
3. Urgent information typically concerns unscheduled events. Therefore, it should be published and updated frequently as it changes. Typical means of publishing urgent information is via VHF voice radio. But AIS and other means to augment voice radio transmission should be considered under special conditions as well.

### 7.5.2.1 Traffic Information Services (TIS)

Traffic Information Services may be provided on two levels:

1. Tactical Traffic Information (TTI) using radar overlaid in a viewer for Electronic Navigational Charts (ENC) and integrated with information from an AIS system.
2. Strategic Traffic Information (STI), such as traffic monitoring for medium- and long-term decision making.

### 7.5.2.2 Tactical Traffic Information (TTI)

1. In poor visibility conditions, vessels should be equipped with radar to monitor all other ships in the close navigational area.
2. AIS data is of great help to improve the awareness of the traffic situation on board and improves the safety of inland navigation. For this reason, AIS should be made mandatory for use on board of inland vessels.
3. If TTI is used for navigation, it is recommended that radar information be complemented by fused AIS and IENC information. This should be done by certified navigation systems and fitted only by certified installers.
4. The display of TTI as a navigation tool should take care that AIS information does not confuse or overload the display. Vessel name is considered as minimum AIS information to be displayed in the traffic image, other vessel-related information should be available upon request.
5. The display of TTI as navigation tool should include from the ENC at least the safety-relevant infrastructural objects.
6. If a TTI display is not used for navigation, it is sufficient to display AIS information on an official ENC. In this case certification is not considered mandatory.
7. The provision of Differential Global Navigation Satellite System (DGNSS) data by means of AIS Message 17 is recommended to improve the quality of position information.
8. TTI to be displayed on shore for Traffic Management purposes, such as VTS and lock and bridge management, should include fused AIS and ENC information at minimum, and radar information if needed.

### 7.5.2.3 Strategic Traffic Information (STI)

1. Strategic Traffic Information should be implemented when permanent monitoring of the traffic situation within the RIS area is needed for medium-term and long-term decision making.
2. AIS and electronic ship reporting should be made mandatory by the Competent Authority for safety purposes, and strategic traffic and transport management Operational Services.
3. Electronic ship reporting complements real-time traffic information and enables deviation management along vessel routes.

### 7.5.3 Traffic Management Information (TM)

1. Traffic management is heavily dependent on the availability of Traffic Information Services including the Technical Services of AIS and electronic reporting.
2. Requirements for TM vary with local conditions (e.g. number of locks and bridges, complexity of the fairway infrastructure, type and volume of traffic). Therefore, the specific needs and goals for TM in a particular area should be analysed carefully before the introduction of traffic management services and systems.

#### 7.5.3.1 Vessel Traffic Services (VTS)

1. A VTS, if implemented, should be planned and operated in accordance with the IALA Recommendation V-120: 'Vessel Traffic Services in Inland Waters', and, where applicable, the CCNR guidelines on inland VTS.
2. RIS implementations do not necessarily include VTS, but VTS uses RIS technical and Operational Services.
3. The Tactical Traffic Image (TTI) to be used in an inland VTS is produced by collecting shore-based radar and AIS information and displaying vessel information on a display system, usually incorporating an ENC. For a long waterway stretch and heavy traffic, the TTI may be enhanced by automated target tracking.
4. AIS enhances tactical and strategic traffic information in a VTS area and, as such, is a critical part of the VTS capabilities. Mandatory use of AIS on board vessels will improve the performance of an inland VTS. AIS provides more vessel-related information, improves the overview of the traffic situation over a wider area than radar, and can improve communication with and among vessels in the VTS area.

#### 7.5.3.2 Lock and Bridge Management (LBM)

1. Optimization of lock and Bridge Management may require Technical Services such as electronic reporting, AIS, a vessel registration database, a lock diary including lock cycle optimisation software, and additional technical (sensor) systems such as CCTV (Closed-Circuit TeleVision), PLCs (Programmable Logic Controller) and SCADA (Supervisory Control And Data Acquisition).
2. RIS should aid in optimising traffic flow and reducing administrative burden on skippers and operators by:
  - Facilitating information exchange for lock and bridge planning with neighbouring locks and bridges.
  - Optimising lock cycles through the calculation of ETAs/RTAs, particularly for chains of locks and bridges.
  - Providing information on waiting times and/or expected and requested time of passing.
3. Optimisation of lock and bridge management should lead to reduced waiting times at locks and bridges, reduced fuel consumption, increased utilisation of the capacity of locks, and improved prediction of voyage duration. Optimisation of lock and bridge management supports more efficient management of logistic chains.

### 7.5.3.3 Traffic Planning (TP)

1. Traffic Planning optimises vessel passage time on a fairway or through a transport corridor by providing information on the state of the fairway and passing times at locks and bridges on a fairway or corridor in an integrated approach.
2. Through electronic reporting and availability of tactical and strategic traffic information, waterway authorities can better anticipate the demand for use of facilities in the RIS area and provide enhanced Traffic Management Services.
3. Based on a desired time of arrival at the final destination, the fairway authority can advise a ship to adapt its speed to optimise the arrival of the ship in consideration of other resources. This allows for better use of infrastructure and reduced waiting times leading to improved efficiency.
4. Traffic Planning (TP) optimises not only voyage planning for vessels but also supports the entire transport chain. Improved Traffic Planning will improve the competitive position and sustainability of inland navigation in the multimodal transport chain.

### 7.5.4 Information to Support Calamity Abatement (CAS)

1. RIS services that facilitate Calamity Abatement include reporting of involved, responding, and affected vessels' positions, voyage information, (dangerous) cargo, and crew (e.g. persons on board). Obtaining this information at the beginning of a voyage, and keeping it up to date during the voyage is critical to effective support of Calamity Abatement.
2. In case of an accident, RIS services should be able to deliver information on the vessel and its voyage, cargo, and crew to meet the requirements of the emergency services. These requirements should be identified in advance of incidents, included in contingency plans, and tested during incident training and drills.
3. In the event of an accident, responsible waterway authorities of neighbouring RIS areas should be informed on the type, status, and possible consequences of the accident.
4. Vessels in the vicinity of an accident should be informed without delay about possible impact of the accident on their voyage in order to limit possible negative consequences.

### 7.5.5 Information for Transport Logistics (ITL)

1. RIS authorities should design their information systems in such a way that information exchange between public and private partners is as easy as possible and privacy and security requirements are addressed. Also, authorities should take the necessary steps to ensure the protection of confidentiality of commercial information.
2. RIS authorities should accommodate the requirements of logistic services to the extent possible, such as:
  - The exchange of information between users and customers relating to vessels, voyages, cargo (capacity), terminals and berths.
  - Vessel and cargo tracking and tracing.
  - ETA/RTA negotiations between vessels and terminals.
  - Information needs of shore-based systems of other stakeholders.

### **7.5.6 Information for Law Compliance (ILC)**

1. RIS should provide information as required by law enforcement authorities.
2. RIS authorities should ensure the information provided by electronic reporting is sufficient to be used for all cross-border inspection requirements.
3. Provision of documents and information by electronic means to inspection and control authorities should reduce administrative burden and should result in fewer, more efficient inspections.
4. Law enforcement agencies in different countries should share vessel, cargo, and crew information to reduce administrative burden and improve the efficiency of law enforcement.
5. Law enforcement agencies should use RIS services to provide positive incentives for skippers, e.g. by providing information on local, regional, and national regulations and rules in via electronic means via FIS or ECDIS.

### **7.5.7 Information for Statistics (ST)**

1. RIS Operational Services for statistics should be based on RIS Technical Services including AIS and electronic reporting. Storing RIS-related information over time will facilitate various statistical analyses for internal use and use by external stakeholders.
2. Using RIS information for statistical purposes should reduce:
  - Costs on both authorities and the logistic sector for provision, collection, and evaluation of data.
  - Duplicative data input in different countries and for different purposes, which leads also to data inconsistency, incorrectness, and high costs.
  - Administrative burden.
3. Using RIS information for statistical purposes should enable well-founded:
  - Decisions on the design of infrastructure.
  - Planning and impact estimation of preventive maintenance.
  - Considerations on strategic decisions in general.

### **7.5.8 Information for Waterway Charges and Harbour Dues (CHD)**

1. RIS Operational Services for waterway charges and harbour dues should rely on the RIS Technical Services, including Electronic Reporting and AIS.
2. Information provided about waterway charges and harbour dues for all users should be language-independent and provided keeping in mind user-friendliness and the importance of ensuring understanding by the user.
3. If sufficient information from AIS and/or electronic reporting is available, it may be used for automated billing, thus reducing administrative burden.

## 7.6 Technical Services

### 7.6.1 General

RIS should be based on Technical Services that facilitate the provision of information related to:

1. Fairway and infrastructure-related information (7.6.2 and 7.6.3)
2. Vessel-related information (7.6.4)
3. Voyage and cargo-related information (7.6.5)
4. Traffic management-related information (7.6.2-7.6.5)

The efficient and effective use of RIS Technical Services is based upon harmonised use of reference data. RIS reference data ensures the interoperability of RIS Operational and Technical Services. Chapter 7.6.6 provides recommendations on the implementation of reference data.

Several RIS Technical Services have their origin in the maritime domain. The following Technical Services are used on a global level:

1. ECDIS (Electronic Chart Display and Information System) as standardised by the IMO (International Maritime Organization) and the ENC (Electronic Nautical Charts) are standardised by the IHO (International Hydrographic Organization).
2. Notices to Mariners following IHO/IMO guidelines for navigational warnings.
3. The Automatic Identification System (AIS) as standardised by ITU (International Telecommunication Union) and IEC (International Electrotechnical Commission). The performance standard for AIS was defined by IMO (International Maritime Organization) and developed by IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities).
4. The EDIFACT (Electronic Data Interchange for Administration, Commerce, and Transport) standard, as published by UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business) incorporating IFTDGN (International Forwarding and Transport Dangerous Goods Notification) messages and partially complying IMO FAL (Convention on Facilitation of International Maritime Traffic) forms.

To ensure interoperability throughout the entire transport and logistics chain the components of the RIS Technical Services shall be aligned with applicable international standards and recommendations such as those issued by CCNR, IEC, IHO, IMO and IALA, ISO, ITU, PIANC, UNECE, CESNI, and other relevant bodies.

Apart from the defined RIS Technical Services, many technologies such as radar and VHF radiotelephone services, mobile data connections (e.g. mobile (telephone) networks, satellite, Wi-Fi, 5G, etc.) are important supporting technologies for RIS. A description of these technologies is beyond the scope of these guidelines.

These Guidelines are based on the basic RIS Technical Services as defined and developed in previous decades. Due to their operational service-driven approach (as depicted in the functional decomposition in Chapter 6) RIS Operational Services are open for the use of new

technologies and Technical Services that might arise in coming years, for example through development of synchromodality and the e-Navigation concept.

In different regions of the world, different versions or types of RIS Technical Services are implemented, as depicted in Figure 2.

Standards for Technical Services					
		Static fairway and infrastructure Information	Dynamic fairway and infrastructure Information	Vessel Information	Voyage and Cargo Information
European Standards		Inland ECDIS (Inland ENC) <sup>10</sup>	Notices to Skippers <sup>10</sup>	Inland AIS <sup>10</sup>	Electronic Reporting (ERI) <sup>10</sup>
USA Standards		Inland ENC	Notices to Mariners/Notices to Navigation Interest	AIS	-
Asian Standards		ENC	Notices to Skippers & Notices to Mariners	AIS	-
Russian Standards		ENC	Notices to Mariners	AIS	-
Maritime Standards		ENC	Notices to Mariners	AIS	IFTDGN

Figure 2: Worldwide application of RIS technical service Technical Services standards

Worldwide provision of static fairway and infrastructure information is primarily accomplished using the Electronic Navigation Chart (ENC) in conjunction with Electronic Chart Display and Information System (ECDIS). In Europe, the inland version (inland ECDIS) is used. In the US inland waterways the Inland ENC (IENC) is used with electronic charting systems (ECS). More information on this Technical Service is given in chapter 7.6.2 with more specific information and the related standards in Annex 3.

Provision of dynamic fairway and infrastructure information is accomplished worldwide using the 'Notices to Mariners'. In the European inland waterways, this information is provided through 'Notices to Skippers'. In the US, this information is provided through 'Notices to Mariners' and 'Notices to Navigation Interest'. More information on this Technical Service is given in Chapter 7.6.3 with more specific information and the related standards in Annex 4.

The Automatic Identification System (AIS) is used worldwide for vessel situational awareness and vessel tracking. In European inland waterways, a version of AIS named 'Inland AIS' is in use. More information on this Technical Service is given in Chapter 7.6.4 with more specific information and the related standards in Annex 5.

For voyage and cargo-related information in European inland waterways, the Technical Service on Electronic reporting (ERI) is in operation. While historically based on the world-wide

<sup>10</sup> Part of ES-RIS.

UN/EDIFACT standard, the XML format has been introduced as an alternative in ES-RIS 2023/1. More information on this Technical Service is given in Chapter 7.6.5 with more specific information and the related standards in Annex 6.

General information on 'reference data' is given in Chapter 7.6.6, with more specific information on standards for reference data in Annex 7.

A recommendation for the further development of the RIS Technical Services is to take into consideration the needs of automated vessels by paying special attention to making Technical Services more machine-centred, ensuring that data provided is not open to interpretation.

## **7.6.2 Technical Services to Support the Provision of Static Fairway and Infrastructure Information**

The principal Technical Service in the RIS domain for the provision of static fairway and infrastructure information is an electronic navigational chart or ENC.

An ENC is an official database created by a national hydrographic office for use with an Electronic Chart Display and Information System (ECDIS), Electronic Charting System (ECS), or other display system. An ENC should at least comply with the S-57 and S-58 standards specified by IHO.

ECDIS is a system for the display of electronic navigation charts (ENC's) and additional geographic-related information. ECDIS displays selected information from a System Electronic Navigational Chart (SENC) with positional information from navigation sensors and, if required, additional navigation-related information. Its purpose is to contribute to safety and efficiency of navigation, protection of the environment, and reducing the workload of the skipper.

Inland Electronic Navigational Charts (Inland ENC) are based on the standards for maritime ENC, supplemented with special information for the use on inland waterways. That means that currently:

- a. Inland vessels sailing in maritime waters with Inland ENC displays are able to portray all maritime ENC information.
- b. Sea-going vessels sailing in inland waters with maritime ENC displays are able to portray all information that is provided equivalent to marine information (e.g. river banks), but they will not portray the additional inland information (e.g. inland notice marks).
  1. Sea-river vessels are recommended to use the additional Inland ENC software libraries in order to obtain full Inland ENC information. These are:
    - S-57, S-63 or S-401
    - S-58
  2. The presentation of ENC's should comply with the IHO S-52 Standard (Edition 3.0) and with the amendments published by the IEHG (Inland ENC Harmonisation Group).
  3. It is recommended to include the water depths in the ENC's (depth contours) for shallow river reaches that limit the draught of vessels using these waterways. The water depths may be referenced to a local datum or sea level. It is recommended to use the S-104 and S-112 product specifications, if applicable.

### 7.6.3 Technical Services to Support the Provision of Dynamic Fairway and Infrastructure Information

In the maritime domain, the Notices to Mariners (NtM) standard is used for publication and provision of the status of navigation infrastructure. This is, however, not the only standard for providing waterway or navigation information, e.g. there is also Navtex, weather warnings, Notices to Navigation Interest, etc.

The general idea is to provide dynamic fairway and infrastructure information in electronic format which allows for intelligent filtering and display of the available information.

1. Typically, the following types of information are provided through NtM:
  - Dynamic fairway information
  - Dynamic traffic-related information
  - AtoN (Aids to Navigation) information
  - Water level-related messages
  - Ice-related messages
  - Weather-related messages
2. It is recommended that the provision of traffic-related messages are:
  - Machine-readable
  - Language-independent
  - Using official standardised location codes to reference geographic objects
  - Provided according to an agreed encoding principle to ensure harmonised encoding in different areas.

### 7.6.4 Technical Services to Support the Provision of Vessel Information

The principal Technical Service in the RIS domain for the provision of vessel information is the Automatic Identification System (AIS).

