Masterplan Digitalisation of Inland Waterways

Contents

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01 Executive summary

1.1 The Digitalisation Vision of IWT by 2032

Interoperability between transport modes is a major challenge in the current logistic world. To meet this challenge, digitalisation and by extension a digital transformation of business processes at all stakeholders in IWT seems to be required. In this context also IWT requires a digital transition of the business processes of stakeholders in IWT. An essential pre-condition for this digital transition is the availability of digitalised Inland Waterways information. The result of the project "Masterplan Digitalisation Inland Waterways" or DIWA is expected to become an essential reference for the Digitalisation of Inland Waterways by the participating Fairway Authorities in the upcoming decade.

As a first step a high-level vision document was elaborated within the DIWA project that provided in addition the strategic means, goals and challenges, organised in thematic areas, based on the vision documents of the EC, National Fairway Authorities and IWT stakeholders. Since the drafting of the DIWA proposal several (inter)national initiatives, related to digitalisation, have evolved that are affecting IWT and are relevant for the execution of DIWA and have been considered.

This DIWA vision is aimed at ensuring that the European Union is able to take full advantage of the opportunities presented by digital technologies in the waterway transport sector. It is hoped that this vision will ensure that the digital transformation of the fairway authorities is carried out in a harmonised, cost-effective, secure and sustainable manner.

Digitalisation can improve the safety of IWT operations in the future by monitoring vessels in a "digital twin" of the fairway or in real-time thus allowing shippers and authorities to detect unsafe practices and take preventive measures.

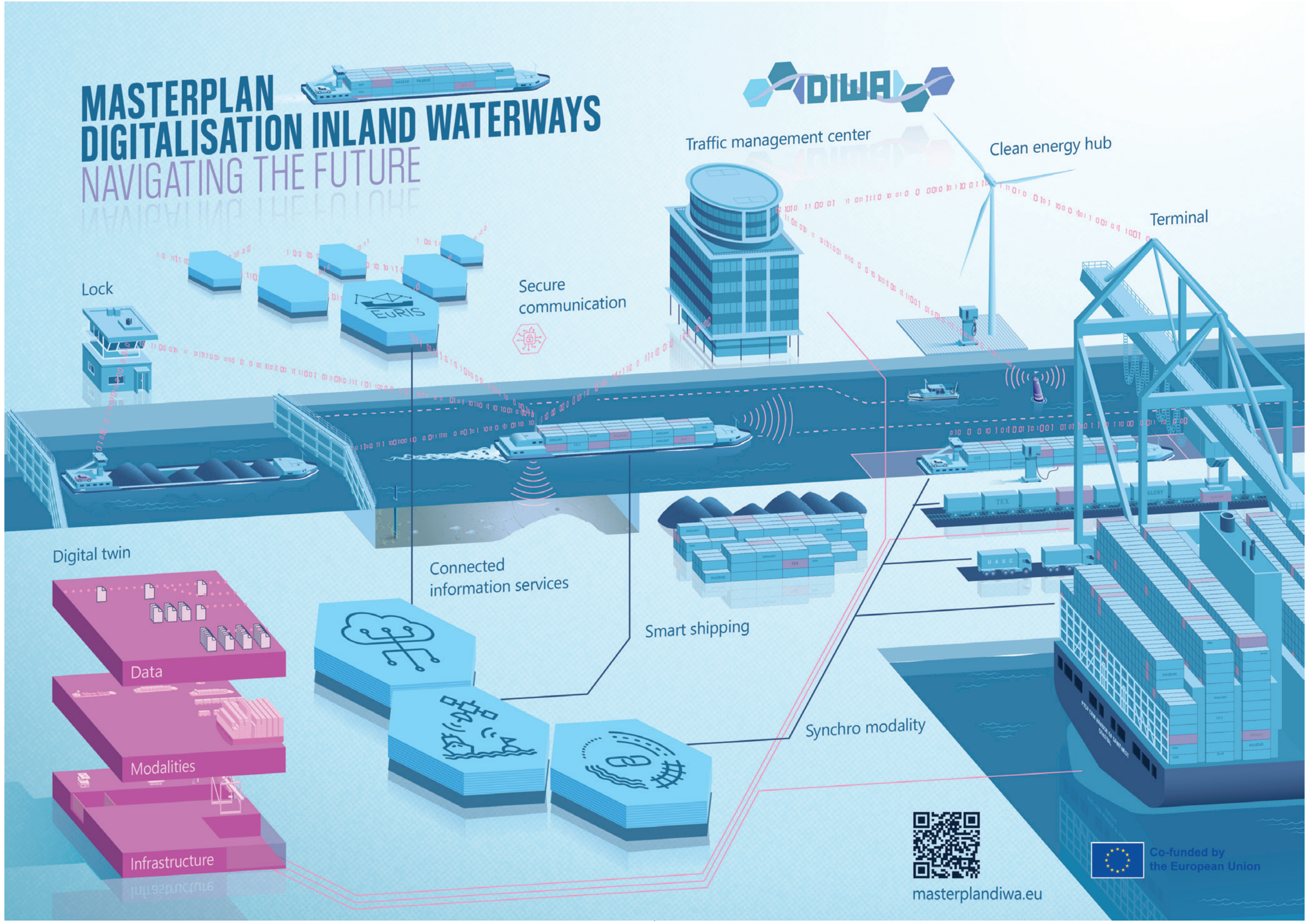


Figure 1: DIWA Vision on digitalisation of IWT by 2032

Finally, digitalisation can also help to improve the efficiency of IWT operations. Digital solutions can enable the tracking of vessels and goods, allowing for the optimisation of routes and the reduction of waiting times. This can reduce the amount of time, energy and resources used in the transport of goods, resulting in fewer emissions and inland shipping can be seamless integrated in the multimodal transport chains.

1.2 The Digitalisation Roadmap for IWT until 2032

The roadmap of the DIWA masterplan aims at achieving the overall objectives of digital transformation defined in European strategies. These objectives include "safe and efficient navigation", the "digital by default" principle, "synchromodal transports", "reliable supply chains" as well as creating a sustainable, green transport sector adapted to climate change and the adaptation to existing staff-shortages. (see Figure 2).

These objectives form the overarching roof of the DIWA project's vision for IWT until 2032 and are supported by the 3 main pillars of measures in the DIWA roadmap. These essential pillars of actions correspond to the focus areas:

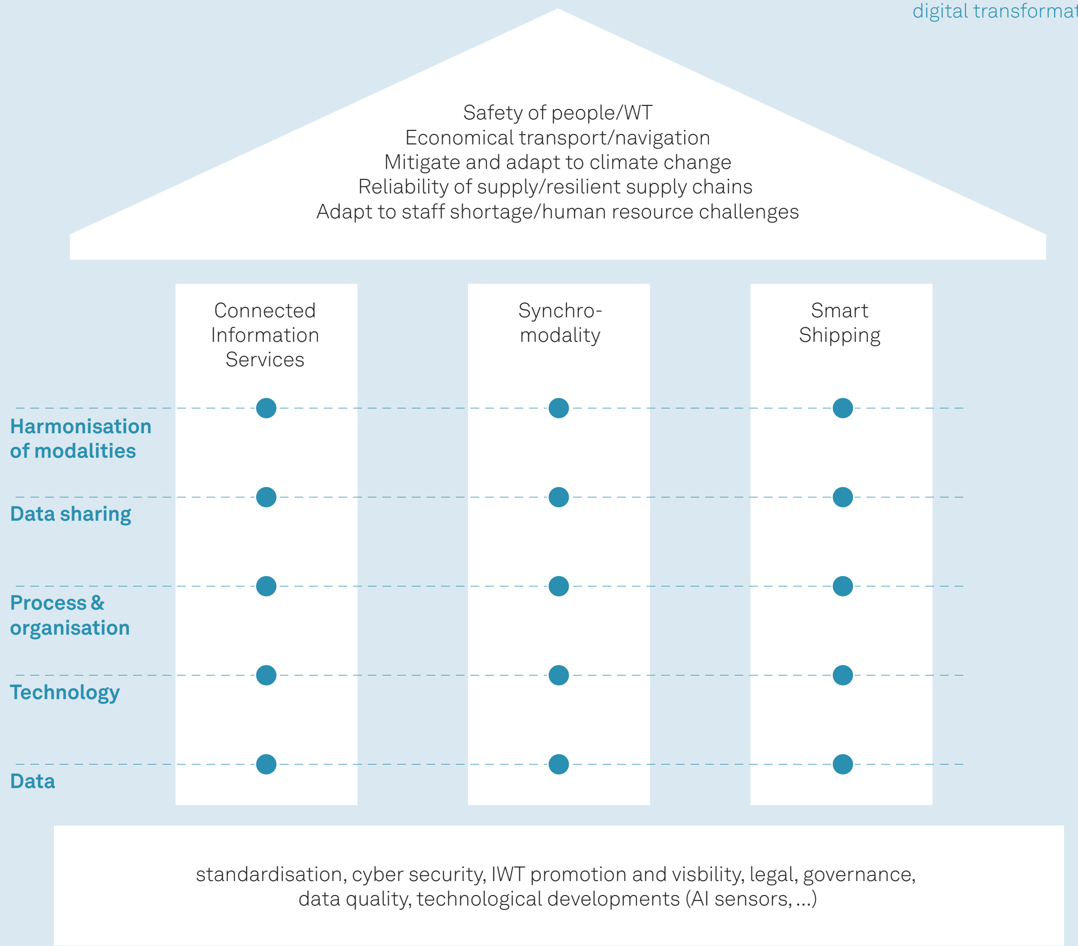
→ "Synchromodality"
→ "Connected Information Services"
→ "Smart Shipping"

Those pillars require a certain level of maturity by means of standardisation, cybersecurity, technology, data quality, legal and social acceptance etc. that is visualised by the horizontal foundation.

Recommended measures in the context of the thematic areas are expected to elevate the level of IWT digitalisation maturity for the pillars from the current level towards higher IWT digitalisation levels.

Actionable measure proposals including their contribution to the overall objectives, addressed stakeholders and related efforts are described for each thematic area per pillar and provide an overview on related technical, financial, organisational and operational consequences.

Figure 2: Interrelation of the DIWA vision, main pillars of the roadmap, thematic areas of measures and the foundation of digital transformation.



The measures were derived from the individual DIWA studies using a cumulative approach and are grouped in the thematic areas “Data Sharing”, “Harmonisation of Modalities”, “Processes and Organisation”, “Technology” and “Data Quality”.

Figure 3 visualises these thematic areas and highlights main measure proposals on a high level.

Reaching a higher digitalisation maturity level through actual implementation of the recommendations does however depend on the level of ambition of fairway authorities and other stakeholders. This also applies to the role of the fairway authorities. Apart from the current and traditional (limited) role of the fairway authorities, measures and activities belonging to areas beyond the current role were explored within the Masterplan DIWA project. These are to be considered as options for fairway authorities that strive for a higher ambition level*.

In order to aid decision making, each recommendation was linked to one of three ambition levels :

- → Basic: contains measures required to at least keep up with digitalisation developments in IWT;
- → Intermediate: additional measures to become part of the frontrunners in IWT digitalisation.
- → Advanced: contains activities added on top of the intermediate package in order to take the lead in IWT digitalisation.

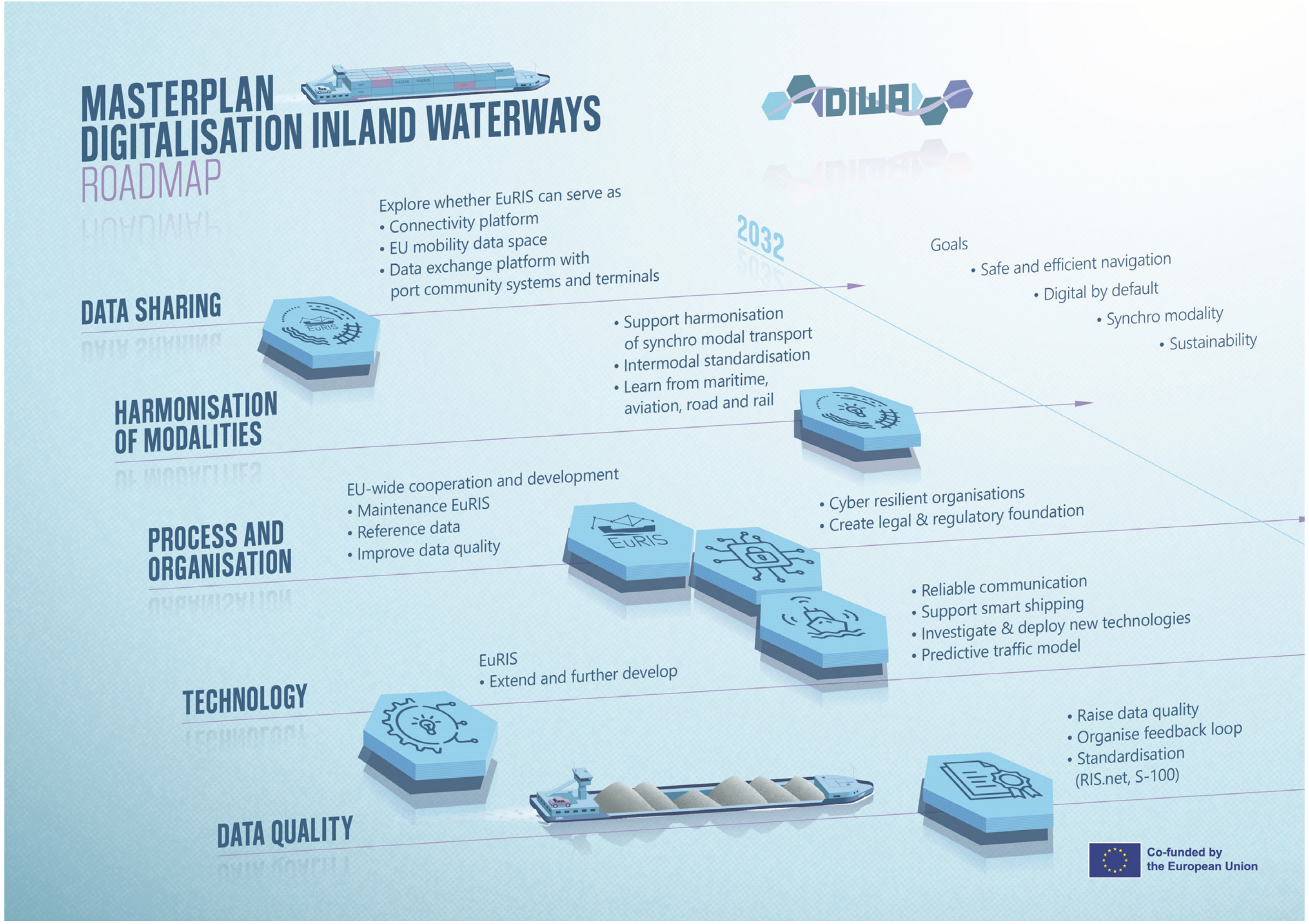


Figure 3: DIWA masterplan Infographic Roadmap

* Implicitly there is of course a fourth ambition level which can be classified as the “stay behind” scenario. Choosing not to implement any of the DIWA recommendations will result in the implicit choice for this scenario.