AIS is a ship-borne radio data system providing (static and dynamic) vessel-related information between equipped vessels, as well as equipped vessels and shore stations. Ship borne AIS stations broadcast the vessel's identity, position, and other data at regular intervals. By receiving this information, shipborne or shore-based AIS stations within radio range can automatically locate, identify, and track AIS equipped vessels, and present this information on an appropriate display integrated with radar and ECS/ECDIS.

AIS is a source for navigation-related information, but it is not a navigation system by itself. AIS does not replace navigation-related services, such as tracking by radar, but augments and enhances them. The strength of AIS lies in the provision of ships identity and other navigation-related data for those vessels fitted with it. AIS and radar have complementary characteristics.

For vessels on international maritime voyages, AIS carriage requirements according to the SOLAS convention (IMO Convention for the Safety of Life at Sea) applies. On inland waterways, the AIS carriage requirements depend upon the region.

To ensure interoperability, it is recommended to use AIS for the provision of vessel information in accordance with the standards as given in Annex 5 taking in account possible regional requirements.

Inland AIS is based on the standards for maritime AIS supplemented with special information for the use on inland waterways.

### **7.6.5 Technical Services to Support the Provision of Voyage and Cargo Information**

Electronic Ship Reporting is a RIS Technical Service that facilitates the following RIS Operational Services:

- Strategic Traffic Information (STI)
- Traffic Management Information (TM)
- Information to support Calamity Abatement (CAS)
- Statistics Information (ST)
- Information to support Law compliance (ILC)
- Information on Waterway Charges and Harbour Dues (CHD)
- Information for Transport Logistics (ITL)

Electronic ship reporting will reduce the administrative burden and improve the quality of information being exchanged. It facilitates electronic data interchange between partners in inland navigation, as well as partners in the multi-modal transport chain involved in inland navigation. It can also help to avoid the reporting of the same information related to a voyage several times to different authorities and/or commercial parties.

Electronic transport notifications are intended to inform the Competent Authorities of the intention to make a defined voyage with a designated ship, either carrying a specified cargo or being empty. The transport notification can either originate from the skipper of the ship or from the shipper of the cargo on behalf of the skipper.

1. Exchange of ship, voyage, and cargo data by electronic reporting reduces the need for voice communication via VHF and reduces errors in (verbally) reported information.
2. Electronic reporting should replace the need for carrying physical documents.
3. Electronic reporting supports safety and calamity abatement and should be made mandatory, as needed, in support of these services.
4. It is the responsibility of the skipper, or the agent, or shipper of the transported cargo, to report required information.
5. It should be required that the Competent Authorities are able to receive and process electronic ship reports in accordance with national or international regulations.
6. The Competent Authorities should take the necessary measures to ensure the confidentiality, integrity, and security of information sent to them pursuant this standard. They should use such information only for the purposes of the intended Operational Services, for example support for calamity abatement (CAS), and border control and inspections as an Information to support Law Compliance Information (ILC) service.

7. It should be required that a request to forward information contained in a ship-to-authority-message to any other involved party will not be executed without explicit approval from the owner of the information (e.g. the skipper of the vessel, the shipper of the cargo).
8. An agreement on the protection of privacy between all involved public and private parties should be reached.
9. It is recommended that transport notifications should be sent before the start of a voyage prior to entering the jurisdictional area of a Competent Authority and after every significant change of the voyage data (e.g. number of crew on board, number of barges in the convoy).
10. When a ship requires a permit for any part of a voyage, it is recommended that the Competent Authority should acknowledge the message after processing the contents of the notification. The acknowledgement will include permission together with a reference or, where applicable, a refusal of such a permit with details about action to be taken.
11. Arrival notification and position reports should inform the local waterway operators – such as lock masters, bridge operators, traffic centre operators, ports and docking crew – of the impending arrival of a ship. It is recommended that position reports should be sent at key reporting points on the waterway. Arrival notifications and position reports can be obtained by AIS, preferably, or by VHF radio.
12. In cross-border transport, it is recommended that electronic reports should be transmitted to the Competent Authorities of the neighbouring jurisdictional area and any such transmission is completed before arrival of vessels at the border.

#### **7.6.6 Reference Data Supporting RIS Operational and Technical Services**

Reference data is used to uniquely identify critical information needed in the provision of services.

RIS references and code tables are key elements in the RIS standards and are an important link between the various RIS operational and Technical Services. The exchange of digital data without direct human involvement between RIS users and the providers of RIS Operational Services is facilitated using codes and references. RIS reference data contributes to the automated and efficient interpretation of RIS information.

1. Ensure success in the use of reference data and code tables, it is recommended to pay special attention to quality and maintenance aspects of the reference data. Maintenance and distribution procedures for reference data and code tables are needed. These procedures should be understood and agreed upon by all parties making use of reference data.
2. As specified in Annex 7, it is recommended to:
  - Use unique and immutable identifiers.
  - Avoid the use of meaningful information in identifiers.
  - Use the UN LOCODE as part of the reference data for locations.
  - Add additional geographic reference data for the unambiguous location of geographic objects.
  - Use the IMO ship identification number as a unique reference for ships and for registered ship owners and/or management companies.

- Use ENI number (European Number of Identification or European Vessel Identification Number) for ships navigating on European inland waters.
- Use the Harmonised System Code (HS Code) to reference transported goods.
- Use the UNECE ADN for the carriage of Dangerous Goods by Inland Waterways in Europe.

## 7.7 RIS-Enabled Corridor Management

It is essential for RIS users or service consumers that information is provided in a harmonised and standardised way throughout the inland waterway network or waterway corridors. This has been a core requirement in defining and developing 'RIS-Enabled Corridor Management', and should be considered as the next step in preparing IWT for synchronomodality.

***“Corridor Management is defined as the mutual provision and sharing of Operational Services among fairway authorities, waterway users, and related logistic partners in order to optimize the use of inland navigation corridors within a network of waterways”.***

1. Corridor Management requires sharing of information between authorities and the cooperation of public and private partners and is necessary to improve both the performance of inland navigation and the use of the existing infrastructure.
2. Corridor Management requires a structured cooperation among fairway authorities to provide a precisely defined set of harmonised Operational Services with the required level of quality.
3. The cooperating waterway and RIS authorities in a specific corridor will have to agree mutually on the Operational Services and functions they are planning to provide in that corridor. Besides the technical and procedural harmonisation, this agreement among the fairway authorities is a key element of Corridor Management.
4. Special attention must be given to the legal aspects of Corridor Management, in particular the processing and exchange of personal data, and the responsibilities and liabilities of each of the cooperating RIS authorities.
5. If corridor management is achieved via a common system (i.e. centralised approach), special attention should be given to the following aspects:
  - Governing boards with sufficient mandate to plan and execute changes on common systems should be established.
  - The cooperating authorities should optimise frameworks for sustainable operation and further development of common systems.
  - Joint user support and content management teams (Service Desk for end users) providing harmonised user support should be established. Setting up 24/7-system operation and user support is highly recommended.
  - The cooperating waterway authorities should ensure national willingness to be part of common systems and to gear their national and/or regional information systems towards these common systems.
  - Ensure the competent authorities are involved in and committed to the common systems and services.

There are three levels of corridor management services, each covering specific information categories specified in Table 4:

**Level 1:** Operational Services to enable reliable route planning by providing harmonised, standardised infrastructure information (dynamic and static).

**Level 2:** Operational Services to enable reliable travel times for voyage planning and traffic management by providing traffic information considering (a) actual waterway network usage (e.g. actual wait times) and (b) predicted waterway network usage (e.g. predicted waiting times) where considered reasonable.

**Level 3:** Operational Services to support transport management data for logistic partners (e.g. deviation management) and information on vessels and cargo.

Corridor Management Level	Information categories on
Level 1	<ul style="list-style-type: none"> <li>• Static Infrastructure information</li> <li>• Dynamic Infrastructure information</li> <li>• Water levels and ice conditions</li> </ul>
Level 2a	<ul style="list-style-type: none"> <li>• Vessel-related information</li> <li>• Traffic-related information</li> <li>• Voyage-related information</li> </ul>
Level 2b	<ul style="list-style-type: none"> <li>• Traffic planning/prediction</li> </ul>
Level 3	<ul style="list-style-type: none"> <li>• Dynamic vessel and cargo information (tracking &amp; tracing)</li> <li>• Tracking information of specific vessels and/or cargo</li> <li>• Voyage-related information (predicted deviation from the original voyage plan)</li> </ul>

Table 4: RIS enabled Corridor Management Service Levels

## 8 CONSIDERATIONS ON MID-TERM RIS-RELATED DEVELOPMENTS

### 8.1 RIS, S-100, AND E-NAVIGATION

Several of the RIS Technical Services have their origin in the maritime domain. Despite their many similarities, the inland and maritime domains operate in different physical environments, may be governed by different regulatory bodies, and sometimes have different information needs, which can cause their data and information standards to diverge, though this is avoided where possible.

In 2003, the worldwide Inland ENC Harmonization Group (IEHG) was formed by North America and Europe to work with the International Hydrographic Organization (IHO) on development of a worldwide standard for Inland ENC in line with the maritime standard. The IEHG, which includes members from North and South America, Asia, and Europe, has been an important link between the inland and maritime world ever since.

When developing new AIS messages for use in the inland waterway transportation via the Application Specific Messages (AIS-ASM), special attention is given to maintain compatibility

with maritime AIS resulting in richer information availability to Inland AIS systems while maintaining compatibility with its maritime counterpart.

When the PIANC WG 156 report on 'e-Navigation for Inland Waterways' published a change in terminology from 'RIS Services' to 'RIS Operational Services' and from 'RIS Key Technologies' to 'RIS Technical Services', the 'PIANC Guidelines and Recommendations for River Information Services' of 2019 adopted the same terminology to increase harmonisation between the inland and maritime domains.

At the same time, there is a clear divergence regarding Notices to Skippers/Mariners and electronic reporting of voyage and cargo information. Here, the differences in physical environment and (the emergence and adoption of) information needs are so different that sustained harmonisation seems implausible and, sometimes, counterproductive. Nevertheless, other developments continue to (re)align the inland and maritime domains. The S-100 Hydrographic Model has strong momentum and may provide a solid framework for drafting, maintaining, and updating international standards for RIS Technical Services. In parallel, e-Navigation (or the Maritime Service Portfolio) is becoming more and more tangible as the underlying S-100 Technical Services are getting fleshed out. Therefore, these Guidelines offer policy and technical recommendations to be considered by those who wish to develop or extend RIS in the upcoming years.

### **8.1.1 General Policy Recommendations**

- Formal coordination between members of the RIS community and the maritime S-100/e-Navigation community should be established beyond the scope of the IEHG. The long-term goal of this coordination should be to broaden the scope to include wider intermodal interaction, whereas the short-term emphasis should focus on the interaction between IWT and maritime transportation.
- Harmonisation between the inland and maritime world is very important, and further development of RIS should be focused on interoperability with the maritime domain wherever it creates benefits for IWT.
- In order to facilitate alignment between RIS and the maritime domain, it is recommended to use the same terminology wherever possible or to identify commonalities if different terms are used. The first steps are already taken; however, further alignment is needed.
- RIS flagship projects should consider ongoing developments in S-100 and e-Navigation.
- Mixed traffic corridors (e.g. the Western Scheldt, Elbe) and hubs (e.g. seaports) should be identified where immediate and close cooperation can reap the highest benefits and achieve quick-wins.
- Priority areas of harmonisation between S-100/e-Navigation and RIS, such as organisational, legal, technical, and geographical coordination, should be identified and addressed within nascent or ongoing flagship projects.

### **8.1.2 Specific Recommendations**

1. The information barriers between maritime and inland waterway transport should be identified and information flows harmonised.

2. All involved organisations should use an agreed set of messages, or at minimum, develop common data dictionaries.
3. A RIS registry should be developed that goes beyond geospatial information. It should be aligned with the e-Navigation Maritime Service Portfolio.
4. Based on the concept of the Maritime Connectivity Platform, two registries could be considered for RIS:
  - a. A generic registry containing specifications of discrete functional services, which might be implemented by organisations in different areas, and
  - b. A service registry containing a list of specific services implemented by different providers in different areas and operating according to the specifications contained in the generic registry.
5. When implementing common systems covering most, or all, of the IWT network, the aforementioned registries can still be interesting instruments, as geographical coverage of some services may still be limited, depending on traffic density, network properties, and other considerations.
6. Standardisation and harmonisation through the use of S-100 and the Common Maritime Data Structure (CMDS) are strongly recommended. Evolutions in RIS should, however, not be held back by linking too strongly with S-100 and CMDS, as their scope and level impact often require a different pace when introducing changes and new features.
7. Harmonised electronic reporting formalities based on the single window(s) principle with seamless data exchange procedures between involved stakeholders should be created in the inland environment to reduce administrative barriers when sailing through different countries. This approach reduces time and money lost due to administrative workload of the crew, and thus can contribute to the increased competitiveness of IWT as an environment-friendly mode of transport.
8. Whereas ship-ship, ship-shore, and shore-ship information needs and messages are for, the most part, well-defined, communication protocols are sometimes ambiguous and/or not officially standardised at the international level. S-100 could provide a framework to achieve further international harmonisation.

## **8.2 Cybersecurity**

Since the end of the last century, the amount and complexity of navigational and information equipment on inland navigation vessels and for inland navigation infrastructure has increased dramatically. Information and Communication Technology (ICT) is transforming shipping, bringing enhanced monitoring, communication, and connection capabilities, thereby facilitating the development of a new generation of intelligent transport systems, including automated inland navigation vessels. While there is already substantial activity on cybersecurity, to protect the ICT-enabled environment in maritime navigation (relating to management of shipping companies, vessels, ports, etc.), important inland navigation stakeholders may not even be aware of the cyber-risks faced by the inland navigation system.

Therefore, PIANC InCom established Task Group 204 to produce an 'Awareness Paper on Cybersecurity in Inland Navigation'. This paper, published in January 2019, provides a situational overview, incorporates best practices from maritime transport and ports

management, and solicits feedback on cyber-risks for inland navigation (including infrastructure) and on mitigating measures. The objective is to raise awareness of cybersecurity risks in inland navigation among practitioners in the management of inland waterways, ports, as well as shipping companies.

In general, the application of ICT, including River Information Services, in inland navigation offers tremendous opportunities. At the same time, it creates new and profound risks to all aspects of inland navigation. Therefore, all feasible measures for mitigating these risks need to be implemented, monitored, and continuously improved. These measures must include contingency plans with procedures on how to manage situations where the integrity of ICT systems has been compromised due to cyberattacks. For a ship, this may even require discontinuing a journey. For the management of a waterway, this may mean the discontinuation of certain services. In most instances, cyberattacks may result in economic damages only. However, it should not be forgotten that people's lives and the wellbeing of the environment can be at risk as well.<sup>11</sup>

The highest risk for lives through cyberattacks is related to harming onboard navigation systems. Such systems should be designed as securely and resiliently as possible with as little connections to other systems or the outside of the vessel. However, that aspect is outside the scope of these Guidelines and is covered by related regulations and standards from bodies like ITU, IEC, NMEA, RTCM, IMO or IALA.

IT Security is a complex and dynamic topic, and these guidelines cannot give a comprehensive, state-of-the-art set of security measures. Therefore, these guidelines focus on the shore-side domain of RIS and shall make best-practice recommendations to RIS Providers in setting up and operating RIS in a secure manner.

Most important is to follow the general rules and recommendations for IT-security which are governed by standards like ISO 27001. The following high-level recommendations should be seen as a minimum set of measures:

- People are the weakest link in the IT-chain. Therefore, users and administrators need to be regularly trained on cyber-risk awareness. This includes verifications of user behaviour by means of fake phishing/spear fishing attacks.
- Physical access to IT infrastructure is critical for cyberattacks. Often, critical IT infrastructure is accessible for external parties, especially when operating in rented office space. This should be avoided as much as possible and mitigated by other measures, like CCTV surveillance and rigid IT-racks with secure locks.
- Always use minimum user rights. Operators should never have administrative user rights.
- Administrators should have personal accounts and shall always use minimum administrative credentials, i.e. use local administrator rights instead of domain/root credentials.
- A suitable password policy with a balance between password complexity/change intervals and usability must be established. It is highly recommended to use two-factor authentication and/or password manager applications instead of unpractical, very complex passwords.

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<sup>11</sup> Source: PIANC Task Group TG 204 – 'Cybersecurity in Inland Navigation

- The use of state-of-the art IT security equipment like firewalls or security appliances is mandatory. It is recommended to not only use security appliances between servers and the outside world, but also between servers and clients.
- Regular backups with long term archives stored in remote locations or in a secure cloud space is mandatory.
- All software and hardware components (e.g. appliances) shall be frequently and timely patched with available security patches. Newly identified vulnerabilities must be mitigated as soon as possible.
- The use of virtualization is highly recommended for server applications. This allows for easy backup and recovery of server applications and optimises the load balancing of server hardware.
- A well-configured monitoring system is key to fast detection of breakdowns or anomalies in the system.
- Web servers which are open to the public should be set up in a DMZ and never within the core network.
- All traffic over interfaces to the outside world should use strong encryption. Weak services, like FTP, should be avoided at all costs.

Besides standard IT measures, there are specific AIS Technical Services which are vulnerable and need special attention. Although no significant cases are known, AIS is especially vulnerable to jamming (harming of the radio signal) and spoofing (sending of wrong or fake AIS data from unauthorized devices) due to its open communication architecture.

While both cases cannot be prevented, it is key to detect spoofed AIS data as quickly as possible to inform the users about the potential threat and try to locate and stop the spoofing attack.

Some possible measures to monitor the performance and integrity of the AIS channel are:

- Implementation of a GNSS monitoring system using receivers on shore to monitor data integrity and generate alarms.
- Implementation of VDL load monitoring, with automatic alarms in case of abnormal behaviour-related to slot consumption.

Lots of information can be derived from continuous evaluation of AIS data content, such as:

- Monitoring the AIS link for 'abnormal' MMSI numbers (wrong MIDs, outside the numbering scheme).
- Monitoring the AIS link for a 'large' number of new transponders (MMSIs) which are completely unknown to the system.
- Monitoring the AIS link for an unexpectedly large number of transmissions from individual AIS targets.
- Monitoring the AIS link for very fast moving or 'jumping' AIS targets (could indicate double MMSI usage).
- Monitoring the AIS link for abnormal amount of SRMs.
- Monitoring the AIS link for abnormal amount of ASMs.
- Monitoring the AIS link for ASMs originating from non-official AIS base stations.

- Monitoring the AIS link for an abnormal volume of AtoN messages.
- Monitoring the AIS link for AtoN messages originating from non-official AIS base stations.
- If available – verifying the integrity of AIS messages (5 and FI 10) by comparing different databases (e.g. MMSI, ENI, VTM, ATIS, etc.).

### 8.3 Mobility Data Spaces

Digitalisation is an indispensable driver for the transformation of the entire transport and mobility system, making it seamless and more efficient. Digitalisation and automation are essential to further increase the levels of safety, efficiency, security, reliability, and comfort, thereby improving global competitiveness through efficient, sustainable, and resilient logistics chains. In order to enable the digital transformation of the transport sector, it has to be ensured that the key digital enablers are in place, including electronic components for mobility, network infrastructure, cloud-to-edge resources, and data technologies. The digital transformation of the transport and mobility sector requires further efforts related to data availability, access, interoperability, and exchange. Currently, they are often hampered due to unclear regulatory conditions, a lack of a market for data provision, the absence of an obligation to collect and share data, incompatible tools and systems for data collection and sharing, differing standards, or data sovereignty concerns. The availability of data and statistics is also essential, in particular real-time data, as it enables better services to users or transparency of supply chains in freight transport.

Intelligent traffic, transport, and logistics or 'intelligent mobility systems' require a large amount of data to support decisions in the best possible way or even enable decisions to be made automatically. Although countless mobility data are already being collected and processed today, this is mostly done in a siloed approach. Comprehensive use of this data is often not possible for technical, legal, or economic reasons.

Mobility Data Spaces create an open data space concept that, in addition to the secure exchange, enables the development of real-time traffic data and sensitive mobility data exchange between data platforms. In this way, comprehensive mobility data can be made available at the national and international levels in the future.

The developments on mobility data spaces is still in an early development phase. This chapter is inspired, based on, and copied from the initiatives related to mobility data spaces in the road and rail sector, like there are the Mobility Data Space<sup>12</sup>, a flagship project in the digital strategy of the German federal government with more than 200 stakeholders, the International Data Spaces Association<sup>13</sup>, as well as the important initiatives iShare<sup>14</sup>, GAIA-X<sup>15</sup>, Federated<sup>16</sup>, and Fenix<sup>17</sup>. In February 2022, the European Commission adopted a working document (SWD

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<sup>12</sup> <https://mobility-dataspace.eu/>.

<sup>13</sup> <https://internationaldataspaces.org/>.

<sup>14</sup> <https://ishare.eu/>.

<sup>15</sup> <https://gaia-x.eu/what-is-gaia-x/>.

<sup>16</sup> <http://www.federatedplatforms.eu/index.php>.

<sup>17</sup> <https://fenix-network.eu/about/>.

(2022) 45 final) on European common data spaces<sup>18</sup> with clear explanations and design principals on the concept.

In order to strengthen the position of IWT in the transport chain and for it to become an integral part of the synchromodal future of logistics, it will be essential for IWT to fully integrate with the mobility dataspace ecosystem. First steps were taken in Europe with the development of EuRIS as a dataspace for IWT traffic and transport-related information services.

### 8.3.1 The Concept of Mobility Data Spaces

Mobility data spaces bring together relevant data infrastructures and governance frameworks to facilitate data pooling and sharing. They:

- deploy data-sharing tools and services for the pooling, processing, and sharing of data.
- include data governance structures which determine, in a transparent and fair way, the rights concerning access to and processing of the data.
- improve the availability, quality, and interoperability of data in domain-specific settings and across sectors.

### 8.3.2 Design Principles

- **Data control:** Driven by sector-specific needs, mobility data spaces promote the development of tools to pool, access, use, and share all types of data, favouring the development of common, open standards and findable, accessible, interoperable, and reusable (FAIR) principles.
- **Governance:** An appropriate governance structure is needed to ensure fair, transparent, proportionate and non-discriminatory access to, sharing, and use of data.
- **Respect of rules and values:** Data spaces will comply with the applicable legal frameworks on personal data protection and security, fundamental rights, environmental protection, competition law, and other rules relevant to the provision of data services, such as international trade commitments under the World Trade Organization's General Agreement on Trade in Services and other trade agreements. In addition, adequate technical, legal, and organisational measures will be put in place to prevent unauthorised access to personal and non-personal data.
- **Technical data infrastructure:** Participants in data spaces will be encouraged to use the common, technical infrastructure and building blocks which will allow the data spaces to be built in an efficient and coordinated manner. The common technical infrastructure will have to take due account of the existing and emerging sectoral frameworks, integrate the cybersecurity-by-design principle, and respect data protection.
- **Interconnection and interoperability:** To avoid fragmentation, high integration costs and the creation of silos, the data spaces could develop on international standards, such as INSPIRE (for spatial data), and FAIR principles to favour interoperability, exploitation of data on computing infrastructures, and being interconnected.

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<sup>18</sup> <https://digital-strategy.ec.europa.eu/en/library/staff-working-document-data-spaces>.

- **Openness:** Participation in common European data spaces is open to all actors (organisations/individuals) that respect rules and values. Openness would also serve to allow competition between different product and service providers.

### 8.3.3 Key Features

- **Transparency and sovereignty:** A clear and practical structure for access to and use of data in a fair, transparent, proportionate, and non-discriminatory manner with clear and trustworthy data governance mechanisms. The interaction of several users, providers, or operators requires a trustworthy exchange of data and interoperability.
- The mobility data space is based on an open, decentralised system architecture and promises data providers sovereignty over their data with security along the processing and value chain, as well as digital rights management.
- **Safe and secure:** A secure and privacy-preserving infrastructure to pool, access, share, process and use data. The Mobility Data Space offers an ecosystem in which data providers can define and control the conditions under which their data is used by other actors. This creates data sovereignty and trust, giving users certainty about the origin and quality of the data.
- **Rules and values:** Personal data protection, consumer protection legislation, and competition law, are fully respected.
- **Privilege separation:** In the data space, data holders will be enabled to grant access to and share certain personal and non-personal data under their control.
- **User-centric:** Accessing the Mobility Data Space is easy and transparent. Data can be reused against compensation, including remuneration, or made available for free.
- **Digital sales channel:** With the linking of public and private-sector data via national data platforms, the Mobility Data Space becomes a digital sales channel for data-driven business models and unfolds completely new possibilities for data development, linking, and utilisation.
- **User scaling:** Participation of an open number of organisations/individuals.
- **One-stop shop for mobility data:** The Mobility Data Space can offer a wide range of mobility data from weather updates to navigation data and logistics data.

## **ANNEXES**

**Annex 1:** Guidelines for Data Quality (Management)

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## **ANNEX 1. GUIDELINES FOR DATA QUALITY (MANAGEMENT)**

High-quality data is the key to synchromodality because it enables decisive action with the most predictable result. Authoritative sources of high-quality data must be deliberate in their cycle of data quality measurement, assessment, and improvement [ISO/TS 8000-60:2017(E) 4.1 – “A Value-Driven Approach to Data Quality Management”] so that their data sets, and the processes which make them, enable high-quality synchromodal services.

While it is not within the purview of these Guidelines to recommend the implementation of any standard or methodology over another, these Guidelines for Data Quality (Management) for RIS Services are mostly derived from two standards published by the International Organization for Standardization (ISO); ISO 8000 – Data Quality and ISO 19100 – Geographic Information. The eminence of these standards is acknowledged by the multiple citations within this annex. The architecture and mechanisms of ISO 8000 and the ISO 19100 series, however, are not described in this document and are left for the reader to investigate for suitable application. The next paragraphs provide a very brief introduction to each.

ISO 8000 is the international standard for the exchange of “portable data that meets stated requirements”. It addresses the quality of data within industrial business transactions through its description of ‘Master Data’ pertaining to individuals, organisations, locations, goods, services, processes, rules and regulations within business entities; ‘Transaction Data’, which identifies and describes events in time pertaining to those Master Data objects; and ‘Product Data Quality’, which measures accuracy and appropriateness of the data and the timeliness of digital transactions underpinning business processes from product conception to manufacturing. This standard enables businesses to classify, encode, and publish product data in a consistent, unambiguous, and portable manner, which enables customers to reliably procure specific products in a complex digital supply chain. [ISO/TS 8000-1:2011 (E) – “Clause 8 Structure of ISO 8000”] [“What is ISO 8000?” – <https://eccma.org/what-is-iso-8000/>].

The interrelated ISO 19100 series contains more than 80 standards that describe methods, tools, and services for geographic data definition, description, management, acquisition, processing, analysis, access, presentation, and quality, as well as digital geographic data transactions among users, systems, and locations. ISO Technical Committee 211 is responsible for this series and works toward standardisation in the field of digital geographic information. [<https://committee.iso.org/home/tc211>]

### **1.1 Data Product Specification**

Before high-quality data may be produced, or its quality measured, the technical requirements for data content, syntax, feature types, attributes, and many other parameters must first be specified in detail to make generating the desired data product possible. These requirements form the ‘Data Product Specification’. “A data product specification is a detailed description of a dataset or dataset series together with additional information that will enable it to be created, supplied to and used by another party. It is a precise technical description of the data product in terms of the requirements that it will or may fulfil.” [ISO 19131:2007(E) – “Introduction”] In short, the data product specification is the blueprint for data quality. This

specification should include minimum quality thresholds necessary to achieve conformance, as well as the evaluation procedures required to measure them. These measures are implemented as part of the quality control process during data production and updates. Potentially, quality measure results are reported as part of the data lineage in metadata. [ISO 19157:2013(E) Annex B.3 – “When to Use Quality Evaluation Procedures”]

Requirements for data product specifications may differ from one data producer to the next. The following elements draw heavily from ISO 19131 – “Geographic Information – Data Product Specifications”. Though your implementation may vary from that standard, it defines several sections within a data product specification that may prove to be insightful. [ISO 19131:2007(E) Clause 6 – “General Structure and Content of a Data Product Specification”]

- Overview – The overview contains an informal description of the specified data product including title, reference date, responsible party, language, topic category, terms and definitions, abbreviations, and acronyms, as well as other general information intended for human interpretation. [ISO 19131:2007(E) Clause 7 – “Overview”]
- Specification Scopes – The scope of a data product should describe its “spatial or temporal extent, feature types and properties included, spatial representation, or position within a product hierarchy.” If data content within the larger scope is partitioned based on separate criteria, then the scope of those partitions may also be elaborated. [ISO 19131:2007(E) Clause 8 – “Specification Scopes”]
- Data Product Identification – A title, abstract, topic category, and geographic description (if applicable) are the basic identifying information for a data product. Other information may be listed, such as a secondary title and/or the intended purpose of the data product. If applicable, the inclusion of spatial resolution and representation type (raster, vector, tabular, etc.) is appropriate. [ISO 19131:2007(E) Clause 9 – “Data Product Identification”]
- Data Content and Structure – A defining conceptual data model, or Application Schema, should be included to provide “the formal description of the data structure and content of the data product... It shall include the representation of feature types, property types including attribute types, feature operations and feature associations, inheritance relations and constraints... All the feature types, their attributes and attribute value domains, the association types between feature types, and feature operations expressed in the application schema shall be described in a feature catalogue” or similar document.” [ISO 19131:2007(E) Clause 10 – “Data Content and Structure”] [ISO 19109:2005 – “Geographic Information – Rules for Application Scheme”]
- Reference Systems – Geospatial data products must provide a description of any implemented spatial reference systems. Likewise, temporal reference systems in use must be specified. [ISO 19131:2007(E) Clause 11 – “Reference Systems”]
- Data Quality – The requirements for acceptable conformance quality levels and their corresponding data quality measures should be described for each specification scope defined for the data product. [ISO 19131:2007(E) Clause 12 – “Data Quality”] [ISO 8000-8:2015(E) Clause 5 – “Information and Data Quality”] [ISO 19157:2013(E) Annex B.3 – “When to Use Quality Evaluation Procedures”]

- **Data Product Delivery** – The product format and delivery medium must be defined. Name and version of the data format, file structure, language, character encoding, and more may be required so that the consumer may correctly interpret the data. Delivery medium may be described as the name of the data medium, estimated size and unit of measure (KB, MB, GB, etc.) of the data product, or other delivery information. [ISO 19131:2007(E) Clause 16 – “Data Product Delivery”]
- **Metadata** – “The format and encoding of the metadata shall be stated in the data product specification.” [ISO 19131:2007(E) Clause 18 – “Metadata”] Metadata provides a structure for describing finished data based on a data product specification. “It defines metadata elements, provides a schema and establishes a common set of metadata terminology, definitions and extension procedures.” [ISO 19131:2007(E) Annex B] In other words, “metadata describes how a dataset actually is, whilst a data product specification describes how it should be.” [ISO 19131:2007(E) Clause 6 – “General Structure and Content of a Data Product Specification”]

As needed, the following may also be necessary:

- **Data Capture** – “The data product specification may provide information on how the data is captured. Where this section of the data product specification is included, it shall contain a data capture statement which shall be a general description of the sources and the processes to be used.” [ISO 19131:2007(E) Clause 13 – “Data Capture”]
- **Data Maintenance** – “The data product specification may provide information on how the data is maintained. Where this section of the data product specification is included, it shall describe the principles and criteria applied in the maintenance of the data once it has been captured. This shall include the maintenance and update frequency which shall describe the frequency with which changes and additions are made to the data product.” [ISO 19131:2007(E) Clause 14 – “Data Maintenance”]
- **Portrayal** – “The data product specification may provide information on how the data held within the dataset is to be presented as graphic output, as a plot or as an image. Where included, this shall take the form of a reference to a set of portrayal rules and a set of portrayal specifications.” [ISO 19131:2007(E) Clause 15 – “Portrayal”]
- **Additional Information** – “This section of the data product specification may include any other aspects of the data product not provided elsewhere.” [ISO 19131:2007(E) Clause 17 – “Additional Information”]

## 1.2 Data Quality Elements

“Data quality elements and their descriptors are used to describe how well a data set meets the criteria set forth in its data product specification or user requirements and provide quantitative quality information.” [ISO 19157:2013(E) 6 – “Overview of Data Quality”] The following discussion of data quality elements begins with the importance of documenting the origin of data, as well as describing any subsequent transformations leading to its current state. The data's current state is also described by evaluating and reporting how well it conforms to its prescribed data product specification or other user requirements. Logical and format consistency, completeness, accuracy (positional, thematic, and temporal), usability, purpose, and usage are essential principles for understanding how data quality is measured and high-quality data is delivered.