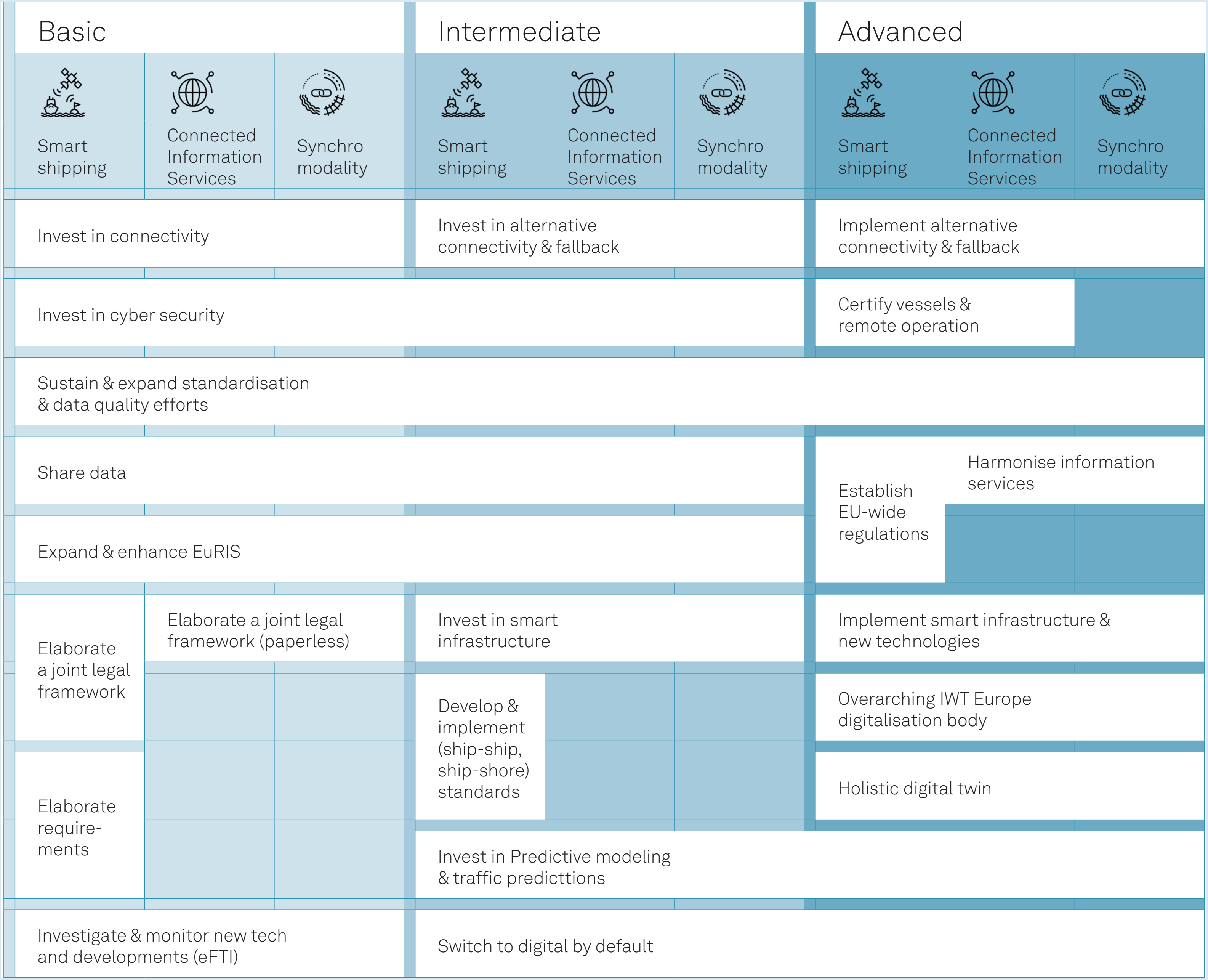


Figure 4: Overview of the main measures plotted over the thematic areas and ambition level

02 Introduction

Digitalisation is transforming our economy and society at a rapid pace. This is a worldwide development, in which digital technologies are used in more and more places. Digitalisation is an important source of growth, innovation and new business. Digitalisation has the potential to transform Inland Waterway Transport (IWT) into a smart and interconnected future mode of transport by improving efficiency, sustainability, safety and incorporation in a multimodal transport chain.

In the DIWA project the need is included to (re-)assess the applicability of existing digitalisation implementation efforts and activities together with the (future) needs and opportunities offered by technological and process-related advances. This shall the future-proof implementation of River Information Services (RIS) and the support of Synchromodality and smart shipping developments.

The result of the project "Masterplan Digitalisation Inland Waterways" or DIWA is an essential basis for the Digitalisation of Inland Waterways by the Fairway Authorities and has the objective to lead to a digitalised and safe Inland Waterway Network, support smart shipping developments and seamless integration into the multimodal transport chain.

2.1 Digitalisation in general

Digitalisation can be defined as a process that aims at transforming business operations and communication by using digital technologies. More specific three 'definitions' are used in the field of digitalisation

Digitisation refers to a process of translating analogue information and data into digital form as for example, scanning a document and storing it on a computer or creating digital versions of former paper forms.

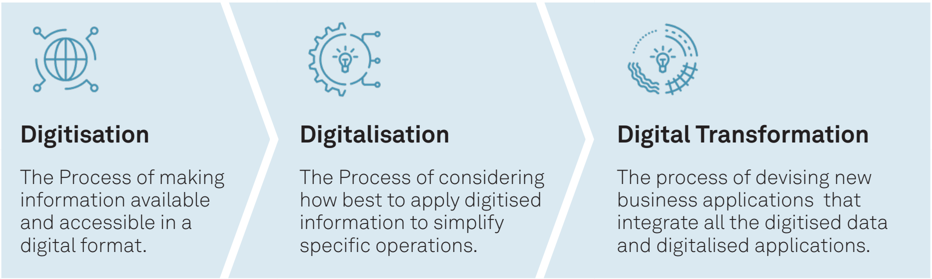


Figure 5: How do we define digitalisation in the context of the DIWA masterplan [source: https://www.the-future-of-commerce.com/service/]

Digitalisation aims at optimisation of processes by using digital technologies to make business processes more efficient as for example fully automated exchange of information throughout the transport modes by electronic means.

The digital transformation refers to the process of devising new business applications based on already digitised data and services. As an example, Data Driven Decision Making can be underlined.

In this report the word digitalisation is used, although in many cases this includes digitisation and supports the digital transformation.

The concept of Digital transition within the Masterplan DIWA documents is considered to be the transition from Digitisation via Digitalisation to Digital transition as defined within this paragraph.

Digitalisation provides the following advantages for today's society and businesses:

- → Increased efficiency of processes by saving time & resources and avoiding errors.
- → Improved accessibility of information to allow for informed decision making.
- → Enhanced communication and collaboration to benefit from knowledge sharing.
- → Enhanced / extended services such as tracking & tracing, real-time information.
- → Facilitation of innovations & enabling the development of new services (e.g. predictions based on Big Data)
- → Contribution to sustainability by reducing physical resources and consequently emissions (optimisation of lockage cycles so that the least water sources are used)

2.2 Digitalisation in IWT

According to the DINA study*, digitalisation is already affecting many sectors and industries. In transport and logistics, the use of digital technologies is essential to streamline business processes between shippers and logistics actors. Several modes of transport have adopted

* Digital Inland Waterway Area; Towards a Digital Inland Waterway Area and Digital Multimodal Nodes https://www.masterplandiwa.eu/wp-content/uploads/2019/09/2017-10-dina.pdf

different kinds of intelligent transport systems and are investigating the possibility of using (semi-)autonomous vehicles. Rapid technological developments have reduced the implementation barriers for such approaches. Public authorities are responding by providing the necessary regulatory frameworks and through specific digitalisation. Furthermore, authorities support digitalisation by providing the best possible data, enabling the industry to introduce new developments.

It is essential for the future competitiveness of inland waterway transport to embrace this trend. True sustainability can only be reached, if the entire supply chain is taken into consideration for optimisation. IWT as part of a larger multi-modal chain requires seamless collaboration with comparable services an essential prerequisite.

Based on the findings of the studies elaborated within the scope of the DIWA project, digitalisation is expected to change several aspects in transport operations for IWT stakeholders.

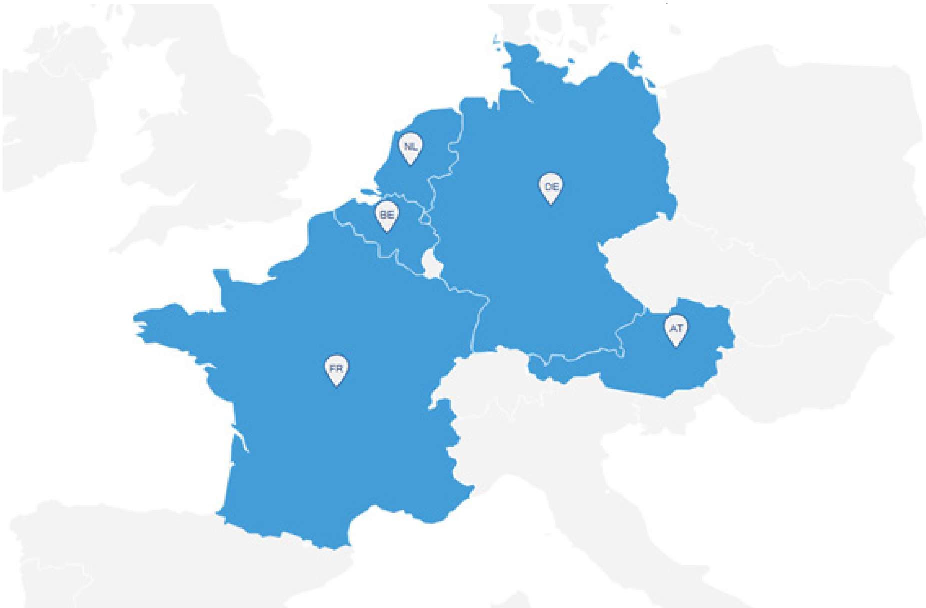


Figure 6: The DIWA project area covers competent authorities in 5 countries being France, Belgium, the Netherlands, Germany and Austria.

Digitalisation will facilitate:

1) optimised route planning with real-time conditions and predictions on water levels, weather conditions and traffic density for reduced fuel costs.
2) optimised traffic management & infrastructure operation with reduced waiting times and real-time tracking of cargo.
3) increased traffic safety due to higher automation levels, supporting technologies such as track pilots and modules for situational awareness (intention sharing, incident warning) and improved communication protocols for ship to ship and ship to shore communication.
4) higher automation levels will help to deal with the prevalent lack of skilled staff
5) the integration and interconnection with other modes of transport at multimodal hubs as a precondition for synchromodal transport operations to support sustainable transport.
6) the reduction of administrative burdens by digital data sharing and the reduction of the number of duplicate business to government reporting
7) the development of new services for stakeholders based on available and accessible data.

2.3 Digitalisation in DIWA

The Masterplan DIWA will contribute significantly to a harmonised and standardised digital transition of the European Inland Waterway and to stay competitive and cope with future digitalisation challenges in IWT.

The results of the DIWA masterplan are expected to become an essential basis for the Digitalisation of Inland Waterways by the Fairway Authorities in the upcoming years and has the objective to lead to a digitalised Inland Waterway Network for those waterways under the responsibility of the participating fairway authorities.

In the Masterplan DIWA project, the participants represent 5 countries (see Figure 6) and cover a large part of the TEN-T network. The DIWA Masterplan focused on the principal waterways of the following corridors:

→ North Sea-Mediterranean Corridor (Netherlands, France and Belgium)
→ Rhine-Alpine Corridor (the Netherlands, German, Belgium and France)
→ Rhine- Danube Corridor (Germany, France, Austria)
→ North Sea-Baltic Corridor (Germany and the Netherlands) and
→ Orient/East-Med Corridor (Germany).

The Danube region has been considered in the study by interviews and accessing other European projects. Moreover, the Masterplan DIWA results, including the sub activity reports, are applicable and valuable for all European countries and publicly available.

2.4 Context of DIWA with regard to European strategies

One of the main initiatives is the creation of a core network of multimodal corridors through Europe. The challenges for IWT include the establishment and adoption of institutional and regulatory frameworks for inland navigation in Europe. These are necessary to achieve a pan-European network of inland waterways of international importance with sustainable and resilient infrastructure and services as an integrated part of the inland shipping networks and markets.

Digitalisation, is considered as facilitator for the modernisation of IWT, the creation of the core multimodal networks; and with that a boost to the improved safety, efficiency, reliability and sustainability. As a result, waterways will become more attractive to new users and the use of the waterways may intensify. Another challenge is in facilitating this usage in an ecological and sustainable manner as transports in Europe are expected to become carbon neutral by 2050 in accordance with the EU Green Deal. Furthermore, IWT needs to adapt to the effects of climate change. Already now, periods of low or high water are getting longer and occur more often. Besides this there are several underlying challenges that will be crucial to the role and position of IWT in the upcoming years.

The masterplan DIWA was elaborated in the context of the needs and challenges identified by strategies of the European Commission and aims at giving direction to closing gaps compared to the current situation:

DINA study

→ The DINA study already laid down the first strategy towards a digital inland waterway area and digital multimodal nodes. The DINA study further elaborated a first roadmap for digitalisation in IWT with both short-term and long-term measures to promote the use of digital technologies in IWT.

  ✓ The DIWA project took up the recommendation that IWT has to keep up with digitalisation and further elaborated required measures.

EU Digital Single Market Strategy

→ The strategy aims to create a single market for digital goods and services across the EU. The strategy also includes the development of the required infrastructure such as high-speed broadband. Due to existing barriers consumers have restricted access to goods and services, businesses cannot reap all benefits from digitalisation, and governments and citizens cannot fully benefit from this digital transformation. The Digital Single Market aimed at opening new opportunities, removing key differences between online and offline worlds, breaking down the barriers to cross-border online activity.

  ✓ The DIWA project aims at increasing the digitalisation levels for IWT and thus contributes to improving access to digital goods and services. Enhanced digitalisation levels are expected to serve as driver for innovation, growth and new services.

European Green Deal

→ The main goal of the EU Green Deal is to make the European Union carbon neutral by 2050. The EU Green Deal promotes sustainable transport including the development of zero-emission vehicles and alternative fuels. Digitalisation in this context is considered as an important enabler. Digital platforms help to promote sustainable mobility and the use of intelligent transport systems enables the optimisation of energy efficiency. The Green Deal strategy expects that Smart Mobility will unleash the full potential of data with the objectives that by 2030 freight transport will be paperless and automated mobility deployed on large scale. In addition, the Green Deal aims at an increase of the modal share of IWT and short sea shipping by 25% by 2030 and expects that by 2050, a fully operational, multimodal trans-European Transport Network for sustainable and smart transport with high-speed connectivity will be established.

  ✓ The DIWA project aims at increasing the digitalisation levels of IWT and closing the missing links to other transport modes, thus increasing the competitiveness of IWT. Synchromodal concepts and interconnections with the ports are expected to shift cargo from other transport modes towards IWT and vice-versa. Enhanced concepts in data exchange and electronic reporting will contribute to paperless transports.

European (Open) Data Strategy

→ The EU (Open) Data Strategy aims at promoting data sharing across the European Union by measures supporting the development of the related infrastructure such as data sharing platforms. Open government data are an integral part of the EU's data strategy. Data driven applications are expected to provide several benefits for citizens and businesses in many ways. The directive on 'open data and the re-use of public sector information promotes high value data sets and encourages the use of dynamic data and APIs.

  ✓ Measures promoting data sharing and data quality as a thematic area are prominently reflected in the

DIWA project and the proposed roadmap. Harmonisation and maintenance of reference data were investigated and the role of EuRIS as potential metadata registry and connectivity platform was assessed.

EU Mobility data spaces

→ The EU Mobility Data Space (MDS) is an initiative of the European Commission aiming at a secure and interoperable framework for the sharing and use of mobility data across different modes of transport.

  ✓ The DIWA project identified EuRIS as comprehensive IWT information platform and an important part of a mobility data space for IWT, which can be extended in the future.