### 1.2.1 Data Lineage/Provenance

On face value alone, there's only so much that one can infer about a data set. Data profiling techniques or standard summary statistics may provide an understanding of apparent field domains and the distribution of values. In the absence of accurate documentation, further conclusions may be just speculation. Metadata that accompanies a data set must enable the user to answer the Who, What, When, Where, Why, and How of the data's origin. Is this the data's original format and value set? Has this data, in whole or part, been transformed in any way since its original collection or creation? How was it collected, by whom, and for what originating purpose? Without knowing the answers to these and many other questions, one cannot know whether a data set is suitable for one's own purpose.

For example, consider bathymetric data. A national hydrographic office may collect acoustically derived soundings for the purposes of navigational charting and feature identification. Another national entity may conduct hydrographic surveys within maritime construction projects, such as navigation channels, to assess channel condition where dredging operations and maintenance is periodically required. Each may use similar equipment, such as real-time kinematic (RTK) positioning receivers to correct for errors inherent to satellite navigation systems, multibeam echosounders to achieve full seafloor sonar coverage, sound velocity probes to measure speed of sound through the water column, etc.

However, even if it were possible for both entities to collect data upon the same seafloor area simultaneously, the hardware systems employed, and the post-processing techniques applied could cause the resulting data to vary substantially. Also, when sorting soundings into a representational grid, such as 1-metre by 1-metre 'bins', the national hydrographer may require the shallowest sounding within the bin. Contrast that with the entity concerned with dredging operations, who may prefer to utilise an average value per bin for the approximation of dredging volumes above construction grade. Each is correct in utilising their methodology for their data's intended purpose. But, if that data is distributed for public consumption, without the accompanying metadata to describe the data's lineage in detail, it leaves the consumer to make assumptions about the sounding values that may be dangerously incorrect.

Data 'lineage' "describes the history of a data set and recounts the life cycle of a data set from collection and acquisition through compilation and derivation to its current form." [ISO 19157:2013(E) Clause 6 – "Overview of Data Quality, NOTE 2"] Data lineage is also described as data *provenance*; "the history or pedigree of a property value" where its presence in the metadata is "the record of the ultimate derivation and passage of a property value through its various custodians." [ISO 8000-120:2016(E) Clause 5 – "Fundamental Concepts and Assumptions"]. Each of these cited ISO standards recognises the importance of tracing data values back to their origin.

Who, what, when, where, why, and how are the elements of information needed for declaring the origin and history of any data set. A statement of scope describing the data's original purpose and processing methodologies should accompany the name of the originating entity. [ISO 19115-1:2014(E) Table G.4 – "Lineage Information"] [ISO 19115-1:2014(E) Table B.5.2 – "Source Information"] Entity information may also include the role of the person, or possibly the name of the person, who created the data to include contact information for follow-up questions. [ISO

8000-120:2016(E) Clause 6.5 – “Provenance Event”] The date and time of the data's first collection or creation should be declared to begin the chronological record of the set [ISO 8000-120:2016(E) Clause 6.5 – Provenance Event”], as well as to facilitate querying or analysis such as tracking trends or making comparisons with similar sets over time. Additionally, citations describing methodologies, algorithms, or references used in the data's origin may be useful, or even necessary, in the data's correct interpretation and use. Likewise, any subsequent transformation of the data should have detailed lineage information to expand upon the originating record. [ISO 19115-1:2014(E) Table B.5.1 – “Process Step Information”] [ISO 19115-1:2014(E) Table G.4 – “Lineage Information”] [ISO 8000-120:2016(E) Clause 7 – “Data Provenance Record”] Only then may a data consumer understand the data originator's intent and correctly interpret the creation, transformations, deletions, and enhancements that may have occurred within the derived data set that they have acquired.

## 1.2.2 Logical Consistency

'Logical consistency', "the degree of adherence to logical rules of data structure, attribution and relationships" [ISO 19157:2013(E) 7.3.3 – “Logical Consistency”], is a fundamental data topic made up of format consistency, conceptual consistency, domain consistency, and topological consistency (if there are spatial features). Unlike other data quality elements, some aspects of logical consistency can be verified in the data without any knowledge of whether the attribute values are true. This is because the syntax and structure of data are based on parameters defined within the data product specification or in an application schema (see Data Product Specification – Data Content and Structure), rather than what is known or regarded as true about the values themselves. [ISO 19157:2013(E) Annex I.2.1 – “General”] [ISO 8000-8:2015(E) Clause 5.1 – “Syntactic Quality”] [ISO 8000-8:2015(E) Annex B – “Syntactic Quality Rules”]

The application schema should describe the logical consistency rules that must be followed. Conformance and non-conformance to these rules must be evaluated, quantified, and reported. Errors under this data quality element may be recorded as a total quantity of errors or as an error rate (number of errors of a certain type divided by the total number of items and expressed as a percentage) within the data set. [ISO 19157:2013(E) Annex D.3 – “Logical Consistency”]

'Format consistency', "the degree to which data are stored in accordance with the physical structure of the data set", should be the first verification performed. This type of check may evaluate the delivery format of the data, the consistency of features, or other aspects of the data's defined physical structure. Uniqueness of primary key values in tables and the referential integrity of foreign key values are basic checks that fall into this category, as well. [ISO 19157:2013(E) Annex I.4.2.4 – “Format Consistency”] [ISO 8000-8:2015(E) Clause 5.1 – “Syntactic Quality”] [ISO 8000-8:2015(E) Annex B – “Syntactic Quality Rules”]

In addition to the structural conformance of the data, attributes may also be checked against a list of permitted values or the attribute 'domain'. This is 'domain consistency'. Attributes are readily verified for their conformance to the expected domain of values specified in the application schema, feature catalogue, or other documentation. [ISO 19157:2013(E) Annex D.3.2 – “Domain Consistency”]

The concept of *topological consistency*, “the correctness of the explicitly encoded topological characteristics of a data set” [ISO 19157:2013(E) 7.3.3 – “Logical Consistency”], applies to geographic data sets and must be verified according to rules that are, both, expressed in the data product specification and implicit to some types of features in geographic space. “Topology deals with the characteristics of geometric figures that remain invariant if the space is deformed elastically.” [ISO 19107:2019(E) – “Introduction”] In other words, if the data set is transformed from one spatial reference system to another, topology rules require that adjacent geometric features must remain adjacent, intersected features must remain intersected, and features which share nodes or vertices will remain linked at those nodes after transformation, even though their shape, area, or some other geometric characteristic may change as a result.

Additionally, the data product specification may have topological requirements. For example, there may be allowable tolerances within the data, such as the permitted distance between two lines by which they may mismatch, overshooting or undershooting, rather than intersecting as intended. These and other spatial parameters must be verified within the data. [ISO 19157:2013(E) Annex D.3.4 – “Topological Consistency”]

Finally, ‘conceptual consistency’ is the measurement of how well the data set conforms to rules of the conceptual schema, itself. “If the conceptual schema explicitly or implicitly describes rules, these rules shall be followed.” [ISO 19157:2013(E) Annex D.3.1 – “Conceptual Consistency”]

### 1.2.3 Completeness

‘Completeness’ is “the presence and absence of features, their attributes and relationships.” It is measured by evaluating data *commission*; the presence of excess data within the data set, and ‘omission’, i.e. the absence of necessary data from the data set in relation to the universe of data required in the data product specification. [ISO 19157:2013(E) Clause 7.3.2 – “Completeness”] [ISO 19157:2013(E) Annex I.4.1 – “Completeness”] Some aspects of completeness may be evaluated in checks for logical consistency (see ‘Logical Consistency’).

Upon evaluation, depending on requirements, a ‘statement of data completeness’ may be required to accompany the data set. Such a statement enables the recipient to know how the data compares to what is known or regarded as true, or to a predefined set of requirements. This document may include the process that generated the data (see ‘Data Lineage/Provenance’), the process used to verify completeness, data completeness evaluation results, and a report of known incompleteness in the data. [ISO 8000-140:2016 Clause 7 – “Statement of Data Completeness”]

An evaluation of completeness may include results that indicate the number of items which are incorrectly present in the data, as well as the number of those which are missing. [ISO 19157:2013(E) Annex D.2.1 – “Commission”] [ISO 19157:2013(E) Annex D.2.2 – “Omission”] For each of these, a detailed error count may be reported. The rate of missing and excess items may also be reported in relation to the total number of items that is known or regarded as true. Based on the values resulting from error count evaluations and/or rate of missing or excess items, an aggregated result may be recorded to provide a pass/fail status of the data set. [ISO 19157:2013(E) Annex E.3.2 – “Specify Data Quality Measures”], [E.3.4.3.4 – “Aggregated Conformance Result”]

## 1.2.4 Positional Accuracy

'Positional accuracy' is "the accuracy of the position of features within a spatial reference system." [ISO 19157:2013(E) 7.3.4 – "Positional Accuracy"] A less abstract description may be that "when two features (a pair with one in the data set and the other in the ground truth) are decided to be representations of the same real-world phenomenon, the deviations between the two are handled as accuracy." [ISO 19157:2013(E) Annex I.3.4 – "Dependency between Completeness and Accuracy"] It is measured by evaluating, potentially, three data quality elements:

- 'Absolute or external accuracy' is "the closeness of reported coordinate values to values accepted as or being true." [ISO 19157:2013(E) 7.3.4 – "Positional Accuracy"] [ISO 19157:2013(E) Annex C.2.1.2 – "Data Quality Element Table C.2"]
- 'Relative or internal accuracy' is "the closeness of the relative positions of features in a data set to their respective relative positions accepted as or being true." [ISO 19157:2013(E) 7.3.4 – "Positional Accuracy"] [ISO 19157:2013(E) Annex C.2.1.2 – "Data Quality Element Table C.2"]
- 'Gridded data positional accuracy' is "the closeness of gridded data spatial position values to values accepted as or being true." [ISO 19157:2013(E) 7.3.4 – Positional Accuracy"] [ISO 19157:2013(E) Annex C.2.1.2 – "Data Quality Element Table C.2"] "The accuracy of gridded data may be described using the same data quality measures as for the horizontal positional uncertainty." Raster cell attribute values may be evaluated using quantitative attribute accuracy measures (see 'Thematic Accuracy'). [ISO 19157:2013(E) Annex D.4.3 – "Gridded Data Positional Accuracy"]

At the most basic level, measuring the quality of horizontal or vertical positional data begins as a comparison between data set positions and what are considered to be corresponding true positions (ground truth). Since the data set measurements are regarded as approximations of the actual value being measured, the quality measure is complete only when accompanied by a quantitative statement of the result's 'uncertainty'. [NIST Technical Note 1297 – "2. Classification of Components of Uncertainty"] Therefore, 'accuracy' itself is not being measured quantitatively here. It is the uncertainty of the data set values, based on error probability, that is being measured. Once evaluated, the result is used to characterise the horizontal and/or vertical positional accuracy of the data. [NIST Technical Note 1297 Appendix D.1.1.1 – "Accuracy of Measurement"]

Commonly, the numeric differences between the data set and true positions are used to derive a mean value, a count of errors within the set that exceed a specified threshold, a ratio of errors to the total positions, bias in the data set related to directional deviation from true positions, as well as a result derived from various statistical methods to a desired confidence level rendering an uncertainty value. [ISO 19157:2013(E) Annex D.4.1.1 – "General Measures for Positional Uncertainties"] It should be noted that 'horizontal positional uncertainties' are measured as 'circular' or 'elliptical' error due to their two-dimensional nature (X-axis and Y-axis coordinates). [ISO 19157:2013(E) Annex D.4.1.3 – "Horizontal Positional Uncertainties"] However, 'vertical position uncertainties' are expressed as 'linear' error, since the value represented exists in only a single dimension (the Z-axis). [ISO 19157:2013(E) Annex D.4.1.2 – "Vertical Positional Uncertainties"]

Additionally, low positional accuracy may not happen in isolation from the other quality measures. Poor positional quality can have cascading effects. For example, when comparing data set geographic data to corresponding ground truth data for determining accuracy, one must determine if the features being linked are, in fact, the same feature within the ground truth set, or if they are different features altogether. If the features are considered to be different, then one must determine if features are missing in the data set (omission, see 'Completeness'), or if there are extra features in the data set that have no link to ground truth (commission, see 'Completeness'). [ISO 19157:2013(E) Annex I.3.4 – “Dependency between Completeness and Accuracy”] [ISO 19157:2013(E) Annex I.4.3 – “Positional Accuracy”]. Additionally, “a coordinate error may generate at least two kinds of errors, a positional error and a topological error.” [ISO 19157:2013(E) Annex B.1 – “Framework of Data Quality Concepts”]. Be sure to consider such interrelatedness when writing data product specifications, applying data quality measures, and analysing the results.

### 1.2.5 Thematic Accuracy

'Thematic accuracy' is "the accuracy of quantitative attributes and the correctness of non-quantitative attributes and of the classifications of features and their relationships." It is measured by evaluating three elements: classification correctness, non-quantitative attribute correctness, and quantitative attribute accuracy. [ISO 19157:2013(E) Clause 7.3.5 – “Thematic Accuracy”]. An effective example to illustrate this data quality element can be found in the attributes of bridge objects in a navigational chart. The 'Category of Bridge' (CATBRG) attribute is encoded with values like 'Fixed Bridge', 'Swing Bridge', 'Bascule Bridge', etc. As such, it could be measured for Classification correctness. Horizontal Units (hunits, e.g. 'kilometres', 'statute miles', etc.) and Horizontal Clearance (HORCLR) attributes could be measured for non-quantitative attribute correctness and quantitative attribute accuracy, respectively.