EU (Sustainable and Smart) Mobility Strategy

→ The EU mobility strategy lays down the pathway for a fundamental transport transformation including green, smart and affordable mobility. The EU mobility strategy focuses on several key areas for action in the domains of sustainable, smart and resilient mobility and transport.

→ The EU mobility strategy aims at increasing Sustainability by making available sustainable alternatives and establishing the right incentives.

  ✓ Increased digitalisation levels promoted by the DIWA project enable highly efficient IWT transports with minimised fuel consumption. Embedding IWT in the synchromodal transport network allows the selection of sustainable transport alternatives. Higher levels of automatisation will potentially lead to less accidents considering the human factor.

→ The EU mobility strategy has the objective to establish the concept of Smart Mobility by taking full advantage of smart digital solutions and intelligent transport systems as well as making use of Connected, Cooperative and Automated Mobility (CCAM). The concept of Smart Mobility further includes paperless transport, planning of multimodal trips, building a Common European Mobility Data Space and making use of AI ecosystems of excellence and trust.

  ✓ DIWA contributes to the establishment of smart shipping concepts in IWT. Proposed enhanced reporting solutions and data sharing platforms contribute to paperless transport.

→ The EU Smart Mobility Strategy identifies the need to enhance the Resilience in transportation.

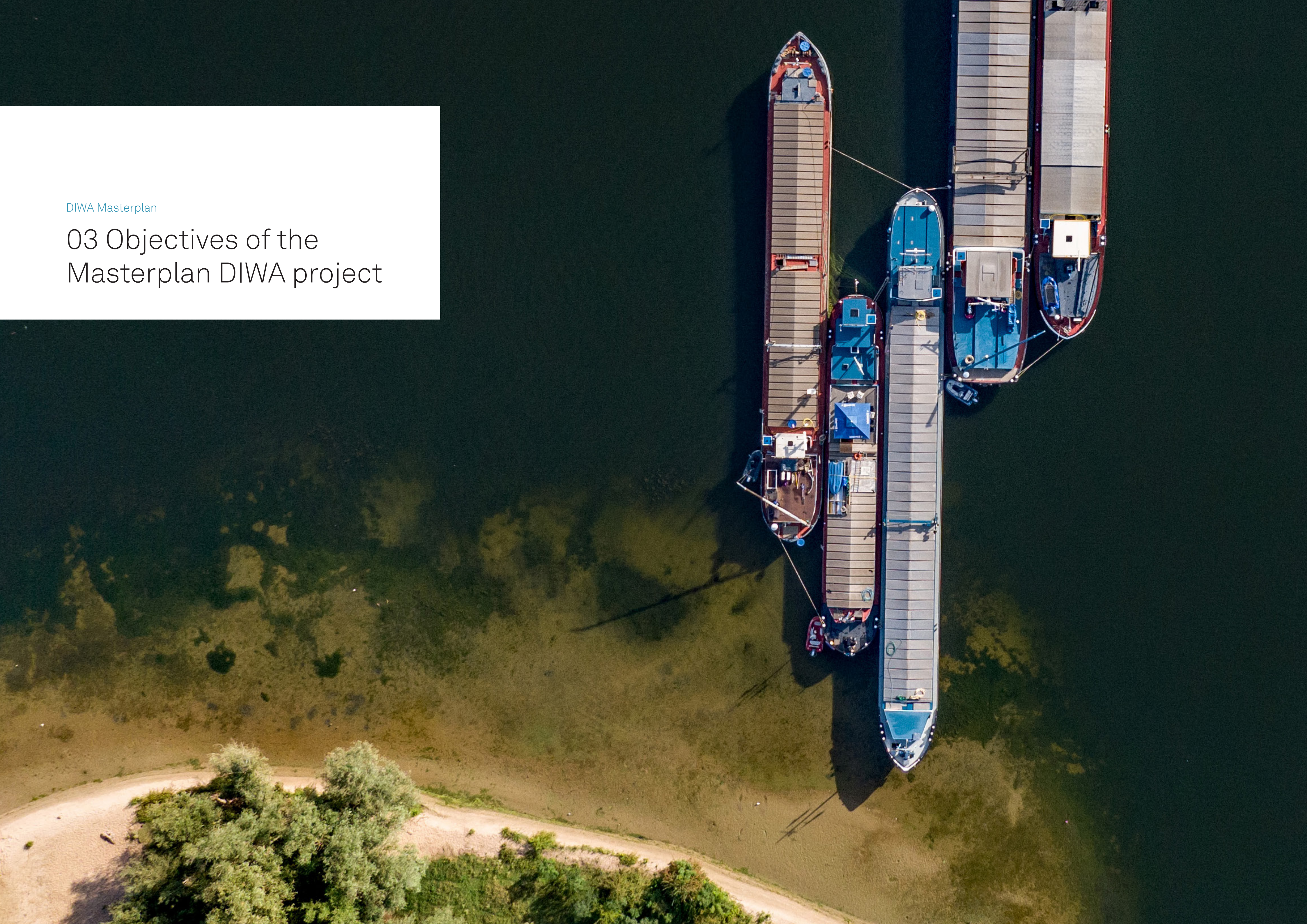
  ✓ The DIWA project proactively contributes to an increase of the resilience of inland navigation by promoting fall-back scenarios and cyber security strategies as well as anticipating on environmental shocks.

NAIADES III programme – Platina 3

→ The NAIADES III action plan focuses on the transformation of EU transport systems towards zero-emissions and modal shift. This has to be achieved by digitalisation of freight transport and logistics, the development of IWT infrastructure for better navigability including inland ports as multimodal hubs and providers of alternative fuels. The PLATINA3 project as policy platform for the implementation of a future inland navigation action programme has the main objective to provide a knowledge base for the implementation of the EU Green Deal and the NAIADES III programme. The platform is considered as a catalyst for awareness, stakeholder engagement and the uptake of outcomes from related European projects and initiatives.

  ✓ The DIWA project worked in close cooperation with PLATINA3 especially with regard to the results and findings in the thematic area of Smart Shipping, Smart Infrastructure and Synchromodality.

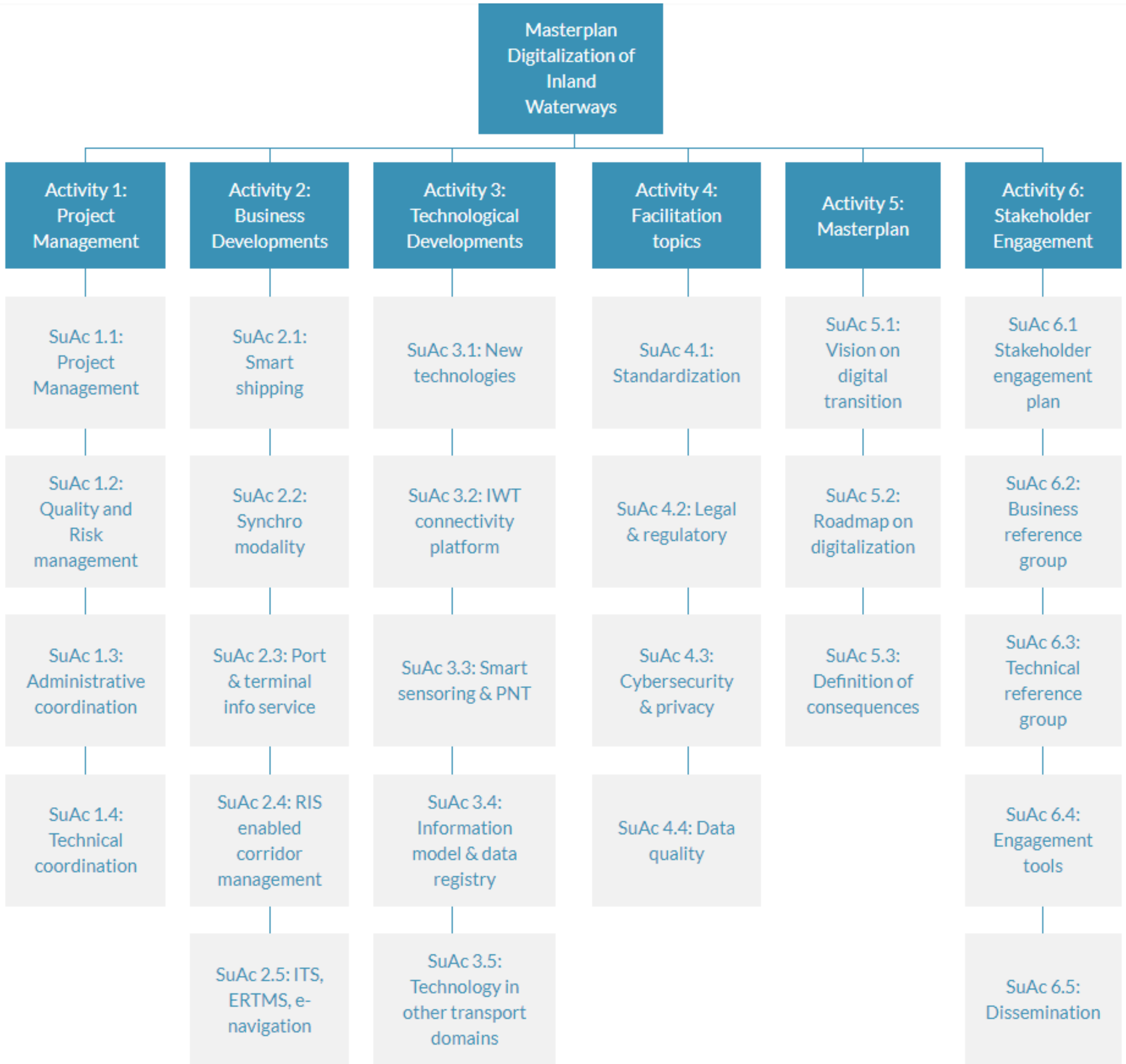
03 Objectives of the Masterplan DIWA project



Main objective of the DIWA masterplan is to create a joint, integral digitalisation strategy for Inland Waterways under responsibility of the participating fairway authorities ready for implementation in the period 2022 till 2032.

The DIWA masterplan offers a guidance for the development and implementation of the digital transformation of Inland Waterways for the support of navigation, traffic and transport management and logistics.

Figure 7: Overview of all DIWA sub activities



3.1 Scope of the Masterplan DIWA project

The scope of the DIWA study is to draft a masterplan for the future of IWT and digitalisation containing a vision and a roadmap. The scope of the study is to incorporate any ideas valuable for business processes and/or provided by technological developments visible to the fairway authorities.

The focus is on recommended actions by fairway authorities participating in the DIWA project. They are about fostering digital transition towards a digitalised and interconnected IWT, assessing the status quo and presenting a list of recommendations.

The project identified several activities to work towards a digital transformation in IWT as shown in Figure 7 followed by a thoroughly investigation on the thematic areas by different sub activities highlighted in chapter 3.2.

Basically, activity 1 dealt with all classical aspects related to Project Management.

Within activity 2 the business developments in the Inland Waterborne Traffic and Transport domain were described. There was a focus on the services, information processes and information requirements related to traffic, transport and logistics that are in a development phase. The consequences for data and information were assessed. An integrated report with the concisely presented conclusions of the five studies was prepared.

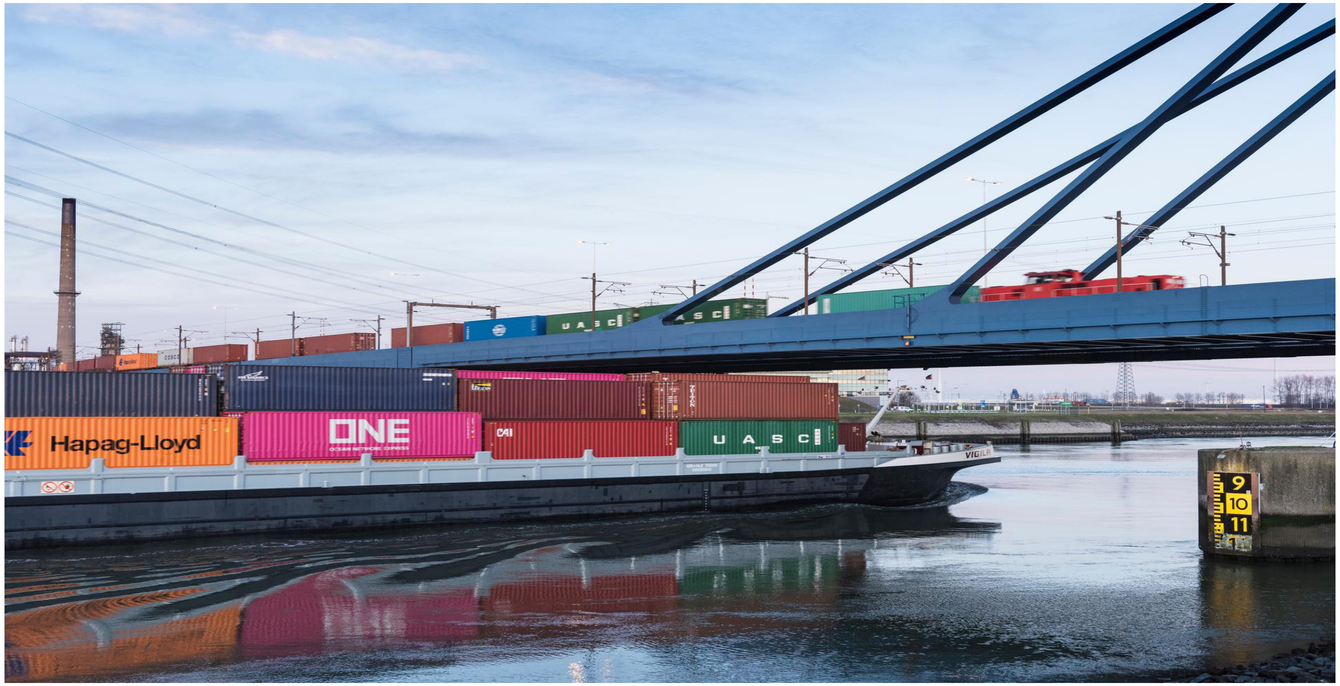
Activity 3 addressed five topics in the area of technological developments (digitalisation) for which it is estimated that they will stimulate IWT in the future. An integrated report with the concisely presented conclusions of the five studies was prepared. This report duly reflects on the technological developments in the IWT information and communication domain.

Activity 4 dealt with the possible stimulators and restrictions for business developments and for the use of technological developments related to navigation, traffic, transport and logistics. Four topics were studied and an integrated report was prepared.

Activity 5 focussed on the preparation of the Masterplan Digitalisation of Inland Waterways. The activity included the preparation of a vision, roadmap and scenarios that form a basis for a joint, integral digitalisation of inland waterways, under the responsibility of the participating fairway authorities and ready for the implementation in the period from 2022 until 2032.

The main objective of activity 6 was to engage the stakeholders of IWT in Europe with a view of dissemination of the (intermediate and final) results of the Action on a national and international level. As the Action had the objective to create new business opportunities and business models for the stakeholders it was essential that the involved stakeholders, could provide their input and are fully aware of the Masterplan so the Masterplan DIWA was aligned with business and policy developments.

All (sub) activity reports and the Masterplan DIWA have been published on the website www.masterplandiwa.eu and are valuable for IWT stakeholders.



3.2 Overview of Masterplan DIWA sub activities

The following summary provides an overview of sub activities associated with the activity 2, 3 and 4 as well as their main subjects and conclusions, which are also included in the overall reports on business developments, technological developments and facilitators.

SuAc 2.1 Smart shipping

Smart shipping is a relatively new business development for IWT. In addition to the required removal of the current legal obstacles, an increased demand for metadata, higher data quality and the need for new communication standards is foreseen.

SuAc 2.2 Synchromodality

The use of synchromodal transport planning and operations by logistics service providers in Europe can be facilitated through a more intensive use of inland waterway data. With the deployment of EuRIS and expansion of the data services most of the needed data services to facilitate this will be in place. Effort is foreseen helping logistics service providers to recognise and use specific data services.

SuAc 2.3 Port & terminal Information services

A lot of services are already digitised; the inland ports are the central hubs for synchromodal transport. So, a strategy needs to be developed and executed on how to connect to inland ports and port community systems.

SuAc 2.4 RIS enabled corridor management

The deployment of EuRIS supports the IWT sector. As a next step an improvement of these services is required together with to the stimulation stakeholders to use the new data services. More data services are foreseen that can push corridor management towards network management, electronic reporting and multimodal integration in the next decade.

SuAc 2.5 ITS/ERTMS/E navigation

An in-depth comparison of data services with the other modalities has been made, and the conclusion is that IWT has similar data services on a functional level. 7 data services from other transport modes were found that could be of interest for IWT. The governance of services in other modalities is also interesting for IWT.

SuAc 3.1 New technologies

The harmonisation of data sets and interfaces together with the re-use of existing service and data provision solutions will result in advanced data exchange platforms initiating and strengthening the multimodal international collaboration. Smart & competitive infrastructure may be monitored with meaningful KPIs, captured by IoT devices. The use of AI in prediction models is expected to change services from decision support to decision making tools. Interconnecting all digital twins of the different transport modes will form a virtual holistic digital twin of the European transport system. Thus, assets and data streams of digital twins need to be interoperable.

SuAc 3.2 IWT connectivity platform

EuRIS as a holistic IWT information platform and important part of the EU data space is expected to evolve to a single-stop-shop for IWT and shall be extended with connectivity platform functionalities. eFTI is further considered as an opportunity towards paperless as well as synchromodal transport and will lower administrative burdens. Projects like FENIX and FEDeRATED provide innovative developments that will be closely followed.

SuAc 3.3 Smart sensoring & PNT

Emission related sensors are gaining more importance. Affordability and the correct calibration are identified as future challenges. Fall-back options and cybersecurity will be highly important for the use of smart sensors as well as guidelines for setting up sensors and training of sensor users. High data quality and the indications of accuracy will become increasingly important as crucial decisions will be made upon sensor data.

SuAc 3.4 Information model & data registry

RIS-net is expected to become one of the pillars of future RIS application. Furthermore, the use of the Maritime Resource Name in IWT is strongly recommended. EuRIS could further evolve to an ERDMS gateway for the IWT community. eFTI is considered as opportunity for IWT to connect with other transport modes. Divergences between eFTI and ERI should thus be avoided where possible. Developments on 'decentralised' architectures as for example proposed by the FENIX project shall be evaluated carefully including their interoperability with established and operational centralised solutions like EuRIS.

SuAc 3.5 Technology in other transport domains

Maturity models are gaining ground with IWT Digitalisation Levels (IDL) being considered as a specific example. Functional and technology-oriented architectures are becoming increasingly important across the transport modes and shall be adapted towards IWT use cases. It is recommended to stringently embark on transformation processes towards Nautical Datalink Communications (NDLC) instead of voice wherever safely possible for both Automated Vessels (AV), Remotely Operated Vessels (ROV) and traditionally operated vessels. The 'S-100 World' was already introduced in IWT with the creation of an own inland domain in the 'S-100' registry and the ongoing development of 'S-401'. The IWT domain shall investigate whether other inland technologies (e.g. NtS, water level information) should evolve to a S-100 product specification.
In addition, the introduction of resilient Position Navigation Timing (PNT) is seen as pre-requisite for higher IDLs.
On top of an overall report on technological developments two guidelines have resulted out of activity 3.5:

SuAc 4.1 Standardisation

Rapid technological developments and fast implementation of solutions required by the market are considered a challenge for the slower standardisation process. Several 'de-facto' standards on a technical level have already emerged. Standardisation is expected to close the missing links between IWT and other transport modes. As a precondition, data elements corresponding to paper forms must be harmonised between the modes. This harmonisation also includes reference data as location codes, which currently vary strongly between administrations & domains. Furthermore, coordinated maintenance procedures for reference data will become crucial for the data quality.

SuAc 4.2 Legal & regulatory

The digital transition and smart shipping in general encompass a variety of different technologies where each emerging technology initiates detailed technical questions. The subject of SuAc 4.2 is the existing laws of the EU and their compatibility with the new technologies and developments discussed in Ac. 2 and 3. Up to now, only partial areas have been regulated in the field of IWT. Legislators are challenged to enable the implementation of new technologies and create new legal structures for the use of those technologies. They must keep the fundamental freedoms of the European Union in mind and at the same time re-think previous principles such as the central responsibility of the shipmaster in (semi-) autonomous operations.

SuAc 4.3 Cybersecurity & privacy

Based on higher automation levels and the increase of information exchange and interconnections the surface for cyber-attacks increases as well. Consequently, cybersecurity standards and requirements are increasingly prominent on international agendas. Vulnerable technologies and a lack of awareness are still threatening transports in the IWT domain. To tackle these issues digital signing of messages, data encryption and Cyber secure by design are becoming the paradigm for new developments.

SuAc 4.4 Data quality

Data quality has an important role in data exchange and inland navigation as incorrect data can lead to damage to humans, material and the waterway infrastructure. Furthermore, data quality is seen as a crucial key factor for further technological developments as smart shipping, autonomous sailing, digital twins and Synchromodality are dependent on high data quality. Since a change in the purpose of data elements can fundamentally change the required data quality, the establishment of one framework as 'the data quality framework for IWT' is considered as untenable.

3.3 Limitations of the Masterplan DIWA project

A number of topics were not addressed in detail during this project as they were out of scope of the Masterplan DIWA project, however these topics might be relevant for the digital transformation in IWT. The topics are:

→ **Social media:** Nowadays social media is widely used for communication about events on the waterways (both for professional and leisure use). The possibilities to use social media as a medium to exchange information hasn't been investigated in depth, although already several Fairway authorities use social media like LinkedIn, Twitter and Instagram to publish information for inland navigation. Also, automated tooling is used to search on social media for messages about a certain fairway authority or waterway so fairway authorities are able to act.

→ **Statistics:** Fairway authorities and economic operators are obliged to provide data about journeys, cargo and transport related data to national and international statistical bodies like Eurostat. Also, other sources are used to come up with reliable statistics and numbers about the different transport flows. The process to further digitalise and harmonise this data wasn't part of this project, although statistics are most helpful and a precondition for the monitoring of the evolution of the digital transformation as statistics are very useful to describe the current situation and monitor changes, including performance indicators for policy objectives.

→ **Certificates:** To navigate on European Waterways skippers need to comply with European laws and regulations, resulting in cargo related documents, crew and vessel certificates. Some documents need to be on board in a paper form, others are allowed to be on board in a digital form (like pdf). The Masterplan DIWA didn't make an extensive inventory of all documents needed on the different EU IWT corridors with their legal reference. Moreover, there are opportunities for further digitalisation and authorised data sharing for paperless and a more efficient transport process and for supporting an effective enforcement process. Within sub activity 3.2 (IWT connectivity platform), 3.4 (IWT Data Model & Information Reg) and 4.1 Standardisation this topic has been addressed briefly.

→ **Enforcement:** The Masterplan DIWA project didn't make an inventory of enforcement processes and digitalisation opportunities, like AI automated and authorised access to documents (see above). An exception is coercion, which was addressed in sub activity 4.2. The Masterplan DIWA project did focus on navigation, traffic and transport management.

→ **Sustainability of Digitalisation:** Digitalisation means you have to invest in technology and IT, which requires electricity (e.g. energy used by computing centres), mining and processing of raw materials like rare earth elements, disposal of materials after technical/economical lifetime as elapsed, etc. and therefore, produces CO_2 and other greenhouse gas emissions. The Masterplan DIWA did consider the effort needed for digitalisation in terms of organisational, operational, technological and financial consequences. The project didn't consider the amount of CO_2 emissions as a sustainability factor or consequence, although awareness about this factor is relevant.

→ **Education:** As clearly shown in the report, digitalisation leads to new possibilities and techniques that will be introduced and used in the field of IWT in the coming years. Smart Shipping, new data services, data sharing capabilities and cyber security awareness means that new competences are needed for skippers, service providers and the operational staff working at the fairway authority e.g. the lock, bridge/water management and VTS operator and the staff who need to ensure robust data services. Therefore, learning these new competences requires additional education, which is not described in detail in this report.

→ Future Role of Fairway Authorities: The Masterplan doesn't contain information about the future role, organisation, tasks and mandate of the Fairway authorities itself

3.4 Boundary Conditions of the Masterplan DIWA project

→ At the start and during the course of the project the following boundary conditions became apparent:

→ The reports and other deliverables of the Masterplan Digitalisation Inland Waterways (DIWA) were created by subject matter experts and/or contracted expertise. Recommended courses of action within these reports and deliverables are meant to be construed as advice on options and alternatives for policy and decision makers. They do not necessarily reflect the official position of the responsible authorities or European Union and its institutions on these matters, nor do they guarantee the execution of any of the recommendations. Respective authorities and other stakeholders are however encouraged to take the DIWA recommended courses of action into account in the decision-making process, in addition to other considerations not covered by DIWA.

→ In line with the previous bullet point the project notices a different maturity level and speed of the implementation of digital transformation by the fairway authorities and also in the other EU countries. Due to capabilities, policy support, etc. some actions will be implemented earlier in some countries. As inland shipping is by default an international transport mode alignment is favourable and, in some cases, even necessary.

04 Work approach

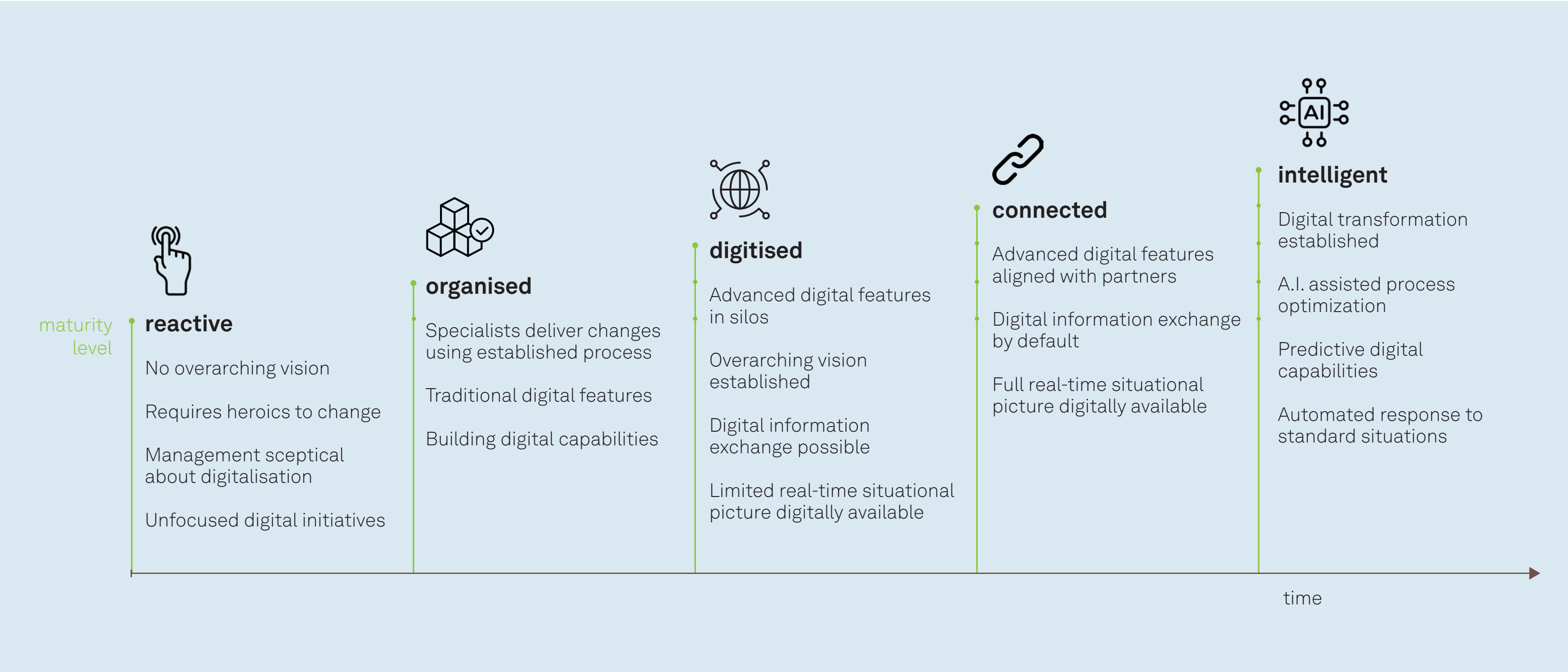


Figure 8: Overview of the Digitalisation Maturity Model used in DIWA

Outlined business developments and standardisation needs were driving factors for the elaboration of this digitalisation masterplan under the responsibility of the fairway authorities. New applications are developed by the industry in increasingly shorter cycles which may require regulation by the authorities concerning rules to comply with a corporate automatisation and safety approach.

The DIWA masterplan was elaborated using a cumulative approach based on 3 crucial complementary activities, namely business developments (activity 2), technological developments (activity 3) and facilitators (activity 4).

The activities and sub activities in DIWA were managed by employees (or delegated expert consultants) of the participating countries. The sub activities (SuAcs) were manned by experts from the different countries to get the best possible overview. Also, external experts and business representatives have been involved by way of interviews.

The DIWA masterplan was written by a core group of experts that also participated in all underlying sub activities and monitored the progress and most essential results to establish a 'linking pin' and enable an efficient elaboration of the DIWA masterplan. The main objective was to elaborate actionable topics and measures based on the recommendations outlined by the sub activities as well as to close identified gaps in the recommendations.

All findings were subsequently presented to main Stakeholders to discuss and incorporate and reflect their feedback in the final results.

In order to structure and order developments and initiatives a Digitalisation Maturity Model was introduced (see Figure 8).

In activity 2 a 3-fold-approach was used to establish a digitalisation roadmap for IWT (see Figure 9). For each sub activity the current situation of digitalisation was elaborated, issues (blocking, obstructing, hindering) and opportunities/possibilities/challenges were investigated from a business perspective. In a next step, a description of the expected future situation including business developments foreseen in the upcoming years was provided.

Finally, technological, operational, organisational and financial measures addressing the identified digitalisation, related issues and opportunities were defined building the basis for comparable scenarios in the roadmap.

Technological developments (activity 3) and facilitation topics (activity 4) followed the same approach. First present an overview of the current (digitalisation related) state of things, discerning incremental innovation, new innovation and disruptive innovation, possibly addressing logistics and fairway & navigation separately as a sector. Finally, all relevant aspects were integrated in the DIWA masterplan (activity 5).

For the development of the vision a gap analysis was performed based on the actual digitalisation status and the results of the studies and requirements on business developments and on technological developments with the restrictions and opportunities described in the study on facilitation topics.

In order to assess technological developments, their usability and their impact on the digitalisation level, a dedicated methodology was developed by sub activity 3.5 and specified in the 'Manual on Inland Waterway Transport Digitalisation and Assessment Methodology*. The proposed roadmap elaborates on how to elevate the IWT fairway & navigation domain in Europe from its present state towards higher IWT Digitalisation Levels (IDLs) with regard to the individual thematic areas studied in DIWA. IDL impact metrics were defined to focus on items with the potential highest IDL increases.