- 'Classification correctness' is the comparison of the classifications encoded within the data to what is known or regarded as true. The accuracy of attribute values may be measured as the quantity of individual misclassifications within the data, the rate of misclassification error within the set, or as a result derived from statistical analysis. [ISO 19157:2013(E) Annex D.6.1 – “Classification Correctness”]
- 'Non-quantitative attribute correctness' is the measure of correctness for qualitative data within the set. Non-quantitative errors may be measured as the quantity of individual misclassification errors within the data, or as a rate of correct or incorrect values compared to the whole set. [ISO 19157:2013(E) Annex D.6.2 – “Non-Quantitative Attribute Correctness”]
- 'Quantitative attribute accuracy' is the comparison of the correctness of quantitative values to what is known or regarded as true. This measure is expressed as attribute value uncertainty to a desired statistical significance level. [ISO 19157:2013(E) Annex D.6.3 – “Quantitative Attribute Accuracy”]

### 1.2.6 Temporal Quality

Temporal values may be recorded as discrete events, continuous periods, or even describe the behaviour of features as a function of time (time series). “The quality of temporal attributes and

temporal relationships of features consist of three quality elements" [ISO 19108:2002(E) – "Introduction"] [ISO 19157:2013(E) Clause 7.3.6 – "Temporal Quality"]:

- 'Accuracy of a time measurement' is the "closeness of reported time measurements to values accepted as or known to be true". [I.4.4.2 – "Accuracy of a Time Measurement – Closeness of reported time measurements to values accepted as or known to be true"] In addition to the quality measures related to the logical consistency of date and time values (see 'Logical Consistency'), the quality of time measurements may also be expressed as an uncertainty value to a desired statistical significance level. [ISO 19157:2013(E) Annex D.5.1 – "Accuracy of a Time Measurement"] [ISO 19157:2013(E) Annex I.2.1 – "General"]
- 'Temporal consistency' is a measure of the correctness of the order of events within data values. Temporal consistency may be measured as the quantity of individual errors within the data, or as a rate of correct or incorrect values compared to the whole set. [ISO 19157:2013(E) Annex D.5.2 – "Temporal Consistency"] [I.4.4.3 – Temporal Consistency – Correctness of the order of events] [ISO 8000-8:2015(E) Annex B – "Syntactic Quality Rules"]
- 'Temporal validity' is a measure of conformance of date and time values to formats specified in the conceptual schema, as well as the validity of values when compared to natural time (correct number of days in a month, up to 24 hours in a day, etc.). Temporal validity may be measured as the quantity of individual errors within the data, or as a rate of correct or incorrect values compared to the whole set. [ISO 19157:2013(E) Annex D.5.3 – "Temporal Validity"] [I.4.4.4 – "Temporal Validity – Validity of data with respect to time"] [ISO 8000-8:2015(E) Annex B – "Syntactic Quality Rules"]

It is important to note that, for some purposes, data may lose its 'timeliness' or 'up-to-datedness' when it is no longer considered current. For other purposes, the original snapshot in time captured by the data may continue to retain or increase in value. This will depend on user requirements. To compensate, the data product specification may require rules for 'supersession', or the replacement of data considered to have lost its value due to passage of time. [ISO 19157:2013(E) Annex I.2.2 – "Other Candidates"] [ISO 8000-8:2015(E) Annex C – "Pragmatic Quality"]

### 1.2.7 Usability

The 'usability' of a data set for a particular application may also be evaluated, though this is more dependent on user requirements than the concepts described in the preceding data quality elements. In fact, the preceding elements may need to be evaluated, in aggregate, before arriving at a result declaring usability. [ISO 19157:2013(E) Clause 7.3.7 – "Usability Element"] [ISO 19157:2013(E) Clause 10.2.1 – "Reporting Aggregation (Aggregated Results)"]

Evaluations of individual feature attributes, for example, are limited in scope when compared to the evaluation of the data set as a whole. Therefore, results from individual quality evaluations may need to be compared to thresholds defined in the data product specification or other guidance document. If enough minimum quality measures are satisfied or a sufficient pass/fail rate is achieved, then the overall usability of the data may be affirmed. The usability of the whole dataset could, ultimately, be declared in a single pass/fail determination derived from individual data quality measurements evaluated in aggregate. [ISO 19157:2013(E) Annex D Table D.77 – Table D.81] [ISO 19157:2013(E) Annex J – "Aggregation of Data Quality Results"]

### 1.2.8 Usage

The 'usage' of the data, written in the metadata for the consumer, "describes the application(s) for which a data set has been used, either by the data producer or by other data users." [ISO 19157:2013(E) 6 – "Overview of Data Quality"] Given such a description, a prospective user may infer the appropriateness of the data set for their own purposes.

### 1.2.9 Purpose

High-quality data is expensive to create and should be developed with intent. Therefore, the developer's 'purpose' should be stated for the user in the metadata. Purpose "describes the rationale for creating a data set and contains information about its intended use, which may not be the same as the actual use of the data set." [ISO 19157:2013(E) 6 – "Overview of Data Quality"]. Again, given such a description, a prospective user may infer the appropriateness of the data set for their own purposes.

## 1.3 Conclusion

"Geographic data are increasingly being shared, interchanged, and used for purposes other than their producers' intended ones. Information about the quality of available geographic data is vital to the process of selecting a data set in that the value of data are directly related to its quality. A user of geographic data may have multiple data sets from which to choose. Therefore, it is necessary to compare the quality of the data sets to determine which best fulfils the requirements of the user." [ISO 19157:2013(E) – "Introduction"]

Ultimately, the application of any data quality element depends upon user requirements. It is not 'one size fits all'. But the care taken to specify, produce, and maintain the data, as well as to improve the process by which it is created, will sum to the data's 'semantic quality'. Incorrect, misidentified, or ambiguous entries can cause a data set to lose its meaning. Therefore, to fulfil the data's intended purpose, high-quality attributes and relationships within the data must be mapped completely, correctly, meaningfully, and consistently. [ISO 8000-8:2015(E) Clause 5.2 – "Semantic Quality"] The data product specification should be highly detailed in defining the data's structure, and corresponding measures to evaluate the quality of that data product, along with a prescribed means of reporting the results, should be part of the ongoing cycle of data quality measurement, assessment, and improvement.

## ANNEX 2. SYNCHROMODAL TRENDS AND DEVELOPMENTS

In this Annex, trends and developments following the implementation of the COMEX corridor platforms EuRIS<sup>19</sup> and CEERIS<sup>20</sup> (Central and Eastern European Reporting Information System), as well as the masterplan DIWA, the project IW-Net<sup>21</sup>, and PLATINA3<sup>22</sup> are evaluated and compared to identify potential contributions to the realisation of the concept of Synchronomodality. Also, trends and developments from sources outside IWT, like EMSWe, FRAME, ETRAC, and, Yellowstar are taken into consideration and evaluated for the same purpose.

### 2.1 Contributions and Current Trends from Corridor Management

The implementation of corridor and network management, including intermodal nodes, as essential building blocks and prerequisites for the realisation of Synchronomodality has introduced important services and approaches for all transport modes.

The scope of intermodal Corridor Management has been outlined by the American Association of State Highway and Transportation Officials (AASHTO) in 2016:

***“Intermodal Corridor Management strives to match the right services to meet demand at the least social and economic cost while maximizing the return on previous and future investments in infrastructure and services. As a management concept, intermodal Corridor Management builds on the principles of multimodal corridor planning, integrated Corridor Management, and active traffic management. It recognizes that multiple modes can satisfy a variety of travel demands within a corridor, and that most movement of people, goods, information, and services in a corridor involves movement between modes. With scarce funds available for transportation system preservation, safety, operations, and capacity additions, all modes must provide more than just choice – they must deliver performance.”***

### 2.2 RIS COMEX Project – RIS Corridor Service Developments

RIS-enabled Corridor Management, as developed by the CoRISMa project, was taken up by the RIS COMEX project and considerable progress has been made in the realisation of harmonised RIS services on the Corridor as well as the European level by implementing EuRIS and CEERIS.

RIS Operational Services were standardized and a single stop shop data portal established, granting stakeholders from all transport modes comprehensive access to IWT information in a single location. Additionally, existing RIS services on routes and networks were improved and linked in order to supply RIS on regional, national, and international levels. Services supporting route planning, voyage planning, transport management and traffic management (previously only available in fragments) were implemented on the level of European RIS Corridors and beyond. The implementation also involved the mutual sharing of information services among waterway authorities, as well as with waterway users and their logistics partners.

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<sup>19</sup> <https://www.eurisportal.eu/>.

<sup>20</sup> <https://ceeris.eu>.

<sup>21</sup> <https://www.iw-net.eu/>.

<sup>22</sup> <https://platina3.eu>.

Preexisting services that were transferred to EuRIS and CEERIS were classified into 3 service levels in line with the previous 'PIANC Guidelines and Recommendations for River Information Services'. Below is a high-level overview of the actual status of service implementation and existing implementation gaps in the European IWT corridors.

- Implemented level 1 services in RIS COMEX comprise static and dynamic fairway- and infrastructure information: water levels, lock status, predictions, and NtS.
- Implemented level 2a services in RIS COMEX include the actual traffic situation: traffic density, passage durations and anonymized vessel positions.
- Implemented level 2b services in RIS COMEX include predicted traffic situations based on traffic planning and forecasts.
- Implemented level 3 services provide information about specific vessels (positions, ETAs, ETA delays) for authorised users as well as cargo and/or voyage information of specific transports for authorised users.

Details on the current implementation status of level 1, 2a, 2b and 3 services can be found in the Masterplan DIWA SuAc 2.4 report on Corridor Services and on the EuRIS and CEERIS web portals.

### **2.2.1 RIS COMEX – Identified Service Gaps Towards Synchronomodality**

The following service gaps and development needs were identified during the implementation of RIS COMEX on European IWT corridors:

- Elimination of gaps concerning predictive services: Implementation of sophisticated prediction tools for level 1 services (vertical bridge clearances and least fairway depth) level 2b services (traffic flows, traffic density, passage duration, infrastructure occupation) and level 3 services (berth reservations, vessel inspections) must be accelerated to keep pace with other transport modes and to enable availability-based transport decisions.
- Elimination of data/service gaps in corridors: Ensure that missing level 1, 2 and 3 services are implemented in the remaining project countries to ensure that IWT provides corridor-wide underlying services to support development of Synchronomodality.
- Geographical extension: Comprehensive rollout of harmonized services to all IWT corridors and countries beyond the 13 COMEX partner countries to ensure that IWT provides network-wide underlying services for implementation of Synchronomodality.
- Increase data quality: Implementation of data consistency/quality checks on corridor/network level.
- Increase accessibility of data and services: Provide access to all relevant involved parties in the supply chain as cargo owners, receivers, shippers, agents and terminal operators.
- Interconnection of ERI (corridor) systems: Provide and exchange transport and voyage data.
- Interconnection with port community systems: harmonise data sets and interconnect port community systems to exchange transport and voyage data.
- Interconnection of existing in-house systems to exchange transport and voyage data.

- Interconnection with platforms of other transport modes: harmonise data sets and interconnect platforms of other transport modes in order to exchange transport and voyage data.

## 2.3 DIWA – New RIS Service Business Needs

DIWA, the CEF co-funded project 'Masterplan Digitalisation Inland Waterways' is a study project with the goal of elaborating the methodology for the digitalisation of inland waterways by fairway authorities during the period 2023-2033. DIWA will advance the development of a digitalised inland waterway network among participating fairway authorities. The five countries participating in the Masterplan DIWA cover a large part of the TEN-T network (corridors): North Sea-Baltic, North Sea-Mediterranean, Rhine-Alpine, and Rhine-Danube. Completion of the strategic masterplan is expected by end of 2023 and will be comprised of business developments (smart shipping, synchromodality, port and terminal information services, RIS-enabled corridor management, developments in ITS, ERTMS, e-navigation), technological developments (including new technologies, IWT connectivity platforms, smart sensors and PNT, information models, and technologies in other transport domains) as well as facilitation topics (standardisation, legal and regulatory aspects, cybersecurity and privacy, data quality).

In DIWA, the main business requirements that RIS can contribute to are identified in sub-activity 2.4 'RIS Corridor Management'. This analysis is based on feedback from IWT stakeholders and RIS users involved in previous and ongoing national and international projects and initiatives. In DIWA sub activity 2.5 the business requirements from sub activity 2.4 as well as from other transport modes, were reflected in an updated list of RIS Functions, which served as input for the amended list of RIS Functions in Chapter 6.2.

### 2.3.1 Identified New Business Needs

The following are the main business requirements that will be addressed by planned RIS corridor service developments:

- Increase accessibility to relevant fairway-, infrastructure-, traffic- and transport-related information. Accessibility needs to be improved in order to optimise route and voyage planning, as well as traffic- and transport-management. This will increase overall efficiency within IWT. Ideally, comprehensive data would be accessed through a single point of access instead of being distributed across multiple regional or national websites/portals/services. The volume of data and number of interconnected services to be integrated and sustained must be given due consideration.
- Reduce administrative barriers and reporting burdens. The reporting burden on skippers and vessel operators needs to be decreased, ideally resulting in a system where they need only report data for their entire voyage once and no further action is required. To reach this target, the existing electronic reporting systems must be optimized and interconnected to enable the automated exchange of voyage- and cargo-related information. The requirements provided by the eFTI directive specifying details on datasets, architecture, and interfaces for the exchange of transport information between the transport modes are important steps towards multimodal transport.
- Integrate RIS into a multimodal transport architecture. This will ease the burden of planning and implementing a system of multimodal transport with fully-integrated IWT

and, therefore, foster a modal shift towards inland navigation. Principles elaborated by the Digital Transport and Logistics Forum (DTLF) initiative concerning paperless transports and corridor managing need to be addressed by new IWT services.

- Provide RIS data to logistics platforms as basis to further interlink advanced logistics services.
- Optimize cycles for locks and bridges. Minimise wait times at facilities and make information on wait times available for use in (multimodal) transport planning platforms. Implementation of this goal also requires reliable infrastructure information (e.g. operating time, status, utilisation), vessel information (e.g. type, dimensions, position and ETA), and utilisation of smart lock/bridge management systems.
- Increase utilisation of available IWT transport capacity. Increase use of available IWT transport capacity, network efficiency, and economic competitiveness by enabling greater coordination and information flow among interested stakeholders.
- Increase awareness of environmental benefits. Optimise voyage planning and traffic management to contribute to a reduction of fuel consumption, generating both environmental and economic benefits.

## 2.4 IW-Net Project

The objective of the IW-Net project<sup>23</sup> is to deliver a multimodal optimisation process across the EU transport system by April 2023, increasing the modal share of IWT and supporting the EC's ambitions to reduce transport GHG (greenhouse gas) emissions by two-thirds by 2050. The project consortium expects that enablers of sustainable infrastructure management and innovative vessels will support an efficient and competitive IWT sector by addressing problems, such as infrastructure bottlenecks, insufficient IT integration along the chain and slow adoption of technologies (e.g. new vessel types, alternative fuels, automation, IoT, machine learning).

To increase the modal share of IWT, several actions must be taken and new services developed:

- Optimised planning of barge operations and predictive demand routing.
- Lockage forecasting.
- Data-driven optimisation on navigability in uncertain water conditions.
- Management of fairway sections with reduced fairway width.
- Use of DGNSS services for assisted guidance services, bridge height warnings and automatic lock entering.

IW-Net recommendations towards Corridor Management and Synchromodality:

- Include Galileo services in the existing service portfolio.
- Expand advanced bottleneck services including low water forecasts.
- Expand predictive traffic services.

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<sup>23</sup> <https://www.iw-net.eu/>.

## 2.5 PLATINA3

The platform PLATINA3 assists the European Commission in implementing the European action programs to support inland navigation and develops the path towards future research, innovation, and implementation needs.

The following priority topics were identified for the success of IWT:

- Integration and digitalisation of IWT toward synchromodality.
- Zero-emission, automated, and climate resilient fleets.
- Skilled workforce to support zero-emission and/or automated vessels.
- Smart and climate resilient waterway and port infrastructure with clean energy hubs.

PLATINA3 recommendations for Corridor Management and Synchromodality:

- Expand services supporting a reliable computation of GHG emissions for inland waterway transport.
- Develop services to enhance the visibility of ecological advantages of IWT.
- Provide services that support zero- and low-emission transports.

## 2.6 EMSWe – European Maritime Single Window Environment

The EC 2010/65 regulation for a European maritime one-stop shop environment, also known as EMSWe (technologically neutral and interoperable and with harmonised interfaces) aimed to facilitate the handling of electronic information of ships entering, staying and leaving any ports in the European Union. In order to ensure competitiveness and efficiency of European maritime transport sector it was considered necessary to reduce the administrative burden on ships and to facilitate the use of digital information with the aim of improving the efficiency, attractiveness and environmental sustainability of maritime transport and contribute to the integration of the sector to the digital multimodal logistic chain. In 2020, Directive 2010/65, also called Reporting Formalities Directive (RFD), was adopted. The aim of this regulation is to establish harmonised rules for the provision of information required at port calls, ensuring that the same sets of data can be communicated at each national maritime single window. It also intended to facilitate the transmission of information between declarants, competent authorities and port service providers in ports of call as well as other Member States.

An evaluation of the directive in 2016 concluded that some objectives were partially achieved while others were not achieved at all. Consequently, the 'Valetta Declaration' was introduced aiming for a harmonised European Single Window environment characterised by the following aspects:

- Fully-harmonised interfaces available to ship operators to provide information in the same way and format across the EU.
- A standardised maximum data set including the information necessary for the management of port and port terminals in order to ensure true submit-only-once. Any relevant data already provided to authorities should be made available among all authorities and not be required again.