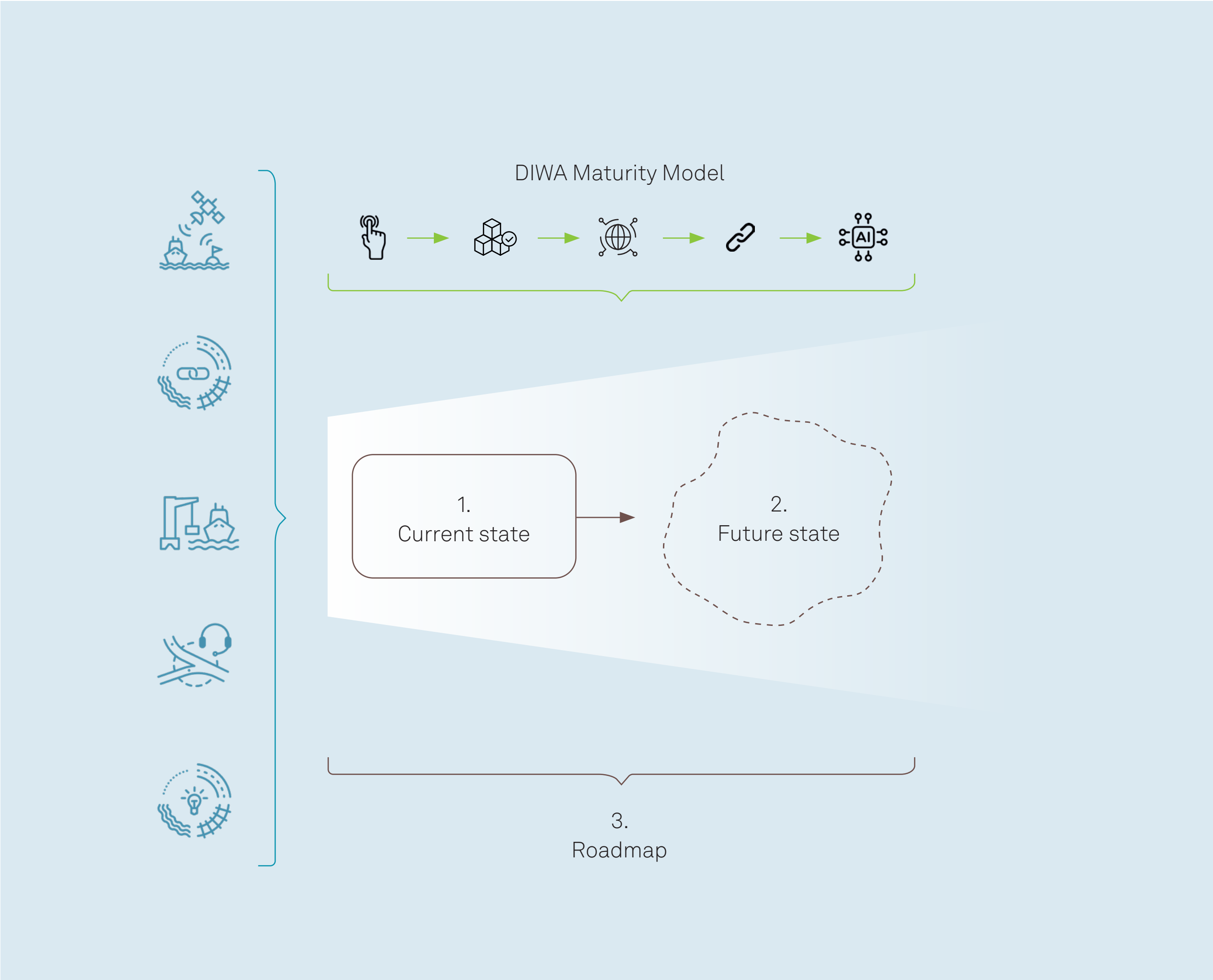


Figure 9: 3-Fold Work Approach

* www.masterplandiwa.eu/wp-content/uploads/2023/03/Masterplan-DIWA-project-3.5-ManualOnIWT-DigitalisationAssessmentMethodology-March-2023-1.pdf

The IDL Impact describes the potential contribution to the digital transformation of the IWT domain and ranges from '0-'(reactive IWT fairway & navigation domain) to 'III' (intelligent IWT fairway & navigation domain).

To assess the maturity of an item quantitatively – or more precisely: its readiness for being adapted or deployed widely the Technology Readiness Level was defined, describing the phases from technology invention with basic principles (value 1) to market expansion (value 9).

The Adaptability Grade provides a metric on the ease (or difficulty) to adapt an item to the IWT fairway & navigation domain. The Adaptability Grade ranges from 'Seamless Adaptability' to 'Not Adaptable'.

In order to arrive at a solid recommendation for the feasibility of adaptation of an item in the IWT fairway & navigation domain, the Adaptability Demand reflects the amount of resources needed. Values range from 'not feasible' (--) to 'little adaptation resource demand' (++).

The Technology Radar method describes the impact of item assessments over a time frame looking ahead into the future. The time phases of expected deployment to the IWT domain are grouped to 2022-2026 (< 5 years from now), 2027-2032 (> 5 years and < 10 years from now) and from 2033 onwards (future box).

The DIWA project made use of a well elaborated stakeholder engagement plan and discussed the main results of all main parts of the study with relevant stakeholders. Within several sub activities experts have been involved for feedback and input so each sub activity report has been elaborated with input of experts.

After finalising the reports by the sub activities ...

→ Reports were approved by the Project Management Team
→ Reports were sent out for feedback by stakeholders and experts
→ The feedback was considered and the reports were finalised, published and approved by the Steering Committee which consists of the beneficiaries of the Fairway Authorities
→ Moreover, Stakeholders were approached actively via presentations (CESNI, RIS week, Strasbourg), workshops (Inland Navigation Week, 22 March 2023 Brussels), stakeholder meetings, interviews & bilateral calls
→ Stakeholder feedback on the masterplan (activity 5) is considered very important, specifically for the conclusions and recommendations that need to be taken up by a cooperation of (international) stakeholders. Therefore, the Project team grouped for each important stakeholder the most important conclusions and recommendations and consulted them bilateral. The feedback of this consultation was incorporated in the annex. We learned that quite some stakeholders didn't have time to read (all) the Sub Activity reports or stakeholders were not able to attend presentations. As stated, the project team has reached out to important stakeholders not present at the events to discuss the Masterplan DIWA content.
→ The masterplan is a synthesis of the individual reports, where a recommendation can have multiple sources. For details visit the respective study.

DIWA Masterplan

05 Vision on digitalisation of IWT

In a future globalised economy, maritime and inland waterway transport is the backbone of the supply of goods to the population and the economy. Compared to other transport modes IWT is climate-friendly, (resource and energy)-efficient, safe, reliable and needs to become more visible* compared to other transport modes. IWT still offers large free transport capacities. Thus, a modal shift towards IWT is further expected to relieve road and rail, increase the sustainability of transports and to reduce external costs of transportation (e.g. by less accidents occurring).

The waterway transport of the future, including predictive, real-time information from and about vessels, cargo, buildings and other sensors, is (fully) automated, digitally mapped ("digital-waterway-twin") to a cloud and connected to other transport modes as part of a larger transport system, comparable with an automated high-bay warehouse/physical internet, relieving people and the environment.

The digitalisation of waterways and the availability of Fairway information under those circumstances can be part of a future (semi)automatic transport system, with a structure based on current industrial, automated production systems and intra-company material flow systems. The customer orders a product or material, and the system autonomously organises the optimal transport from source to destination based on captured data and by taking boundary conditions into account following the principles of the physical internet.

Introducing reliable voyage planning by providing all necessary information with regard to alternative fuels locations, cargo and (the status of) infrastructure data lays the foundation for less greenhouse gas emissions whilst increased safety reduces pollution caused by accidents and contributes to the European Green Deal.

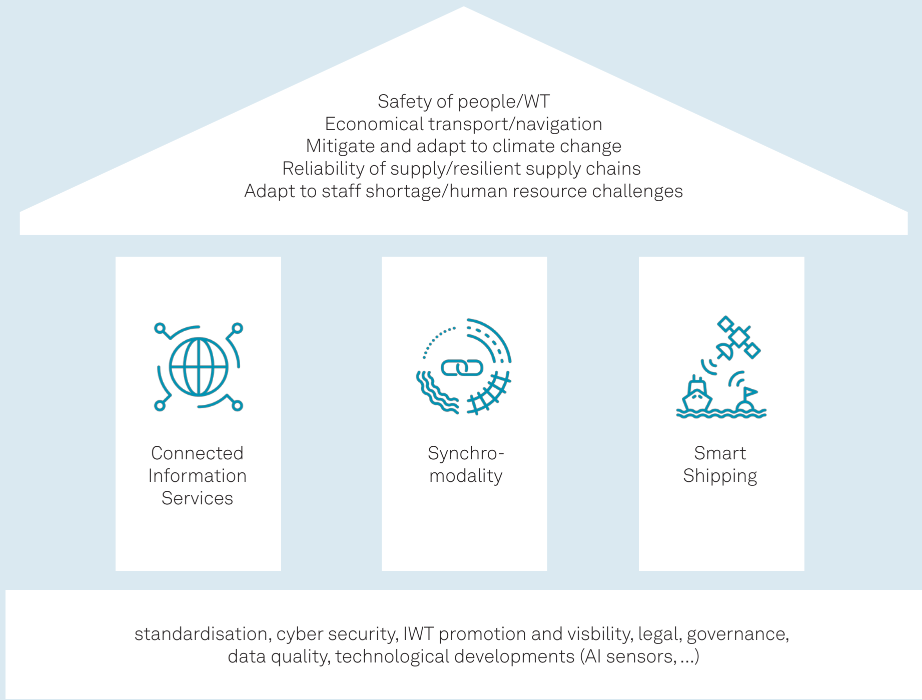


Figure 10: Objectives of the digital transformation of IWT, their pillars and their foundation

In addition to this, cyber security is a critical concern, and measures will need to be taken to increase awareness, securing reliable connections and information and protecting against cyber-attacks, which may have direct impacts on vital infrastructure and industries.

In a nutshell, the digitalisation of IWT offers opportunities to mitigate the challenges posed by climate change and low water problems, while also making IWT more attractive and efficient. These opportunities are based on synchromodal transport concepts and highly accurate and accessible forecasts of fairway conditions such as water depths and traffic situation.

The digital transformation of IWT is founded on three pillars as depicted in Figure 10: Connected Information Services, Physical Internet/Synchromodality and Smart Shipping. These three pillars are derived originally from the three Green Deal objectives** used in the mobility strategy of the EU. This transformation was done to put these abstract objectives into concrete actions and developments in IWT. The smart mobility objective is equivalent to the smart shipping pillar in IWT. Resilient mobility is

* People use road and railway transport on a daily basis and are aware of the existence of those. However, even people who live close to a major waterway (most people don't) are not aware of the existence and capabilities of IWT. Visibility and raising awareness is important with regard to funding, finding employees, etc.
** https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf

achieved by synchromodality and chosen topics from availability of information. Similar sustainable mobility relies on certain aspects of synchromodality but mainly on availability of information. Those pillars are obviously intertwined, as smart technology requires data and information as well as synchromodality relies on reliable data. However, they are independent in certain aspects, which allows them to see as different means to achieve the overall objectives.

The pillars are described in more detail below, one subchapter dedicated to each of those pillars. They require a certain level of standardisation, cybersecurity, technology, data quality, legal and social acceptance etc. that is visualised by the horizontal foundation.

The primary goals of fairway authorities are safety, resilience of transport, attractiveness of IWT and sustainability in transport. Digitalisation and smart shipping are means to achieve the aforementioned goals. Therefore, the ambition to achieve the Connected maturity level (Figure 8: Overview of the Digitalisation Maturity Model used in DIWA) is envisioned in the upcoming ten years with already driving towards Intelligent in several subject areas (e.g. predictive digital capabilities).

Digitalisation is vital for other services and means e.g. supply chain resilience, so it should be pursued as a facilitator. Likewise, smart shipping has to be fostered in order to increase safety, adapt to climate change, compensate for lack of personnel, make IWT economically more feasible. Those are the pillars required by the overall objectives.

The different sub activities in DIWA contribute to the pillars and the overarching topics. The masterplan and the recommendations describe an approach for reaching the higher maturity levels.

5.1 Reflection on the High-Level Vision

At the start of the DIWA project, the High-level vision document on the digital transformation of IWT was written focussing on the responsibilities and the possibilities of the fairway authorities and within the objectives of the project DIWA according to the Grant Agreement for DIWA:

„The main objectives of the digital transformation of IWT are to make IWT safer, traffic and transport more efficient, the IWT transport activities and logistics connected, integrated, automated and transparent and the IWT domain more sustainable and attractive. DIWA will study and define a common coordinated approach (i.e. a masterplan) of the fairway authorities towards the digital transformation of IWT in order to strengthen the position of IWT and modal share in the smart, sustainable and resilient synchromodal supply chains of 2032.“

This vision is still valid. The full high-level vision document has been used as an input and guiding document for the execution of the DIWA project.

In the DIWA project the need is included to (re-)assess the status of existing digitalisation implementation efforts and activities together with the (future) needs and opportunities afforded by technological and process-related advances in order to enhance the future-proof implementation of River Information Services (RIS) and the position of IWT. With the next wave of major game changers on the horizon it is necessary to take stock of what there is and how it meets the needs for the near future. It is not only an ever-increasing move towards seamless transport and logistics or increased technological capabilities that are driving this need, but also the increased confidence and benefit experienced by the current RIS users that enable the possibilities to further integrate towards an interoperable and service-oriented approach.

Over the past two years several developments, either from policy documents (green deal), extreme weather conditions or an evaluation and new insights from the DIWA sub activities led to increased attention for some areas and topics and therefore have been considered in the Masterplan DIWA report.

- → Solid, comprehensive and transparent legal basis/regulation(s) for IWT (e.g. for any kind of data exchange/storage/provision; transport reporting requirements, (non-)liability related to information provision.
- → Increased awareness of a smooth transhipment at seaports
- → The green deal has the ambition of a 25% increase of transport by short sea and inland shipping by 2030
- → Digitalisation supporting: Visibility of shipping as a transport mode, smart waterways, management and flow of information and the support of Synchromodality, utilisation of capacities (infrastructure, vessels, waterways), efficiency (and hence the economic viability of IWT), features, status, traffic, forecast information of the network
- → The renewal and greening of the fleet (regarding information about alternative fuel availability) and the expected lack of personnel in the future

5.2 Reliability of supply – Resilience, Synchromodality and Physical Internet

Due to the ongoing climate change, low- and high-water periods will likely occur more frequently. This is a threat to waterway transport and the supply of goods. By switching transport from roads to waterways, greenhouse gas (GHG) emissions can be reduced, which is beneficial for the environment. This can be done by making transport via waterways more attractive, e.g. with smart shipping, increased transparency, concepts for hinterland connections and integrating waterways into intermodal logistics.

Smart sensor networks for waterways, including the real-time information collected by vessels, may generate enough data for accurate mid-term predictions of water-levels and meteorological conditions and henceforth simplify navigation and route planning via different waterways. Low- and high-water periods require suitable logistical concepts in order to contribute to the continuous availability of waterway transport. During the low water periods, Synchromodality and bypass routes become more important as some goods may be transported using lorries or trains (cargo may even prioritise itself).