This European Single Window environment is now being established by EC regulation 2019/1239<sup>24</sup> with the objective of establishing the legal and technical framework for harmonized reporting interfaces as well as services for:

- User registry and access management
- Common addressing service
- EMSWe ship database
- Common location database
- Common hazardous material database
- Common ship sanitation database

EMSWe recommendations for development of Corridor Management and Synchromodality:

- Implement fully-harmonised interfaces available to ship operators that provide information consistently across the EU.
- Implement a standardized and harmonised maximum data set including the information necessary for the management of port, port terminals, and IWT corridors in order to ensure true submit-only-once. Any relevant data already provided to authorities should be made available among authorities and not be required again.
- Harmonise and maintain reference data.

## 2.7 European Road Network Projects

In this section, trends and developments elaborated within the implementation of European road network projects such as FRAME (the FRamework Architecture Made for Europe), C-Roads Platform (Cooperative ITS), Beter Benutten Program (Better Use) and Initiatives as ERTRAC were evaluated and compared to identify potential contributions for the realisation of the concept of Synchromodality and necessary steps towards this goal.

In the road sector ITS applications and services and their interfaces with other modes of transport are addressed by the EU Intelligent Transport Services (ITS) directive 2010/40 that includes both passenger and freight transport services. The directive set out overarching objectives for service developments:

- Cooperative Intelligent Transport Systems (C-ITS)
- EU-wide real-time traffic information services
- Information services on recharging/refuelling stations
- Access to vehicle data for road operation and maintenance purposes
- eCalls (emergency services)

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<sup>24</sup> <https://eur-lex.europa.eu/EN/legal-content/summary/european-maritime-single-window-environment-emswe.html>.

### 2.7.1 FRAME – the FRamework Architecture Made for Europe

The FRAME Architecture programme<sup>25</sup> was created to provide a minimum stable framework necessary for the deployment of integrated and interoperable ITS within the European Union. The aim of the programme was the establishment of a single European road transport area. Reference architectures were developed for National Access Points (NAP), emergency services (eCall), Cooperative Intelligent Transport Systems (C-ITS) and Truckparking. The following services were focused on to guarantee compliance at the interfaces of other systems so that seamless services can be provided for cross-border travel:

- Freight and fleet operations
- Traffic management
- Road tolls
- Public transport management
- Trip Planning and travel information
- Support for safety and emergencies
- Support for law enforcement

FRAME recommendation for development towards Corridor Management and Synchromodality:

- Harmonise and standardise architecture principles and interfaces with other transport modes.

### 2.7.2 C-Roads Platform

The C-Roads Platform<sup>26</sup> is a joint initiative of European Member States and road operators for testing and implementing C-ITS services to support cross-border harmonisation and interoperability. C-ITS encompass a group of technologies and applications that allow effective data exchange through wireless communication technologies between components and actors of the transport system, between vehicles (vehicle-to-vehicle or V2V), and between vehicles and infrastructure (vehicle-to-infrastructure or V2I).

These services comprise top-level requirements and functionalities for use cases such as signalised intersection, in-vehicle signage, probe vehicle data, hazardous location notification, and road work warning [C-roads Brochure; 2021].

### 2.7.3 Dutch Multimodal Network Management ‘Beter Benutten’

In the Dutch ‘Beter Benutten’ (Better Use) programme, national authorities, regional authorities and industry worked together to improve accessibility by means of road, water and rail transportation. The programme has resulted in a significant reduction in congestion during the

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<sup>25</sup> <https://frame-online.eu/>

<sup>26</sup> <https://www.c-roads.eu/platform/about/about.html>

rush hour on specific routes. These results have been achieved through a package of over 350 measures.

The programme focuses mainly on measures that enable travellers to get to their destination quickly and in a smart way. Measures are clustered into three types: supply, demand, and Intelligent Transport Systems and Services (ITS)/dynamic traffic management measures.

The programme implemented several multimodal services:

- Multimodal passenger travel planner based on real-time information and alerts for deviations in the voyage plan.
- Real-time performance indicators to inform about disruptions and possible changes to another transport mode.
- Blue wave information on bridge and navigation lock opening times and improvement to voyage planning process.
- Business to Business service for combining cargo resulting in more efficient transport by water.

'Beter Benutten' recommendations for Corridor Management and Synchronomodality:

- Share real-time performance data and notifications with users.
- KPI monitoring and KPI definition could become an important step towards multimodality enabling the user to choose the optimal mode for his transport.
- Facilitate services for combining cargo for more efficient transport with higher utilisation rates.

#### **2.7.4 ERTRAC (European Road Transport Research Advisory Board)**

The European Roadmap on 'Sustainable Freight System for Europe – Green, Safe and Efficient Corridors', elaborated by the ERTRAC Working Group on Long Distance Freight Transport in 2011, intends to show the best path to develop and implement transport corridor concepts and measures to improve the safe and clean usage of transport infrastructure.

Concerning Logistics and Intramodality, the roadmap states that the business sector and in particular the logistics services, are driven by an optimised use of all transport modes as well as network planning based on existing and forecast traffic flows. In order to support this, corridor performance information must be collected and distributed. This would be a benefit to both private and public parties since it allows all stakeholders to better plan and coordinate transport activities. Another important need is standardisation of the measurement frameworks for transport performance, environmental footprint, and negative transport effects. Additionally, the means to collect real-time data and deliver it to these measurement frameworks must be developed.

ICT is one of the key enablers for creating a safe, sustainable, and efficient transport system. The roadmap states that the main challenges here are interoperability and harmonisation. According to the European Roadmap, research and innovation activities in all areas should start with collating existing ITS solutions to assess the needs for further research and requirements for integration of individual technologies into sub-systems and full-scale systems.

ERTRAC recommendations towards Corridor Management and Synchronomodality:

- Generate and provide information about corridors logistic performance to better plan and coordinate transport activities.
- Standardise the measurement frameworks of transport performance, environmental footprint and negative transport effects and feed these measurement frameworks with real time data feeds obtained from transport and logistics operations.

### **2.7.5 Strategic Transport Research and Innovation Agenda (STRIA) – Smart Mobility and Services (SMO)**

The European Strategic Transport Research and Innovation Agenda (STRIA) is supported by the European Transport Research and Innovation Monitoring and Information System (TRIMIS)<sup>27</sup> in the analysis of technology trends and research and innovation capacities of the European transport sector. Their research agenda outlines future transport research in seven thematic transport research areas:

- Connected and automated transport (CAT)
- Transport electrification (ELT)
- Vehicle design and manufacturing (VDM)
- Low-emission alternative energy for transport (ALT)
- Network and traffic management systems (NTM)
- Smart mobility and services (SMO)
- Transport infrastructure (INF)

In the Roadmap on 'Smart Mobility and Services', several recent developments are noted as significant including:

- Integrated fare management and smart parking
- Multimodal transportation solutions including real-time information
- Urban freight and micro-distribution
- Vehicle sharing
- Electric and autonomous driving services and emergency services
- Drone technology and on-demand services
- Smart data management and intelligent traffic management

'Smart Mobility' recommendations for Corridor Management and Synchronomodality:

- Provide services to identify free transport capacities.
- Expand harmonised services for berth management and fee calculation.

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<sup>27</sup> <https://trimis.ec.europa.eu/>.

## 2.8 Rail Corridor Service Developments

The implementation of the European Rail Traffic Management System (ERTMS) aimed at replacing the different national train control and command systems in Europe to facilitate cross-border transports. It is a single, EU-wide, signalling and speed control system that ensures interoperability between national railway systems. This telecommunications technology reduces the purchasing and maintenance costs of signalling systems, increases the speed of trains, raises the capacity of infrastructure and improves the level of safety.

In ERTMS 'levels' define different uses of ERTMS as a train control system, ranging from track to train communications (Level 1) to continuous communications between the train and the radio block centre (Level 2). Level 3, which is in specification development phase, will further increase ERTMS' potential by introducing a 'moving block' technology and reducing trackside equipment for train detection. It is commonly acknowledged that to date, ERTMS level 2 offers considerable benefits. However, even the use of only level 1 already provides significant advantages for railways and enables High Speed travel.

ERTMS recommendations for Corridor Management and Synchromodality:

- Further investigate the development of automated and harmonised ship to ship communication.
- Further investigate the development of automated and harmonised ship to shore communication.

### **Yellowstar/Rail Cargo Austria - Corridor Transport Management in RAIL**

Rail Cargo Austria deployed a new transport management system (TMS) and terminal operating system (TOS) for controlling its international intermodal transport operations and enabling the exchange of traffic management-related data. Yellowstar (a Dutch IT provider) was commissioned with the development and offers full supply chain IT solutions on top of existing systems. TMS and TOS work from a single platform which partners and customers will have access to. Via the web or EDI, they will be able to see orders, upload documents and more. All operational information will be made available to all users throughout the entire international network. Customers are able to directly receive real-time information about every step in the transport. Furthermore, workflow management, track and trace, event management, and issue management were implemented for users.

According to Rail Cargo Austria the following Corridor Services are provided:

1. Real-time full supply chain management (Control towers offer actual control over logistics chains, Insight into all orders at all times, from factory to delivery, pro-actively management, tracking and adjusting inbound and outbound flows, from booking to invoicing, functions as a shell over existing ERP system).
2. Intermodal Transport Management System (through clear criteria-required speed, costs, restrictive conditions – the best workflow and modality can always be determined: road, rail or inland shipping).
3. Transport Planning (a central planning board for road transport that can simultaneously be used at multiple office locations offers full, round-the-clock insight).

4. Modular Terminal Operation System for inland terminals (management of inland terminals, seamlessly connects pre-transport and post-transport, planning and controlling of the actual terminal operation and terminal capacity to organising all the associated links together with chain partners, full insight into all visiting trucks, barges and trains).
5. Digital Power Strip (ESB, Enterprise Service Bus) for quickly and securely connecting systems and 24/7 real time data exchange (converts all data into the desired format for pertinent users and always distributes it to the relevant parties). Correct interfaces for all relevant connections are provided (ERP systems, logistics management systems such as a TMS, WMS or TOS, community systems).
6. Web-based solution for 24/7 real-time data exchange with multiple parties (efficient communication with customers and carriers with pro-active alerts based on a control tower allowing for master data management, event management, user management equipped with a dashboard (customer orders and status)).
7. Logistics module for social supply chain communication (direct communication within the supply chain).
8. Configurable KPI dashboard with 24/7 logistics insight (employees can set up a separate environment with KPIs relevant for their specific position allowing for immediate interventions and adjustments).

Rail Cargo Austria/Yellowstar recommendations for Corridor Management and Synchromodality:

- Further research coverage of the full supply chain and full supply chain visibility.
- Investigate interfacing functionalities to enable the use of existing ERP systems.
- Investigate best workflow and optimisation of modal choice.
- Ensure service interoperability at terminals.
- Implement performance indicators for services.

## 2.9 General Comparison with Other Transport Modes

A comparison of data services with the other modalities provides evidence that IWT has similar data services on a functional level. Objectives and principles are mostly derived from a European and global perspective and thus are largely similar. Differences in offered service portfolio depend on the characteristics of the respective transport mode and level of integration in multimodal service platforms.

## 2.10 Green Deal

Awareness about taking care of the environment is global, but the focus is different per continent. Inland navigation could play a significant role in support for transition of mobility towards higher environmental friendliness.

### 2.10.1 European Green Deal

Climate change as a general threat to the world is the topic for the new European policy called European Green Deal. On 14 July 2021, the European Commission adopted a set of proposals to transform the EU into a resource-efficient and competitive economy, where no net emissions of greenhouse gases will be reached by 2050, economic growth will be decoupled from resource use and no person and no place left behind.

With transport contributing around 5 % to the EU GDP, employing more than 10 million people in Europe and as the second-largest area of expenditures for European households, the transport system is critical to European businesses and global supply chains. At the same time, transport is not without costs to our society: greenhouse gas and pollutant emissions, noise, road crashes and congestion.

In Europe there are three major objectives – Sustainable Mobility, Smart Mobility and Resilient Mobility.

#### **Sustainable Mobility:**

Today, transport emissions represent around 25 % of the EU's total greenhouse gas emissions, and these emissions have increased over recent years. A clear path is needed to achieve a 90-% reduction in transport-related greenhouse gas emissions by 2050. As a middle term goal, the European Commission adopted a set of measures for reducing net greenhouse gas emissions by at least 55 % by 2030, compared to 1990 levels. Transportation by inland waterways and short sea shipping is envisioned to increase by 25 % by 2030.

#### **Smart Mobility:**

Smart mobility in freight transport by inland waterways consist of the objective to unleash full potential of data, by 2030 freight transport will be paperless and by 2050, automated mobility will be deployed on large scale.

#### **Resilient Mobility:**

Building a mobility system that is resilient means investment in transport infrastructure and by 2050 a fully operational, multimodal Trans-European Transport Network for sustainable and smart transport will be available, with improved conditions for transport workers and the highest standards of safety and security in European transport. As a result, the death toll for all modes of transport in the EU should be close to zero by 2050.

### **2.10.2 Green Deal Strategies in Asia**

China aims to become carbon neutral by 2060, with an emission peak by 2030. The focus lies on industry, energy mix, urban & rural development, transport, innovation, carbon storage, regulations standards and policies related do carbon dioxide emissions.

Japan aims to be carbon neutral by 2050. Here the focus seems more on renewables, nuclear power, carbon recycling & storage. South Korea aims at being 40 % renewable by 2034, with special attention for an increase of renewable energy in transport fuel, for example via the broad usage of biodiesel.

Singapore aims to become carbon neutral somewhere between 2050 and 2100. Special attention is given to the reduction of water usages and waste generation, and halving the energy used for desalination.

### 2.10.3 How Could RIS Help to Fulfil Green Deals?

Creating a 'Green Deal' in transport is not only about shifting from fossil fuels to low- and zero-emission mobility, but also about more efficient use of energy, reduction of waste and consumption, removing administrative burdens and introducing smart mobility instruments which foster multimodal and sustainable mobility with fair jobs.

RIS could play a significant role in supporting IWT on these topics:

- 1) Support for availability of refuelling infrastructure for renewable and low-carbon fuels.
- 2) Optimisation of port services, integration with transport services and smart logistic solutions and traffic management towards zero-emission ports.
- 3) Support multimodality and IWT in cities by the interconnected multimodal exchange of data plus smart traffic management systems.
- 4) Fully paperless transport could significantly reduce administrative burden and support multimodality and change of modes, including traffic monitoring and smooth availability of harmonized transport data.
- 5) Smart transport system with efficient capacity allocation and traffic management could provide efficient logistic services and reduction of CO<sub>2</sub> emissions.
- 6) Integration of IWT in a digital single market. IWT could then play a significant role in sustainable and innovative clean mobility solutions.
- 7) RIS could support technological innovations in mobility by a e.g. harmonised framework for connection between market players, sharing data and provision of big-data tools for more efficient, safe and smoother navigation.
- 8) Information services could enable efficient use of worker skills and make navigation on waterways less dependent on local knowledge and extension of access to the labour market and make it more attractive.

## 2.11 Industry 4.0

'Industry 4.0' (or the fourth industrial revolution) stands for the intelligent networking of machines and processes in industrial production enabled by information and communication technology. The German 2030 vision for Industry 4.0 (also called 'Industrie 4.0') describes the shaping of digital ecosystems and creating a future data economy in line with the requirements of a social market economy. It identifies 3 closely interlinked strategic fields of action: Autonomy, Sustainability, and Interoperability.

**Autonomy** is the freedom of all market players to take independent decisions and to act in fair competition. This requires an autonomous data infrastructure<sup>28</sup>. Key elements of autonomy are technology development, security, and a digital infrastructure.

**Sustainability** is in line with the UN Sustainable Development Goals, which can be clustered into economic, environmental, and social aspects. 'Industry 4.0' identified the following development paths towards a digital, connected, and sustainable future:

- Path 1: Reduce consumption, increase impact: towards resource-efficient and carbon neutral, digitalised manufacturing.
- Path 2: From mass production to transparent service offerings: how a changed value proposition influences digital business models.
- Path 3: Sharing and networking: sustainable digital business means cooperating and operating in circular economic systems.

Key elements for **Interoperability** are:

- An asset administration shell, hosting a digital representation of each object/asset and describing it digitally in a standardised manner.
- The reference architecture model (RAMI) and standardisation.