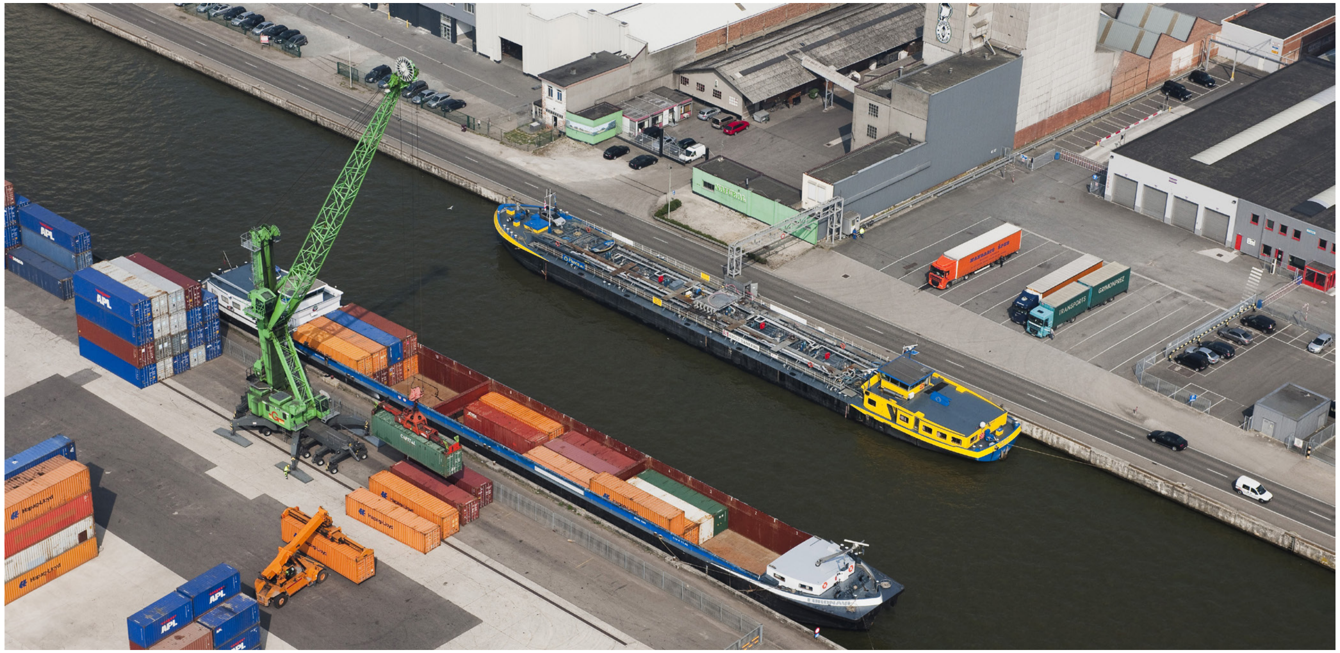
The real-time availability of positioning and navigational information concerning vessels and cargo and reliable predictions of arrival times allows the integration of waterway transport into multi- and intermodal systems. These require (smart) hubs, where transport modes can be changed easily. Concepts for autonomously very fast (un) loading of parts of the cargo may be developed. The use of different modes can create bypass routes for (highly prioritised) cargo if the main route cannot be sailed with a fully loaded vessel. Transporting cargo partly over bypass routes (which may be other waterways, railways or roads) changes the vessel's draught and may even allow continuing with the rest of the cargo on the main route.

IWT (or multimodal transport systems) might even reach the form of a high-bay warehouse. Any good is delivered to the receiver in a self-organised way. In addition to the provision of fairway and traffic data, IWT authorities can provide a legal and technical framework suitable for those concepts. They can also introduce test sites and encourage projects by funding. Live operation is supported by provided high-quality data and enabling data exchange between all involved parties.

Unlike road or railway transport, the general public and potential customers are largely not aware of the importance, existence and capabilities of waterway transport. In order to make waterway transport more attractive, people should be informed about the advantages. Transport planning by Inland Waterway Transport has to become "easy-to-use" and be promoted as such. Even though the future supply chain coordinators do not have to know all the details about transport modes, waterway transport must become more visible and transparent to them.

A vital prerequisite is the availability of detailed, standardised and verified data on infrastructure, especially with regard to (clean energy) hubs, ports and terminals and their capability of shifting cargo, including extra heavy or bulky cargo, to other modes of transport.

Compared to road and railway routes the capacity of inland waterways is not yet fully used, so IWT can relieve other modes of transport, prevent congestion and even make the construction of new roads or railway routes unneeded thus contributing to the environment.



5.3 Connected Information Services - Availability of information, real-time communication and reliable distribution of data

All objectives depend on the information management and the flow of information. Some of those concepts provide (raw) data, like sensor networks, some rely on the provided (and analysed) data. This requires a digital infrastructure provided by fairway authorities. That infrastructure must be easily maintainable in order to grow over time and to be able to address the needs of all involved countries and parties. The entirety of the information is a real-time digital image of the waterways (“digital-waterway-twin”) and can be used to develop new business concepts.

Smart sensor networks along the waterways, e.g. in bridges, locks, buoys, sensors on connected vessels, etc. can collect information to be used for predictions of water-levels and arrival times at locks, docks, hubs, etc. The information exchange of smart infrastructure concerning vessels, transported and (un)loaded cargo simplifies cargo tracking and the creation of digital cargo papers. Already track and trace information of a vessel is available through the EuRIS portal with consent of the vessel owner/operator. Cargo information is available from economic operators. Availability of traffic data from other vessels and the knowledge of water-depths also contribute to safety and reliability.

A goal is to reduce the administrative burden associated with IWT. This may be done by introducing electronic (paperless) travel documents shared by all competent authorities. This would mean that a vessel has to perform only a single, electronic registration for transporting cargo. Furthermore, also information about crew members, the vessel and certificates shall be provided only once, accessible by all competent authorities. A connection to maritime shipping (and other modes of transport) is sensible. This will make waterway transport more attractive.

This can be achieved by an ecosystem of portals, which receives all relevant data from all European countries and delivers information to all parties, who have a reasonable interest in it. A mobility dataspace that is an open data sharing community for exchanging (real time) information including sensitive data can be created based on a (decentral) data architecture. The EuRIS portal is proposed to be developed further towards a clear position in such an ecosystem. The responsibility for the implementation and operation of such an ecosystem is partly a governmental task, laying the foundation for a safe, secure, fair, confidential, compliant and legal commercial and non-commercial use obeying the rules of GDPR and an adequate level of cybersecurity.. Private parties are encouraged to take part in these ecosystems instead of creating private islands, however the ownership of the data remains with the source. These interconnected portals have to offer an Application Programming Interface (API), so that private companies may develop their own applications supporting logistics and making a connection to their own business processes and to other modes of transport. It is quite likely that completely new business models and concepts will be developed as soon as those possibilities are made available. This ecosystem can be used for data collection and transmission of fairway related data as well as for information sharing within a competent authority. Besides information exchange for the purpose of voyage planning, navigation or smart cargo routing, such a platform offers the opportunity to report only once to the authorities fulfilling all legal requirements by incorporating an electronic travel document as described above. This applies especially to cross border transport. By combining private data with governmental data, private parties who join these ecosystems will be able to gain higher efficiencies in their transport processes and become more competitive.

An ecosystem of information exchange platforms does not necessarily have to be limited to professional or official information (nautical, technical, commercial, legal) but can have a connection to social media or other sources of personal and private information (possible leisure activities, public facilities or transport, events, …). Such a platform (or an appropriate user surface, not necessarily provided by authorities) might even be used for personal communication and interaction between barge personnel and other involved people.

Equipping waterways with charging stations or hydrogen stations could make alternative propulsion systems possible and more attractive. This requires reliable information on available (energy) infrastructure or charging levels of battery systems ready to be picked up in a port. Using renewable energies is an important way of reducing GHG emissions *.

The availability of detailed information about the fairway, especially water depths and the nature of the riverbed in combination with accurate positioning information of vessels may allow the use of vessels even during low-water periods or on small and currently for transport unused waterways. If the large waterways like the Rhine and Danube become narrower and more shallow, new bottlenecks are likely to appear, demanding further information provision and traffic management done by authorities in order to continue operation of vessels in addition to other physical measures like vessel design.

For statistical reasons, taxes, safety and security purposes, monitoring the transport of goods is vital. Vessels have to be registered properly, skippers' licences documented, misdemeanours penalised etc. Therefore, transporting goods is impossible without some administrative burden. For both sides – the administration and the barge operators – digitalising the administrative processes is likely to be helpful.

Different technologies and different users require standardised processes, information models and data quality. A fit-for-the-future policy should consider that there are already some de-facto standards (e.g. ERIVOY) but also that some of those (e.g. RIS index) are not recommended to be used for a future system. Moreover data, especially with regard to infrastructure and geography, should be provided by authorities in a standardised format to prevent required patchwork by private companies.

The availability of statistical data, positioning data, navigational tracks etc. is a valuable source for monitoring, research and education. As hinted before, IWT has to become more visible, especially to logistics operators and potential employees. So, it is crucial to provide information about IWT to policy makers, for education and research and the public.

Based on this ecosystem, third parties may implement user surfaces, which can provide further services (e.g. connection to messenger services, social media, streaming services). However, this requires a legal basis establishing data privacy and fairness. Even though the task of integrating the services mentioned above is definitely out of the scope for fairway authorities, the legal basis is still necessary and should be provided by authorities as is the encouragement to develop similar systems.

In addition, technical means of conveying data must be established. This includes AIS, mobile communication, satellite connections, cyber security measures, etc. The amount of data and the desired speed and redundancy are going to increase in the future, so the involved technologies have to be developed further and need to be implemented. Governance and governmental infrastructure must foster digitalisation in order to allow this vision to become true.

* CCNR Roadmap for reducing inland navigation emissions (https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf)

5.4 Smart Shipping

Smart waterways include smart vessels, which can navigate (semi)autonomously or remotely controlled on waterways by using the information provided by their own sensors, augmented by smart sensor networks. Vessels operated with less or even without personnel are more cost efficient and may even allow using small sized vessels on certain routes, which currently cannot be used economically. Civil engineering facilities, like locks and movable bridges, can become automated and therefore be operated 24/7. Moreover, safety may be increased because the likelihood of human error is reduced. Smart shipping based on prediction of water-depth and arrival times can be used to optimise speed and therefore energy-efficiency, reducing costs and GHG emissions.

Waterways, bridges, locks, terminals, berths, vessels and buoys can be equipped with smart sensors. The advantage of smart sensors is that they can provide the necessary metadata leading to a highly coherent and consistent data stream. Those sensors may be interconnected using an exchange platform as described above, contributing to a large set of real-time, well-maintained, complete and therefore useful information, forming the base for machine made decisions with regard to vessel navigation, voyage planning, cargo scheduling and loading procedures. Virtual AtoNs can adapt to vessel size and draught indicating available space for manoeuvring and proposing a navigable track to follow.

The human role in IWT is going to change obviously as smart and automated systems will assist and, in some cases, take over plenty of tasks carried out today by people. This includes “soft work” like generating and sending automated messages, reporting to authorities and notifying e.g. terminals and cargo operators as well as “hard work” that is steering the vessel, (un)loading it or performing manoeuvres like mooring a vessel in a harbour or a lock. The necessary digital infrastructure can be provided by the fairway authorities. Besides, a reliable and predictable arrival time estimation may allow to rotate personnel through a fleet. For example, if two or more vessels from one company have to pass one particular lock, crew-members towing the vessel may stay at the lock after the first vessel has left, waiting for the second to assist there. So, a fleet may need less workers than the same of single vessels. Single, independent, vessels may still request help from other vessel’s personnel against a fee thanks to a reliable ETA.

Key to safe navigation (disregarding whether a vessel is steered by a human being or a machine) is communication. Currently, this is done mostly via phone, VHF or other radio devices, relying on spoken language. This seems impossible for autonomous vessels. Therefore, in a mixed environment with (semi)autonomous and manually steered vessels those have to be able to communicate in an unambiguous and easy to handle way. This can be done, as for example it is used in aviation, by communication codes, which are ideally connected to a display in front of the skipper showing the fairway and all vessels around him. If he wants to deliver some information to one specific vessel (e.g. to announce overtaking) all he has to do is to select it on the display and to send a standard message.

Further automation and remote control may allow different new working concepts. Currently, a skipper always has to be on board at the helm (steering wheel). This could change when a vessel is operated remotely or autonomously. The skipper could be anywhere in the world, as long as it is in accordance with prevailing law and under prevailing law enforcement of the vessel’s position and steering his vessel (or even a fleet of vessels) located somewhere else. 24/7 Operation will be more likely and more feasible, reducing costs and transport times. On the other hand, one able crewmember might have to stay on board in case there is a technical malfunction, so that at least an accident can be prevented. The single job of that person is to stay on board and act only if a malfunction does occur. This implies that they may do different things including working remotely for another company (digital nomad) in a constant standby to act if the technical systems fail. These people might not even have full training as a skipper but have received only a limited and specific short training. This example shows very clearly that drastic changes in working culture in IWT can happen. A prerequisite is either the ability to conduct automated mooring or workmen being available at harbours/locks/berths performing the actual mooring process.

Autonomous vessels are especially not limited to large vessels carrying their load over long distances but may include fleets of small boats carrying very small loads used in a confined area e.g. inside ports. Those might also be used for transport within cities and shorten the “last mile”.

In addition, (semi)autonomous shipping can enable transport on waterways during low water periods or if other obstacles occur (e.g. platooning can be used on curvy shallow waterways when push boats cannot navigate anymore). An autonomous vessel may take certain details with regard to the waterway into account, such as the actual depth on a certain point of the fairway, further virtual AtoNs or communication between autonomous vessels.

06 Roadmap on digitalisation

During the course of the Masterplan DIWA project the IWT digital maturity was discussed, investigated and looked at from many different viewpoints. In general, the participating fairway authorities assessed their IWT maturity to be at the "Digitised" level (see Manual on Inland Waterway Transport Digitalisation and Assessment Methodology* and Figure 8). The joint vision translates into the ambition to achieve the Connected maturity level in the upcoming ten years including already driving towards Intelligent in several subject areas (e.g. predictive digital capabilities).

6.1 Vision on the transition - the role of the Fairway Authorities

Although a relatively small player in the global digitalisation developments, fairway authorities can have a proactive and agile attitude towards the digital transformation in IWT. Availability of information of the waterways and inland navigation is seen as a precondition for smooth and safe navigation and the maintenance and enhancement of data will be a constant factor, based on RIS. Support of Smart Shipping and Synchromodality requires continuous cooperation, testing and (new) guidelines and legislation.

Supporting Synchromodality by the fairway authorities needs public-private cooperation as the fairway authority is part of a larger governmental organisation which can support a neutral, trusted platform for data sharing. The Masterplan DIWA results and the roadmap provide a solid base to cope with the digitalisation challenges, although it's hardly possible to predict all the digitalisation developments in the upcoming decade. So, digitalisation is a topic that needs frequent attention and therefore it should be part of the future agenda of organisations dealing with digitalisation. It is worth mentioning that simply copying analogue processes into the digital world by implementing them in a computer program does not do any good usually. It is to be expected that plenty of administrative processes have to be reengineered completely.