### **Conclusion:**

With 'Industry 4.0', the creation of value will no longer be based on mass production. Digitalisation and networking enable the industrial production of individualised, customised products tailored to an individual need. The variety of products will increase while quantities of production and thus volumes for transport will decrease.

In a smart factory all production stations and workbenches are equipped with sensors and ICT to communicate data in real time. The analysis of data enables immediate reaction in case of any malfunction. Big data allow better planning and control, facilitate the prediction of material required and a smooth supply.

At the end of its serviceability, a product won't be wasted but will be decomposed into its components for reuse.

In the fields of product development, production, use, maintenance and decomposition of products, different competences and skills are needed. The success of companies no longer solely depends on proprietary knowledge. Companies cooperate with external knowledge and cooperation will not depend on a convenient location.

## **2.12 Physical Internet**

An extremely high level of digitalisation and automation will make it possible to send cargo over a network like we are now sending data over the internet. This envisioned network of automated multimodal hubs is called the 'Physical Internet'.

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<sup>28</sup> <https://www.gaia-x.eu/>

The roadmap of the Physical internet<sup>29</sup>, published by ETP-ALICE, is the main source of information in this chapter. The roadmap is divided into different areas, i.e. logistic nodes, logistic networks, system of logistic networks, access and adoption, and governance. Since the concept of the Physical Internet deals with both infra- and infostructure, the main focus will be on the steps (RIS-)authorities need to take to support the realisation of the infostructure layer.

- From Logistics Nodes to PI Nodes: In Logistics Nodes, goods are consumed, stored, transformed, or transhipped from one transport mode to another. Ports, airports, logistics hubs, terminals, distribution centres, warehouses, depots are examples of Logistics Nodes. The Physical Internet envisions the development of the Logistics Nodes into Physical Internet nodes in which the operations are standardised and the usage of a family of standard and interoperable modular load units from maritime containers to smaller boxes is extensive. Services in PI nodes are visible and digitally accessible and usable including planning, booking and execution operations.
  - Impact on infostructure: Define nodes on the different networks (road, rail and waterway). To gain insights in these nodes, digitalisation by means of digital replicas or twin are needed. Relevant information related to inland shipping transshipments is also necessary.
- From Logistics Networks to Physical Internet Networks: Logistics Networks include Logistics Nodes as well as the transportation services connecting the Logistics Nodes and reaching to the destination. Logistics Networks are under the control of a single company either a shipper, a freight forwarder or a logistics service provider reaching their value chain (i.e. customers and suppliers). PI Networks are expected to build seamless, flexible and resilient, door-to-door services consolidating and deconsolidating all shipments within a logistics network in which all assets, capabilities and resources are seamlessly visible, accessible and usable to make the most efficient possible use of them.
  - Impact on infostructure: The different networks need to be encoded in such a way they allow route planning.
- Developing the System of Logistics Networks towards the Physical Internet: Includes individual logistics networks that are interconnected. Therefore, the assets, services and resources of the individual logistics networks can be accessed by all logistics networks owners. The System of Logistics Networks forms the backbone of the Physical Internet and requires secure, efficient and extensible services for the flow of goods, information and finances across logistics networks.
- Access and Adoption: This area describes the main requirements to access the Physical Internet through a logistics network. It also includes different steps towards the adoption of the Physical Internet concepts, including buy-in from the stakeholders.
- Governance: Governance includes the developments needed to evolve Logistics Nodes, logistics networks and the System of Logistics Networks into the Physical Internet, i.e. the rules defined by the stakeholders forming or using them as well as the trust building processes and mechanisms.

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<sup>29</sup> <https://www.etp-logistics.eu/alice-physical-internet-roadmap-released/>.

## 2.13 Success Factors for Sychromodality

In order to reach the goal of sychromodal transport services, a number of critical success factors, reflected in a case study and literature review executed by the University of Applied Sciences in Upper Austria<sup>30</sup>, need to be addressed in the elaboration of future services for IWT.

- **Network, Collaboration and Trust:** The case study indicates that many companies in the different transport domains can be reluctant to cooperate with competitors, requiring a rethinking process to generate a network which is characterised by trust and awareness of the advantages of cooperation. Efforts must be made in the communication with IWT stakeholders in particular to raise the awareness for the importance of data sharing with the incentive of a potential win-win situation.
- **Sophisticated Planning:** The functioning of a sychromodal transport network is based on sophisticated dynamic planning and simulation of transport routes and patterns including demand mapping and forecast tools. Customer preferences, traffic density, and available resources of hubs and modes must be made available for transport decisions at platforms for sychromodal transport.
- **ICT/ITS Technologies:** High quality standardised data is considered key for multimodality. Data from different stakeholders (port, terminal and vessel data) must be made available on IWT platforms in a way that all stakeholders within the transport chain are enabled to access and properly use.
- **Legal and Political Framework:** Harmonised transport regulations constitute the basic framework for a functioning sychromodal network. The implementation of an appropriate legal framework in IWT transport corridors and networks is deemed crucial, as is the clarification of liability issues.
- **Awareness and Mental Shift:** Choice of transport modes and routes will move from the cargo owners to the service providers and platforms for sychromodal transports based on current performance indicators of the network. Only basic framework conditions such as departure, destination and ETA are expected from customers.
- **Pricing/Costs/Services:** Transport costs are dependent on factors such as transport equipment type, availability and route. However, for sychromodal transports, these parameters are not determined in advance. Consequently, transparent service pricing models and protocols are required.
- **Physical Infrastructure:** Physical infrastructure production sites, ports, terminals, and their connection by transport routes influences the possibility of efficiently bundling transport flows. The presence of IWT at multimodal transport hubs represents a prerequisite for its consideration in transport decisions.

## 2.14 Conclusions

The analysis of the above trends reveals the following aspects and conclusions:

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<sup>30</sup> Pfoser et al. (2016): "Critical Success Factors of Sychromodality", *Transportation Research Procedia* 14 (2016) 1463-1471.

- Greening of transports: In order to make the ecological advantages of inland navigation visible, the underlying services must include all relevant components (such as calculation of pollutant emissions of the transport) in a holistic model. An enhanced knowledge base on external cost performance of the fleet is considered as important prerequisite. Future services need to address the information needs of zero- and low-emission transports including charging and refuelling infrastructure.
- Synchronising of services: In order to move in the direction of multimodal or synchromodal transport service on a network/corridor level, it is considered necessary to synchronize the underlying service solutions of the individual transport modes.
- Compilation and centralisation of services: The strong fragmentation of systems and services in the past shows significant disadvantages for the development of services and new applications on a network level. Bundling new services and consolidating existing ones hence appears unavoidable.
- Federated platforms: Projects such as FENIX and Federated introduced the concept of federated platforms, which need to pass a certification process according to the set governance rules. Within DTLF, rules and functional aspects are outlined for platforms to enable authorities to retrieve data within the scope of the underlying eFTI regulations.
- Focus on Physical Internet nodes: Developments towards the Physical Internet require the harmonization of datasets and interfaces. This is, especially true for the nodes at central access and interconnection points (multimodal hubs).
- Interoperability with ports and hubs: RIS services are broadly implemented on the level of IWT corridors but are not yet interoperable with ports and multimodal hubs concerning exchanged data, interfaces and services.
- Mapping the whole supply chain: Gap analyses indicate that corridor/network management need to provided traffic and transport services addressing all parties in the supply chain in order to fulfil logistics sectors requirements. The alignment of hubs and corridors can be described as import steps towards synchromodality.
- Real time performance: Real time performance indicators and full transparency of workflows are required as a precondition to reaching the goal of synchromodality.
- Use of big data: New services in other modes of transports are increasingly based on big data analysis, which could also serve as input for potential future IWT services. such as demand-related tolling.
- Services facilitating smart shipping: Smart Shipping applications require machine-readable services and formats as well as high-quality 'real-time' data together with an increased amount of meta data. Furthermore, autonomous transport needs standardised vehicle to vehicle and vehicle to shore communication with standardised communication protocols.

## **ANNEX 3. STANDARDS AND INFORMATION ON TECHNICAL SERVICES FOR THE PROVISION OF STATIC FAIRWAY AND INFRASTRUCTURE INFORMATION**

The Technical Services on the provision of static fairway and infrastructure information in waterborne transport that is standardised is restricted to the maritime standard ECDIS and Inland ECDIS based on the maritime standard.

### **ECDIS Standards:**

1. Performance standard according to IMO A.817(19).
2. Operational and performance requirements, methods of testing and required test results according to IEC-1174.

### **IHO ENC Standards<sup>31</sup>:**

1. S-52 is the standard that determines how ENC data is displayed on an ECDIS screen through symbols, line styles, colours and other visual cues. This means that what the mariner sees on the screen is displayed in the same way across all approved makes and models of ECDIS.
2. S-57 is the data format standard used for the transfer of digital hydrographic data between national hydrographic offices and for its distribution to manufacturers, mariners and other data users.
3. S-58 is the standard that sets out validation checks that must be performed on ENCs by hydrographic offices before they are released.
4. S-63 data which meets these standards is authenticated and comes from an official source, reducing the risk of using inaccurate data that is posed by unofficial ENCs and the risk of malware being introduced to a ship's IT systems.
5. S-100 is IHO's universal hydrographic data model and provides the data framework for the development of the next generation of ENC products, as well as other related digital products required by the hydrographic, maritime and GIS communities.
6. S-100 extends the scope of the existing S-57 standard. S-100 is more flexible and makes provision for the use of imagery and gridded data types, enhanced metadata and multiple encoding formats. It also provides a more flexible and dynamic maintenance regime via a dedicated on-line registry. Within S-100 there is a section for IENC: S-401 maintained by the Inland ENC Harmonization Group<sup>32</sup> (IEHG). The S-100 framework is described in the document<sup>33</sup> that explains how the IHO will use and extend the ISO 19100 series of geographic standards for hydrographic, maritime and related issues.

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<sup>31</sup> See <https://iho.int/en/standards-and-specifications> for more information.

<sup>32</sup> <http://ienc.openecdis.org/?q=content/iehg>.

<sup>33</sup> [https://iho.int/uploads/user/pubs/standards/s-100/S-100\\_Ed%204.0.0\\_Clean\\_17122018.pdf](https://iho.int/uploads/user/pubs/standards/s-100/S-100_Ed%204.0.0_Clean_17122018.pdf).

7. S-101 – Electronic Navigational Chart Product Specification based on S-100 (Edition 1.0.0, December 2018).
8. S-102 – Bathymetric Surface Product Specification (Edition 2.1.0, October 2022).
9. S-104 – Tidal Information for Surface Navigation Still Under Development (Edition 1.0.0, August 2021).
10. S-401 – Inland Electronic Navigational Chart Product Specification based on S-100 as used for inland navigation and specified by the Inland ENC Harmonization Group [IEHG] (future use).
11. S-402 – Inland Bathymetric IENC Product Specification based on S-100 and used for inland navigation and specified by the IEHG (future use).

### **Formal Standards for Inland ECDIS in Europe are:**

1. European Standard for River Information Services (ES-RIS) published by CESNI and updated every second year. ES-RIS contains a part dedicated to inland ECDIS and another part dedicated to the inland ECDIS operational and performance requirements, methods of test and required test results. At the time of writing, ES-RIS 2023/1 (adopted in October 2022) is the latest version.
2. The Central Commission for the Navigation on the Rhine refers to edition 2021/1 of ES-RIS in several regulations applicable on the Rhine such as the Rhine Police Regulation (RPR). Since 1 January 2024, CCNR refers to ES-RIS 2023/1. The European Commission has adopted implementing Regulation 2018/1973 concerning the technical specifications for the electronic chart display and information system for inland navigation (Inland ECDIS) in application of the RIS Directive 2005/44/EC Directive 2005/44/EC. This implementing regulation is fully consistent with ES-RIS.
3. UNECE Resolution No. 48 'Recommendation on Electronic Chart Display and Information System for Inland Navigation (Inland ECDIS)', revision 4 (ECE/TRANS/SC.3/156/Rev.4), was adopted on 8 November 2019. This resolution is harmonised with European Commission Implementing Regulation 2018/1973.

### **Specific Aspects and Criteria for the Use of Inland ENC in Inland Waterways in Europe**

On the Rhine, the Article 4.07 of the Rhine Police Regulation (RPR) requires that vessels are equipped with an inland ECDIS or a comparable electronic chart display system. Some vessels are exempted of this obligation due to their characteristics or under some conditions.

The inland ECDIS part of ES-RIS provides technical specifications for the use of Inland ENCs as well as the equipment for the display of Inland ENC on board. Special attention is given to the 'Navigation' mode where an Inland ECDIS is being integrated into the radar display.

The inland ECDIS part of ES-RIS also provides technical specifications for the content of inland ENCs. These technical specifications are based on IHO S57 Standard with specific additions or modifications concerning inland navigation elaborated by the IEHG.

Inland ECDIS displays may be used in navigation mode or in information mode.

- a. Information Mode means the use of an Inland ENC display without radar overlay.
- b. In navigation mode, an Inland ENC display (operating system software, application software and hardware) shall have a high level of reliability and availability at least of the same level as other means of navigation.

CCNR and European Commission regulations require that Inland ECDIS equipment for navigation mode is certified by the Competent Authority. The competent authority is entitled to check Inland ECDIS compliance of installed systems at any time. Official inland ENCs are published by recognised National Hydrographic Offices (NHO) or the responsible authority.

### **Specific Aspects and Criteria for the Use of Inland ENC in the United States**

Vessels operating on inland waters in the US may meet chart carriage requirements through use of certified Inland ENCs "in conjunction with a system sufficient for the intended voyage". [USCG NVIC 01-16] However, carriage of Inland ENC display systems are not mandatory, and vessels may meet the requirement through carriage of paper charts that are properly updated and maintained.

Inland ENC overlays are being used and tested on US waters for delivering information in addition to the Inland ENC. This includes sounding updates in areas with highly changeable bathymetry, aids to navigation, and short-term changes to waterway configuration.

## **ANNEX 4. STANDARDS ON TECHNICAL SERVICES FOR THE PROVISION OF DYNAMIC FAIRWAY AND INFRASTRUCTURE INFORMATION**

### **International Regulations for Maritime Notices to Mariners are:**

1. Resolution MSC.148(77): Performance standards for narrow-band direct-printing telegraph equipment for the reception of navigational and meteorological warnings and urgent information to ships (NAVTEX).
2. Resolution A.700(17): Performance standards for narrow-band direct-printing telegraph equipment for the reception of navigational and meteorological warnings and urgent information to ships (MSI) by HF.

### **Formal Standards for Notices to Skippers (NTS) in Europe are:**

1. European Standard for River Information Services (ES-RIS) published by CESNI and updated every second year. ES-RIS contains a part dedicated to Notices to Skippers. At the time of writing, ES-RIS 2023/1 (adopted in October 2022) is the latest version.
  - The European Commission has adopted implementing Regulation 2018/2032 concerning the technical specifications for Notices to Skippers as referred to in Article 5 of the RIS Directive 2005/44/EC. This implementing regulation is fully consistent with ES-RIS.
  - UNECE Resolution No.80, International Standard for Notices to Skippers in Inland Navigation, revision 1 (ECE/TRANS/SC.3/199/Rev.1) was adopted on 8 November 2019, and amendment 1 adopted on 9 October 2020. This resolution is harmonised with European Commission Implementing Regulation 2018/2032.

### **Specific Aspects and Criteria for the Use of Notices to Skippers in Inland Waterways in Europe**

In Europe the Technical Service to provide dynamic fairway and infrastructure information is 'Notices to Skippers'.

NTS provide the following information in a standardised format:

- Dynamic fairway and traffic-related messages
- Water level-related messages
- Ice messages
- Weather-related messages

The NTS part of ES-RIS provides technical specification for the format of the message (using XML) and for their provision through web-services (using SOAP technology).

On its 96<sup>th</sup> plenary session the Danube Commission has adopted its decision (CD/SES 96/14) about the procedure and terms for informing the Danube countries in advance in case of the termination of navigation on certain sections of the Danube. Member States are requested to publish information on planned navigation closures as early as possible via the standardised Notices to Skippers. This information will be available for the navigation as well as for the competent authorities of other countries and the Secretariat of the Danube Commission.