* www.masterplandiwa.eu/wp-content/uploads/2023/03/Masterplan-DIWA-project-3.5-ManualOnIWT-DigitalisationAssessmentMethodology-March-2023-1.pdf

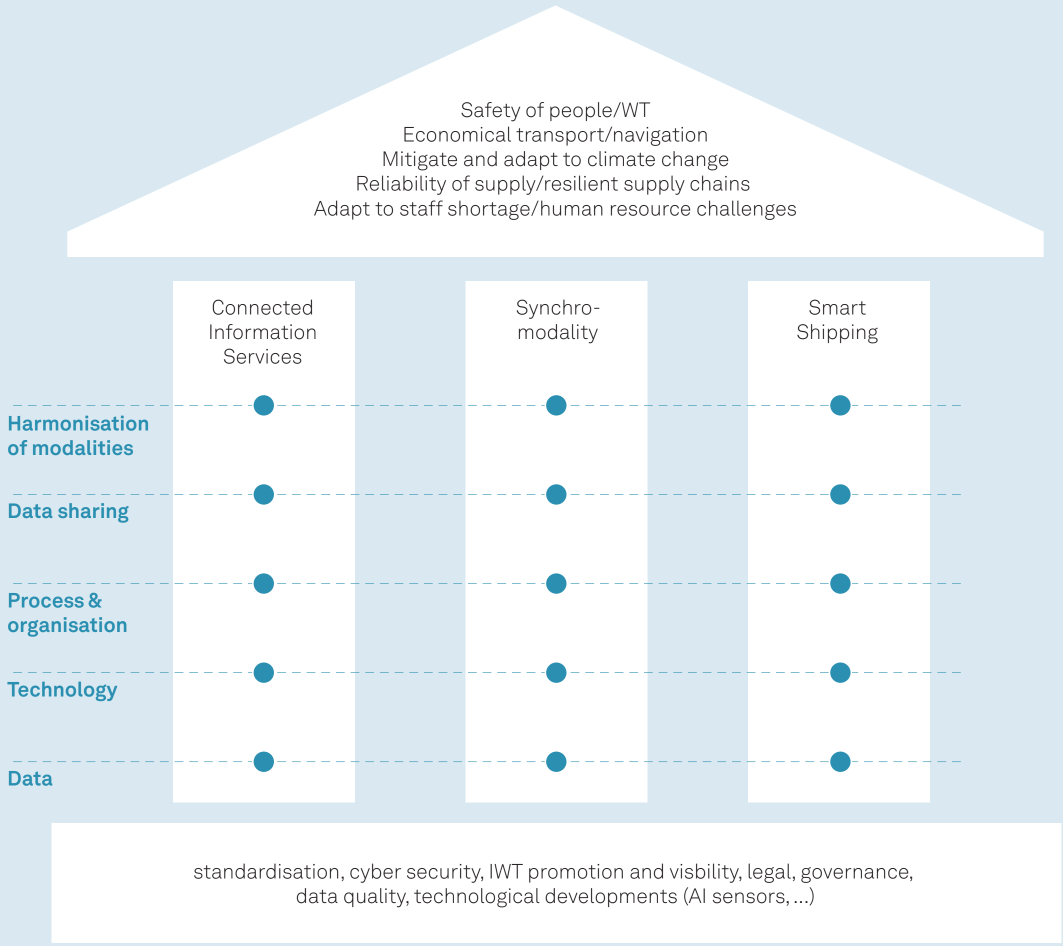
6.2 Pillars of the DIWA masterplan contributing to the overall policy objectives

In order to structure the many recommendations from the Masterplan DIWA sub activities into a manageable format, these were first aggregated into clustered recommendations, then attributed to one of the three vision pillars and further grouped into five thematic areas which were partly already identified in the high-level vision (see chapter 5.1) and partly emerged during the project as a result of investigations:

→ Data; covering all data related recommendations
→ Technology; covering all recommendations having a strong technology focus
→ Process & Organisation; covering the recommended actions to adapt processes and organisational arrangements
→ Data sharing: covering all recommendations leveraging data exchange and data sharing between stakeholders
→ Harmonisation of modalities; covering additional intermodal digitalisation recommendations

In subsequent sections of this chapter the clustered recommendations have been plotted on a roadmap for each pillar and encapsulated thematic area towards higher maturity levels. The estimated impact and consequences when acting upon a recommendation cluster have been organised in a table, per thematic area.

Figure 11: Contribution of thematic areas in the digitalisation pillars to high level policy objectives



6.3 Roadmap Synchromodality

Synchromodal related digitalisation level gains are to be found in increased cooperation between modality stakeholders and standardisation of their digital interaction. Of particular note is the need to deploy data and technology to be more predictive. Successful cooperation also requires adequate cybersecurity and safeguarding of data in order to provide the necessary trust.

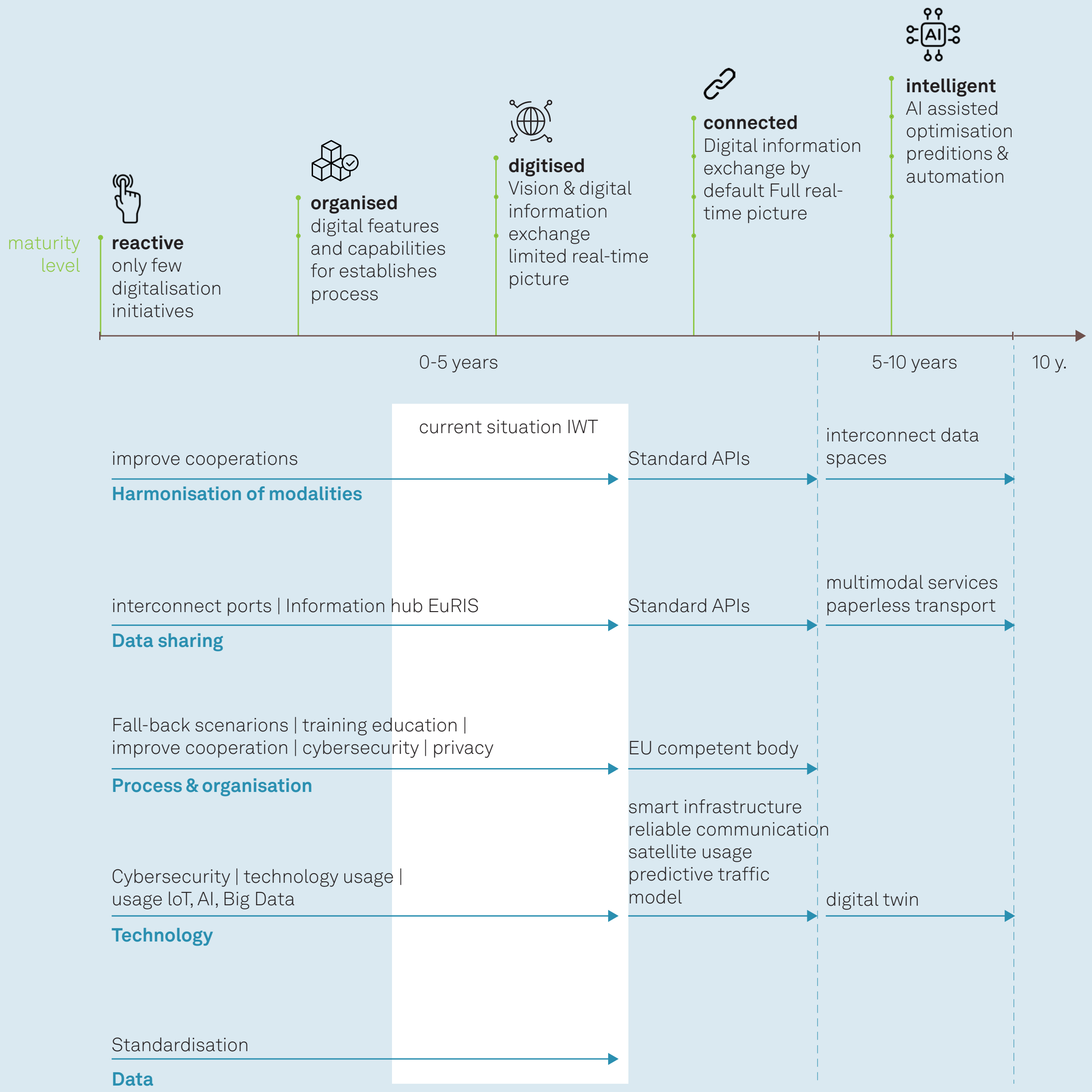


Figure 12: Roadmap towards a higher maturity level in Synchromodality

6.4 Roadmap Connected Information Services

A significant maturity leap towards Connected has been made in the COMEX project, resulting in the establishment of the EuRIS portal. Secured sustainment, expansion and improvement (data, technology and services) are necessary to keep performing at the Connected level and build a foundation for moving towards the Intelligent level. Connections and interoperability with ports as the modality transfer points and logistic stakeholders constitute next steps, requiring cybersecurity, data protection, cooperation and development of predictive abilities efforts similar to the Synchromodality pillar.

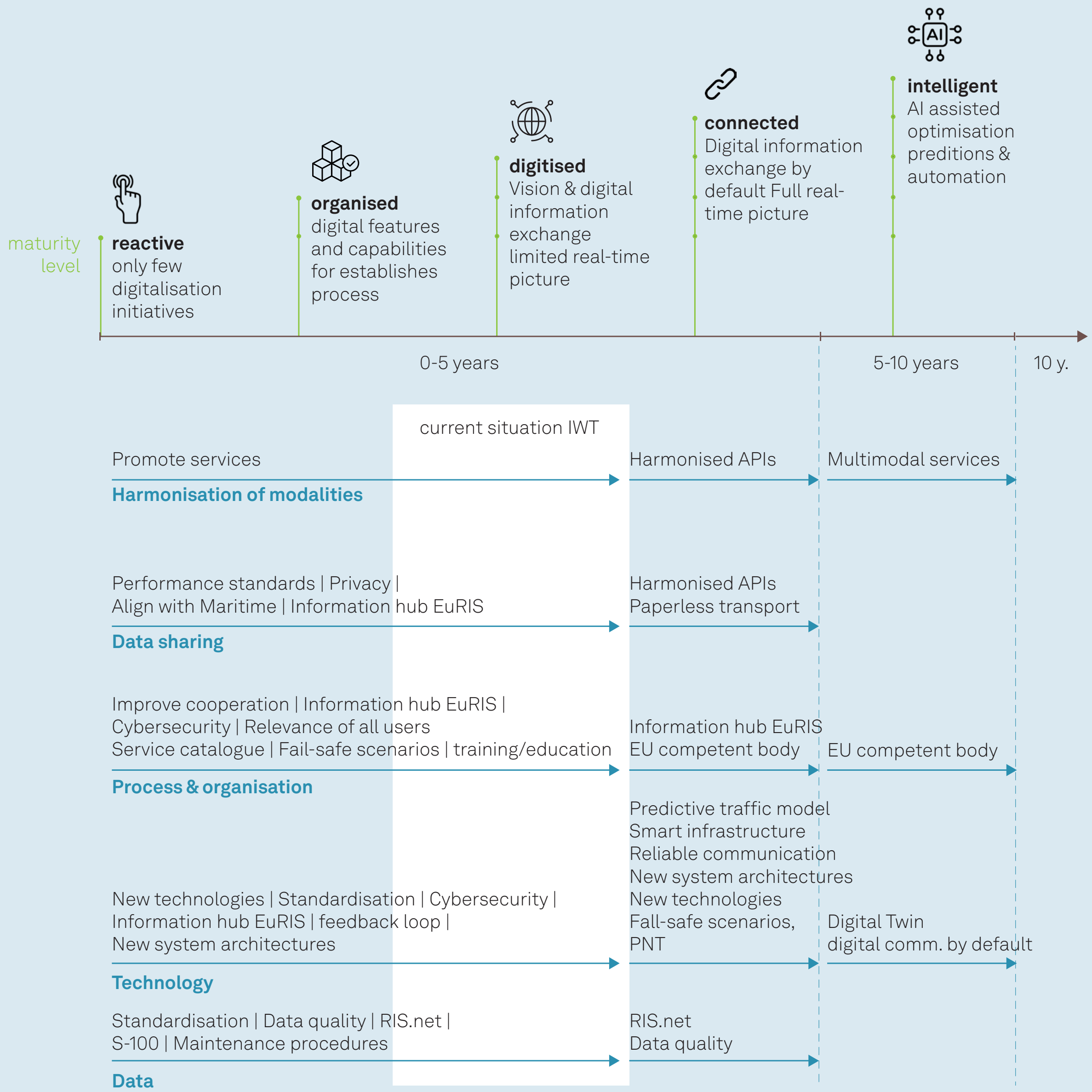


Figure 13: Roadmap towards a higher maturity level in Connected Information Services

6.5 Roadmap Smart Shipping

The main challenge for Smart Shipping in the upcoming years lies in the development of a supportive legal framework, preferably covering the entire EU waterway network. Progress in the legal area and policy decisions are essential to elevate IWT digitalisation maturity in the context of Smart Shipping. In addition, elevating IWT digitalisation maturity will require continuous fairway authority efforts to increase data quality, assist in providing supportive technology, promote and actively engage in standardisation activities while also helping IWT stakeholders to increase their cyber resilience. Developments in maritime can and should be incorporated in IWT since these are steadily driven by large global entities and will inevitably be encountered by IWT in mixed traffic areas.

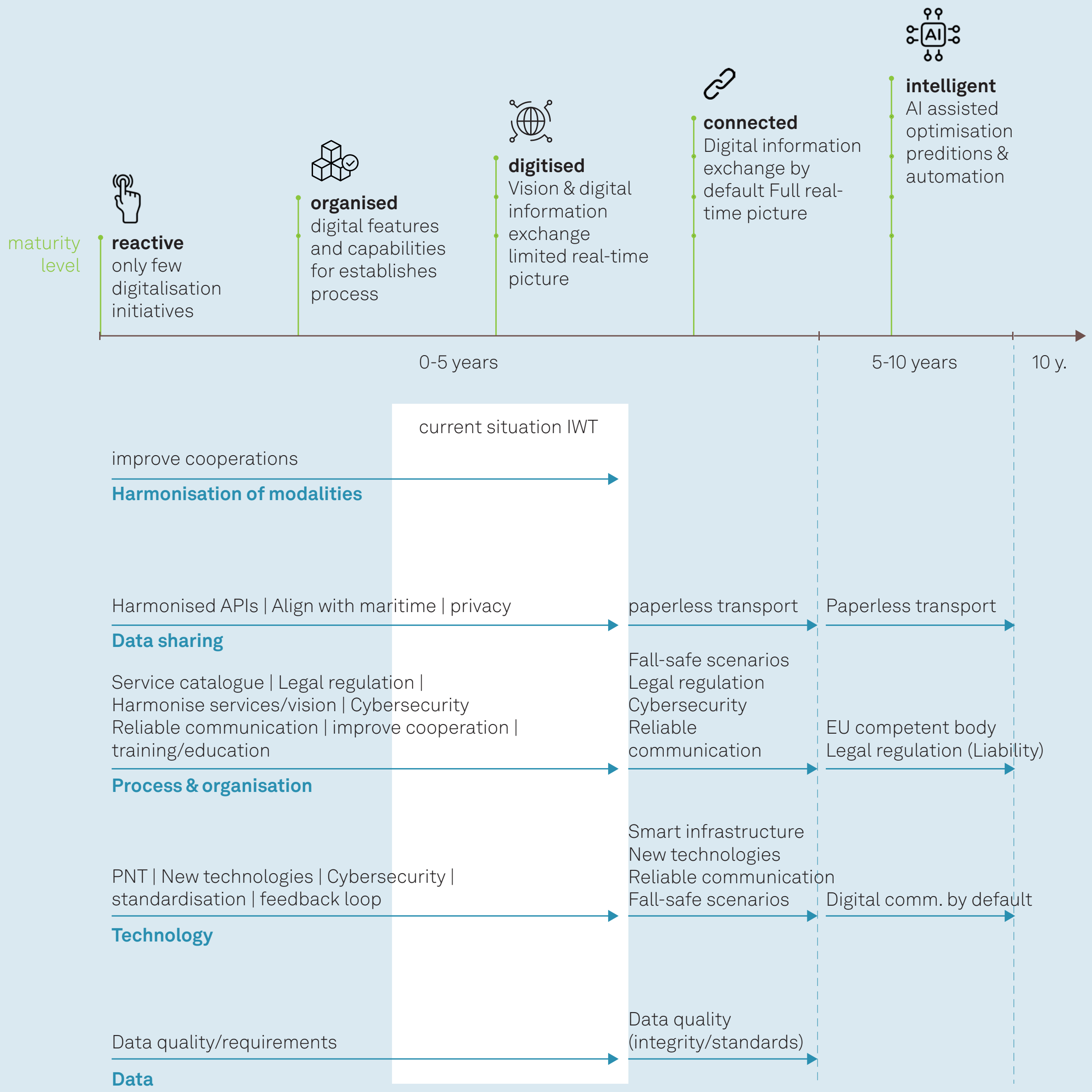


Figure 14: Roadmap towards a higher maturity level in Smart Shipping

6.6 Detailed Measures

Despite grouping recommendations and measures, the resulting list still numbers nearly one hundred measures. A number of avenues to represent the list of measures in an information rich, but at the same time easily readable format were explored. In the end the choice was made to offer the reader several options to digest the information. The master table of recommendations will be made available separately in an online format with filter options to allow the reader to zoom in on measures. In addition, the following chapters contain an extract of the master table of recommendations. The columns were limited to fit on a single page while still containing the major impact elements of a measure. Furthermore, the measures were split according to thematic area over separate sub-paragraphs to partition the table size into more accessible parts.