## **ANNEX 5. STANDARDS AND INFORMATION ON TECHNICAL SERVICES FOR THE PROVISION OF Vessel Information**

The standard for the Technical Service to provide vessel information is AIS or for inland waterways in Europe Inland AIS.

### **International Regulations for Maritime AIS are:**

1. IMO Resolution MSC.74(69) – Annex 3: “Recommendation on performance standards for AIS”.
2. ITU Recommendation ITU-R M.1371: “Technical Characteristics for a Universal Shipborne Automatic Identification System, Using Time Division Multiple Access in the VHF Maritime Mobile Band”.
3. ITU Recommendation ITU-R M.585: “Assignment and Use of Identities in the Maritime Mobile Service”.
4. IALA Recommendation A-124 on the AIS Service.
5. IALA Technical Clarifications on Recommendation ITU-R M.1371-3.
6. IEC 61993-2: “Automatic Identification Systems (AIS) – Part 2: Class A Shipborne Equipment of the Universal Shipborne Automatic Identification System (AIS)”.
7. IALA: “Guidelines on the Automatic Identification System (AIS)”, IALA Guideline No. 1028 on The Automatic Identification System (AIS), Volume 1, Part I – Operational Issues.
8. IALA Guideline No. 1029: “The Automatic Identification System (AIS) – Volume 1, Part II – Technical Issues”.
9. IALA Guideline No. 1081: “Provision of Virtual Aids to Navigation”.

### **Formal Standards for Inland AIS in Europe are:**

1. European Standard for River Information Services (ES-RIS) published by CESNI and updated every second year. ES-RIS contains a part dedicated to Vessel Tracking and Tracing and another part dedicated to Inland AIS Shipborne equipment operational and performance requirements, methods of test and required test results. At the time of writing, ES-RIS 2023/1 (adopted in October 2022) is the latest version.
  - The Central Commission for the Navigation on the Rhine refers to edition 2021/1 of ES-RIS in several regulations applicable on the Rhine such as the ‘Rhine Police Regulation’ (RPR). Since 1 January 2024, CCNR refers to ES-RIS 2023/1.
  - The European Commission has adopted the implementing Regulation (EU) 2019/838 on technical specifications for vessel tracking and tracing systems referred to in Article 5 of RIS Directive 2005/44/EC. This implementing regulation is fully consistent with ES-RIS.
  - The Danube Commission in the revised Fundamental provisions for the navigation of the Danube (DFND) edition 2023 also refers to ES-RIS.

UNECE Resolution No.63 – ‘International Standard for Tracking and Tracing on Inland Waterways (VTT)’, revision 2 (ECE/TRANSC/SC.3/176/Rev.2) has been adopted on 9 October

2020. This resolution is harmonised with European Commission Implementing Regulation 2019/838.

## **Specific Aspects and Criteria for the Use of Inland AIS in European Waterways**

On the Rhine, the Article 4.07 of the Rhine Police Regulation (RPR) requires that vessels are equipped with an inland AIS. Some vessels are exempted of this obligation due to their characteristics or under some conditions. Installed inland AIS are subject to type-approval.

The Danube Commission in the revised Fundamental provisions for the navigation of the Danube (DFND) also specifies obligation for vessels to be equipped with inland AIS.

The two parts of ES-RIS relative to VTT and AIS Shipborne equipment operational and performance requirements, methods of test and required test results are fully based on maritime AIS Class A mobile station but defines additional application-specific messages (ASM) for transmitting inland-waterway related information. ES-RIS is used as a reference for type-approval of new inland AIS.

In addition to functional and technical requirements for inland AIS devices, these parts of ES-RIS also defines inland specific Application Specific Messages (ASM) for data exchanged between inland AIS devices connected applications and inland-specific types of Aids to Navigation reports.

Some messages must be integrated into the inland AIS device, while others are handled and displayed via Inland ECDIS displays connected to the Inland AIS.

In view of their shared information content, Inland AIS and maritime AIS are compatible.

All data transmitted can be received by both maritime and Inland AIS devices to be visually displayed and analysed, however the specifically Inland AIS information is only transmitted and assessed by Inland AIS devices.

On several European Inland waterways, a carriage requirement for Inland AIS is in force for vessels greater than 20 m in length.

The information transmitted by AIS can be divided into the following categories:

- a. Static information, such as vessel number, call-sign, vessel name, and vessel type.
- b. Dynamic information, such as position of the ship with data on accuracy and integrity status.
- c. Voyage-related information, such as length and beam of combinations, and dangerous cargo.
- d. For inland AIS in Europe specific information is required like:
  - Standard European Vessel Number (ENI)<sup>34</sup>
  - Inland vessel and convoy types according UNECE Recommendation 28

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<sup>34</sup> Seagoing vessels should use the IMO number but are obliged in Europe to have inland AIS implemented on inland waterways.

- Category of dangerous cargo (number of blue cones/lights)
- Estimated time of arrival (ETA) at locks, bridges, terminals, borders (if regionally required)

Inland AIS in Europe uses the same parameters and the same message structure as AIS Class A mobile stations according IMO requirements. However, Inland AIS extends the information content in line with inland navigation requirements. Fields with unused parameters are defined as 'not available'.

When using Inland AIS in inland navigation the boat master must manually input the following data at the start of the voyage and whenever the data is amended and available:

- a. Navigational status
- b. Inland vessel and/or convoy type
- c. Length/beam of vessel
- d. Category of dangerous cargo (if regionally required)
- e. Draught of the vessel (if regionally required)
- f. Loaded/unloaded (if regionally required)
- g. Port of destination and ETA (if regionally required)

The boat master has to regularly check to ensure the static and dynamic ship data is correct and reflects the current situation.

The Minimum Keyboard and Display (MKD) for Inland AIS mobile stations must allow users to enter and view the mandatory data for Inland AIS to be transmitted via Application-Specific Messages (ASM). Other features provided via these ASMs which cannot be interfaced through the MKD should be processed and displayed on an external device connected to the Presentation Interface (PI) port of the Inland AIS mobile station. Typically, such external device is an Inland ECDIS application, use in either navigation or information mode. It is essential to harmonize the requirements for processing and display of Inland AIS ASMs in Inland ECDIS applications and the mandatory ASMs on the MKD.

## **ANNEX 6. Standards and Information on Technical Services for the Provision of Voyage and Cargo Information**

Electronic Reporting is based on standardised procedures and messages, only in operation on European inland waterways.

### **Formal Standards for Electronic Reporting in Inland Waterways in Europe:**

1. European Standard for River Information Services (ES-RIS) published by CESNI and updated every second year. ES-RIS contains a part dedicated to Electronic Ship Reporting in Inland Navigation. At the time of writing, ES-RIS 2023/1 (adopted in October 2022) is the latest version.
  - The Central Commission for the Navigation on the Rhine refers to edition 2021/1 of ES-RIS in several regulations applicable on the Rhine such as the 'Rhine Police Regulation' (RPR). Since 1 January 2024, CCNR refers to ES-RIS 2023/1.
  - The European Commission has adopted the implementing Regulation 2019/1744 on the technical specifications for electronic ship reporting in inland navigation referred to in article 5 of Directive 2005/44/EC. This implementing regulation is fully consistent with ES-RIS.
  - The Danube Commission in the revised Fundamental provisions for the navigation of the Danube (DFND) edition 2023 also refers to ES-RIS.
  - UNECE resolution No.79, International Standards for Electronic Ship Reporting in Inland Navigation, revision 1 (ECE/TRANS/SC.3/198/Rev.1) was adopted on 9 October 2020. This resolution is harmonised with European Commission Implementing Regulation 2019/1744 and containing updated information on UN Recommendations where needed.
2. United Nations recommendations regarding the interchange of trade data (UN CEFACT recommendation 25, 31 and 32, EDI and E-Commerce agreements). UN/CEFACT Trade Facilitation Recommendations<sup>35</sup>:
  - Recommendation No.25 – 'Use of the UN Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT)', revision 1 (TRADE/WP.4/R.1079/Rev.1), adopted in September 1995.
  - Recommendation No.31 – 'Electronic Commerce Agreement', first edition (ECE/TRADE/257), adopted in May 2000.
  - Recommendation No.32 – 'E-Commerce Self-Regulatory Instruments (Codes of Conduct)', first edition (ECE/TRADE/277), adopted in March 2001.

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<sup>35</sup> [https://unece.org/trade/uncefact/ef\\_recommendations](https://unece.org/trade/uncefact/ef_recommendations).

## Specific Aspects and Criteria for the Use of Electronic Reporting on European Inland Waterways

Article 12.01 of the Rhine Police Regulation (RPR) requires that vessels report electronically on the Rhine, using technical specifications defined in ES-RIS. This obligation applies to vessels based on their type and/or size, for safety reasons.

The Electronic Ship Reporting part of ES-RIS is the European standard for electronic reporting of voyage and cargo information in Europe.

Electronic reporting includes the following messaging procedures:

- a. Ship-to-authority messaging, dealing with:
  - Voyage notification message.
  - Transport notification messages on the voyages of loaded or empty ships within the jurisdictional area of the authority where such is applicable.
  - Arrival notification and position reports at locks, bridges, reporting points of traffic centres.
- b. Authority-to-authority messaging dealing with transport notifications for ships, carrying cargo or being empty, travelling from one jurisdictional area to the other.
- c. Authority-to-ship messaging mainly consists of acknowledgements and responses to previously submitted notification messages and may also include the sending of dynamic fairway information, such as Notices to Skippers and may also include voyage notification updates.

Currently five messages are specified in the Electronic Ship Reporting part of ES-RIS:

- ERINOT – Reporting of voyage-related information and of information on dangerous and non-dangerous cargo carried on-board vessels sailing on inland waterways.
- ERIRSP – Acknowledgement and optionally response from authority.
- PAXLST – Transfer of passenger/crew data from authority to authority.
- BERMAN – Notification sent by vessels sailing on inland waterways before arriving at or departing from a berth or a port.
- ERIVROY – Reporting of itinerary (including timing) of voyage, especially if there are multiple stops or several alternative routes possible in the area.

## **ANNEX 7. INFORMATION ON REFERENCE DATA**

### **Fairway and Infrastructure Reference Data**

#### **UN/LOCODE**

The UN/LOCODE is a geographic coding scheme developed and maintained by United Nations Economic Commission for Europe. The UN/LOCODE assigns codes to locations used in trade and transport with functions such as seaports, rail and road terminals, airports, Postal Exchange Office and border crossing points.

UN/LOCODEs have five characters.

- The first two letters code a country by the table defined in ISO 3166-1 alpha-2.
- The three remaining characters code a location within that country. Letters are preferred, but if necessary, digits 2 through 9 may be used, excluding '0' and '1' to avoid confusion with the letter's 'O' and 'I', respectively.

#### **European RIS Index for Inland Waterways**

A special group of reference data is covered by the RIS Index.

All Technical Services in the European context of RIS – Inland ECDIS, AIS, electronic reporting and Notices to Skippers in Europe – require unambiguous coding of locations of geographic objects. The use of the RIS Index for geographic objects in Notices to Skippers and ECDIS facilitates the integration of Notices to Skippers in Inland ECDIS.

This RIS Index contains an entry for each piece of infrastructure with importance for RIS. All entries have a single unique and immutable ID: the location code.

The location code used in the RIS Index is a 20-digit alpha-numerical code – the ISRS location code – which consists of the following data elements:

- a) UN Country code (2 letters)
- b) UN Location code (3 letters)
- c) Fairway section code (5 digits, alpha-numerical)
- d) Object reference code (5 digits, alpha-numerical)
- e) Fairway section hectometre (5 digits, numerical)

The values of these data elements are used to create the ISRS location code when the RIS Index item is created and should not be changed afterwards, even if one or more of the corresponding attributes of the RIS Index item changes (e.g. new UN Location code after a merge of municipalities).

The RIS Index is basically a list of location ISRS location codes with additional information on the objects like their characteristics (name, fairway, etc.), restrictions (available depth, clearance, etc.), operating times, etc.

In an international fairway network, the introduction of a harmonised fairway ID is seen as a positive contribution to the need for linking the RIS index of different countries.

With the increasing use of the RIS Index in the RIS Technical and Operational Services, it has become apparent that using attribute values to generate a unique identifier that should be immutable leads to practical issues:

- The corresponding data elements are sometimes extracted from the ISRS location code, even though the subparts of the ISRS location code may no longer correspond to the actual values of the data elements. This can lead to the use of incorrect data, and mismatches in communication and/or display.
- The same applies when the data element values of a RIS Index item are used in communication (e.g. ERINOT message): sometimes these data element values are concatenated to create an ISRS location code.
- When one of the data elements used to generate the ISRS code is changed, sometimes the ISRS code itself is also updated by the responsible authority, as it feels strange to have a 'mismatch' between the data elements in the RIS Index entry and its ISRS location code. Changing this supposedly immutable ID can lead to mismatches in communication and/or display and requires updating iENC for continued correct display of any dynamic information (NtS, AIS ASM, etc.) related to the updated RIS Index item.

The examples above summarise some of the experiences with the RIS Index in Europe and were one of the triggers for the development of a replacement to the RIS Index: RIS Net. RIS Net will combine the information in the RIS Index with rich geographical information and an attribute-based connection between related entries enabling, among other things, the creation of a connected network (or graph) linking all infrastructure with importance for RIS. In RIS Net the ISRS location code will become a regular data element, and its role as an identifier will be replaced by the RIS Id, a unique and immutable identifier that shall not contain any meaningful information.

## **Vessel Identification Reference Data**

### **IMO Vessel Number for Maritime Vessels**

The International Maritime Organization (IMO) number is a unique reference for ships and for registered ship owners and management companies. IMO numbers were introduced under the SOLAS Convention to improve maritime safety and security and to reduce maritime fraud. For ships, the IMO number remains linked to the hull for its lifetime, regardless of a change in name, flag, or owner.

The IMO ship identification number is made of the three letters 'IMO' followed by the seven-digit number. This consists of a six-digit sequential unique number followed by a check digit. The integrity of an IMO number can be verified using its check digit.

IMO ship identification numbers are assigned by IHS Markit (previously Lloyd's Register-Fairplay).

### **ENI Number for Inland Vessels**

The ENI number (European Number of Identification or European Vessel Identification Number) is a registration for ships capable of navigating on European inland waters. Like the IMO number, it is a unique, eight-digit identifier that is attached to a hull for its entire lifetime, independent of the vessel's current name or flag.

The ENI number consists of eight Arabic numerals. The first three digits identify the Competent Authority where the number is assigned (see 'List of Prefixes' below) and the last five digits are a serial number.

The ENI number is based on the Rhine Vessel certification system previously used for ships navigating the Rhine. The ENI number is issued by the national Competent Authority for vessel inspection.

In order to ensure the uniqueness of ENI numbers, the European Vessel Hull Database (EHDB) operated and maintained by the European Commission provides a central repository of all ENI numbers issued in Europe.

## Reference Data on Cargo

### HS code

The Harmonized Commodity Description and Coding System, also known as the Harmonized System (HS) of tariff nomenclature is an internationally standardised system of names and numbers to classify traded products. It has been developed and maintained by the World Customs Organization (WCO).

The HS code consists of 6-digits. The first two digits designate the HS Chapter. The second two digits designate the HS heading. The third two digits designate the HS subheading. HS code 1006.30, for example indicates Chapter 10 (Cereals), Heading 06 (Rice), and Subheading 30 (Semi-milled or wholly milled rice, whether or not polished or glazed).



Figure 3: Example of the hierarchical structure of the Harmonized System

### UNECE ADN (Dangerous Goods) Code

There is a European code for the Carriage of Dangerous Goods by Inland Waterways (ADN) developed and formalised by the UNECE and the CCNR.

ADN contain provisions concerning dangerous substances and articles, provisions concerning their carriage in packages and bulk on board of inland navigation vessels or tank vessels, as well as provisions concerning the construction and operation of vessels carrying this type of cargo. ADN also addresses requirements and procedures for inspections, the issue of certificates of approval, recognition of classification societies, monitoring, and training and examination of experts.



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**<http://www.pianc.org> | VAT BE 408-287-945 | ISBN 978-2-87223-030-3**

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