Column headers used in the master table are explained below:

- → Label: links the measure to the roadmap element in paragraphs 6.3, 6.4 and 6.5;
- → Measure: concise measure name;
- → Description: short description of the measure;
- → Stakeholders: lists the stakeholders that need to act in the execution of the measure:
  - ↳ FA=fairway authority
  - ↳ VOp=vessel operator
  - ↳ VOw= vessel owner
  - ↳ oA=other Authorities
  - ↳ VTM=vessel traffic manager
  - ↳ LSP=Logistics service provider
  - ↳ Sk=Skipper
  - ↳ SWS=Software Supplier
  - ↳ ES=Equipment Supplier
- → Effort: Size estimation of effort was done using the T-shirt size scale used in agile software development* (S-M-L-XL-XXL);
- → Technical: technical aspects regarding impact of the measure;
- → Financial: Because of the large number of influencing factors and the inherent uncertainty at the level of aggregation, the financial impact estimation used a broad 3-point scale (€: up to 100K-€€: between 100K and 1000K-€€€; upwards of 1000K)
- → Organisational: Another type of effort estimation was performed by estimating the executing organisational structure for the activity (in order of increasing magnitude):
  - ↳ SuAc: sub activity
  - ↳ Ac: activity
  - ↳ Project
  - ↳ Programme
- → Operational: Operational aspects regarding impact of the measure;
- → Contribution to: Elements in the roof of the “vision temple” figure (figures 9 and 10), the measure is expected to contribute to;
- → Time box: For the estimated implementation time, each clustered recommendation was assessed to be most likely implemented either in the upcoming 5 years, between 5 and 10 years or beyond the 10-year horizon;
- → Pillar: The pillar(s) of the “vision temple” figure (figures 10 and 11), the measure contributes to. (Synchromodality, Connected Information Sservices (CIS), Smart Shipping)

The high-level estimates in the tables are intended to provide a first indication of the required effort. A more detailed effort estimation, considering regional and organisational specifics, is advisable.

During aggregation, clustering and grouping, details are inevitable lost. Detailed descriptions of individual recommendations are however available in the sub activity reports while clustering considerations are available in the activity reports. Please visit these underlying documents for details, considerations and further explanations.

* https://doasync.com/blog/what-is-t-shirt-sizing/

6.6.1 Recommended measures in the thematic area of Data

6.6.1 Recommended measures in the thematic area of Data (1/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
data quality	**M83** Increase data quality	Increase the quality of the data by investing in quality of existing data instead of a focus on sharing new types of data. Data quality will play a key role for the necessary further technological developments and e.g., Smart Shipping. Therefore, to check the data quality, it is important to make use of the data quality parameters in IWT as researched to ensure that the used data, meet the associated parameters. Analyse and improve the quality of data based on the findings of the report of DIWA SuAc 4.4. An investigation is recommended whether mass data analysis could improve data quality. Use other (reference) data to check the quality of own data as well as the correctness of AIS data (including control mechanism). Furthermore, Process Mining can be implemented to detect irregularities or possible errors in the data. Data quality (analyse current situation and measures to improve) should be a topic in future European projects.	FA	M	**Technical:** Define data quality parameters for every information provided to fairway users or other stakeholders. Assess the quality of gathered data and provided information. Fix data quality issues **Operational:** improved or optimised data quality. More reliable information on RIS portals **Financial:** €-€€ | **Organisational:** SuAc	Safety, Economical transport, Reliability of supply	basic 0-5	CIS, Smart Shipping
data quality	**M84** Provide meta-data	Need for more clarity on the quality (meta data) of existing data and the source of data. This allows users to verify on critical functional parameters.	FA	S M	**Technical:** Add meta information to the data provided. Provide information on how to use the data and for which purposes it can be used. Allow identification of the source of the data (e.g. GIS data). **Operational:** Data quality parameters are visible to users, Make resources available to enter and maintain meta-data **Financial:** €-€€ | **Organisational:** Ac-Project-Programme	Safety, Economical transport, Reliability of supply	interim 0-5	Smart Shipping
data quality	**M85** Install a (virtual) data quality team for European IWT data	a hands-on EU-wide data quality team for harmonising IWT data. Automated data validation can be used for feedback to data providers. EU wide actions to facilitate the enhancement and harmonization of data	FA	L	**Technical:** - **Operational:** Dedicated resources for such task, additional staff, Data analysis team based on user feedback and supported by analysis tools **Financial:** €€ | **Organisational:** Project	Economical transport, Reliability of supply	interim 5-10	Synchro-modality, CIS, Smart Shipping
data quality	**M95** Investigate and develop quality standards	Development of a new quality standard with associated quality monitoring tools for RIS key services Autonomous/Automated Shipping need a higher accuracy of information (e.g. position). Investigations are needed to identify the required accuracy of the relevant data.	FA	M	**Technical:** - **Operational:** Make experts available to investigate and develop quality standards **Financial:** € | **Organisational:** Ac	Safety, Economical transport, Reliability of supply, paperless transport	interim 0-5 5-10	CIS, Smart Shipping
Data quality	**M96** Investigate and define data quality requirements on national, regional and international aspects	Investigate and determine the different data quality needs from the regions in Europe within the existing IWT standards. Ideally, the investigations should be performed together with other transport modes. An inventory of current situation of data quality issues should be created as well. Define a same level of up-to-dateness to reach a similar quality level for IENCs in different countries. Define a set of "business rules" for checking data at the source. This can be offered as a EuRIS Service. Someone can provide data and receives a rating about its consistency. Integrate information from 3rd parties (self-maintained or via focal point).	FA Ports SWS	S M	**Technical:** Detailed definition of minimum requirements **Operational:** Make experts available to investigate and define quality requirements **Financial:** € | **Organisational:** SuAc	Economical transport, Reliability of supply, paperless transport	basic 0-5	Synchro-modality, CIS, Smart Shipping

6.6.1 Recommended measures in the thematic area of Data (2/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
feedback loop	**M79** Feedback loop	Enable easy feedback on discrepancies between provided data and information and the real-life state. A Single point of contact (SPoC) can be contacted by the users of the data to report any data issues and the SPoC will respond and act accordingly. A feedback loop to the different levels of users is recommended.	FA Ports VTM LSP VOp Sk	S	**Technical:** Create a service (e.g. on the EuRIS portal) for users to give feedback on the provided information. A single point of contact (SPoC) per national data provider for EuRIS. **Operational:** users indicate when data quality deficiencies occur, Provide routing to (expert) resources who are available to fix the issues and provide status feedback to issue reporter **Financial:** € | **Organisational:** SuAc	Economical transport	basic 0-5	CIS, Smart Shipping
Information hub EuRIS	**M89** Implementation of a reference data support service	(Reference) Data Support Service – EuRIS as buffer/cache. Provision of unambiguous reference data for common sections. DG Move could foster such implementations (provide financial and other incentives)	FA	S	**Technical:** Implementation of interface with ERDMS and synchronisation of data from EuRIS. Provide unambiguous reference data for common sections (jointly provided by competent authorities) **Operational:** reduction of administrative burden of EuRIS partner organisations **Financial:** € | **Organisational:** SuAc	Economical transport	basic 0-5	CIS
maintenance procedures	**M92** Maintenance, harmonisation and synchronisation of reference data	Improve the maintenance, harmonisation and synchronisation of reference data, by means of e.g.: Harmonisation of reference data where feasible, otherwise linking of code tables Implementation of services and procedures for the synchro-nisation of reference data across all applications and services involved Improve NtS regarding: Timeliness, Completeness, Accuracy Maintaining data quality should be obtained by cooperation and by offering help by DG MOVE to the Member States.	FA Ports SWS oA	L	**Technical:** National and international implementation of linking and synchronization services **Operational:** Streamline processes. Reduce the number of reference databases to one (1) **Financial:** €€ | **Organisational:** Project-Programme	Safety, Economical transport, Reliability of supply	basic interim 0-5 5-10	Synchro-modality, CIS
RIS.net	**M86** Continue elaboration of RIS.net	Potentially make RIS.net an official standard and implementa-tion of RIS.net in a future European project. Replacing the RIS Index can have a huge impact on the RIS Technical Services and most, if not all, RIS Operational Services. Sufficient time and funding should be made available to further elaborate RIS-Net with the help of, at least, the CESNI/TI work-ing groups and the IEHG, for example in a follow-up project of RIS COMEX	FA	L	**Technical:** elaborate, amend, finalise RIS.net specification and provide it to EuRIS maintenance provider and CESNI **Operational:** after first elaboration of data according to RIS.net the update work is a standard task **Financial:** €€ | **Organisational:** Project	Economical transport	basic 0-5	CIS
RIS.net	**M87** Implement RIS.net	RIS.net should be the future data model in IWT. It should con-sider the information in the IHO Geospatial Information Registry, the Maritime Resource Name and the need of TENtec. It has also to be considered as a possible future part of ES-RIS 2029/1 to specify the requirements stipulated in the RIS Direc-tive for Member States to publish data facilitating route- and voyage planning	FA	M L	**Technical:** Technical: Finalise, amend and implement data model in EuRIS + all partners provide data according to RIS.net **Standardisation:** Provide results to CESNI and put it into a standard **Operational:** after first elaboration of data according to RIS.net the update work is a standard task **Financial:** €€ | **Organisational:** Project	Economical transport	interim 0-5 5-10	CIS

6.6.1 Recommended measures in the thematic area of Data (3/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
S-100	**M88** Assess impact of S-100 on IWT & decide on actions	The S-100 framework in fact identifies itself as the 'Universal Hydrographic Data Model' and thus as being capable to incorporate all data entities associated with the waterway domain. Propose to add investigation of the S-100 framework to CESNI/ TI Work Programme.	FA	S	**Technical:** Assessment of the technical specifications and impact on RIS key technologies **Operational:** compliancy with maritime standards is important for mixed areas. New standards will bring new ways of working into daily operation, Make resources available for assessment and follow up **Financial:** € | **Organisational:** SuAc	Economical transport	interim 0-5	CIS
standardisation	**M80** Maintain standardisation work	Active involvement in standardisation process Detailed uniform definitions of terms used in inland shipping. The common standardisation procedure in the rail sector could be a useful example for an standardised stakeholder involvement.	FA	M	**Technical:** further standardisation of data and services **Operational:** European services provided to users or other stakeholders, Continue making experts available **Financial:** €-€€ | **Organisational:** Project	Economical transport, Reliability of supply	basic 0-5 interim 5-10 advanced 10+	Synchro-modality, CIS
standardisation	**M81** Formalise de facto standards	There are some de-facto standards (e.g. RIS Index, VisuRIS COMEX Reference Network Model, ERINOT 1.2 XML, Exchange of Object Status Information, ERIVOY, RTA, Lock Access) which are not official standards. Integrate them in existing software and start a trajectory to formalize them.	FA	S	**Technical:** Develop de facto standards into official standards. Test-implement new specifications in European Projects to gain experience and to involve technical experts. Standardise proven services and processes. Integrate the preliminary standard used in the COMEX project in the RIS standards suite to safeguard further implementation of the TIS.4 RIS service across the European waterways **Operational:** new standardised data structures or messages, Continue making experts available **Financial:** €-€€ | **Organisational:** SuAc-Ac	Economical transport, Reliability of supply	basic 0-5	CIS
standardi-sation	**M82** Implement updated standards	Implementation of RIS key technologies and other relevant services need to follow the standardisation (updates), e.g. ES-RIS	FA	M	**Technical:** Use new standards in databases and messages **Operational:** harmonised data and information **Financial:** € | **Organisational:** SuAc	Economical transport	basic 0-5	CIS

6.6.2 Recommended measures in the thematic area of Technology

6.6.2 Recommended measures in the thematic area of Technology (1/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
cybersecurity	**M52** Adopt PKI to encrypt data exchange	Public-key infrastructure will result in the possibility to sign and / or encrypt almost all information flows - thus providing protection against tampering.	FA, SWS	M-L	**Technical:** Implement an authentication and encryption mechanisms in the software **Operational:** benefit: secure data exchange and communication **consequence:** incorporate periodic renewal of certificates into process **Financial:** €€ | **Organisational:** Project	Safety, Economical transport, Reliability of supply	interim 5-10	CIS, Smart Shipping
cybersecurity	**M53** Implement (basic) cyber security and data protection measures	Any IT/smart sensor systems/networks need cybersecurity measures to mitigate new risks. It is very important to comply with GDPR rules when generating new data. The GDPR requires organisations to implement appropriate technical and organisational measures to protect personal data against unauthorised access, alteration, and destruction. This includes implementing robust cybersecurity measures.	FA, oA, SWS, Ports, VTM, VOw, VOp, Sk	S-M	**Technical:** Implementation of state-of-the-art cyber security measures. Perform regular software updates and hardening of devices & software. Segregation/segmentation of the network. Decommissioning of (legacy) equipment **Operational:** benefit: sensors or sensor networks are secure against cyberattacks **consequence:** make cyber security experts available to implement the measures **Financial:** €€ | **Organisational:** Project-Programme	Safety, Reliability of supply	basic 0-5, 5-10	CIS, Smart Shipping
cybersecurity	**M65** Define cybersecurity minimum requirements for autonomous/ remotely operated vessels & centres	Cyber vulnerability of autonomous/remotely operated vessels constitutes safety risks for fairway authorities	FA, oA, Vow, EP	M	**Technical:** specify cybersecurity minimum requirements for operation of autonomous/remotely operated vessels & centres **Operational:** benefit: lower cyber risk when operating AV/ROV on the fairways **consequence:** Make regulatory, cyber and subject matter experts available **Financial:** € | **Organisational:** SuAc	Safety, Reliability of supply	basic 0-5	Smart Shipping
cybersecurity	**M66** Reduce AIS cyber vulnerability	The integrity, confidentiality and availability of data exchange should be guaranteed. Secure all communication data links between vessels and between vessels and shore stations/infrastructure and guarantee the validity of the originator and recipient. Should be a part of the certification of vessels and ROC's procedure.	FA, SWS, ES	M-L	**Technical:** assessment of AIS cyber vulnerabilities. consider new communication systems or implement authentication and encryption mechanism **Operational:** (more) secure AIS communication, Will require long term actions on different organisational levels to mitigate the AIS cyber vulnerability. requires also alignment with Maritime **Financial:** €€ | **Organisational:** Ac-Project	Safety, Economical transport, Reliability of supply	basic 0-5, 5-10, 10+	CIS, Smart Shipping
cybersecurity	**M91** Define cybersecurity minimum requirements for smart infrastructure	Smart Infrastructure consists of data gathering devices which distribute data via connections often provided by contractors of the infrastructure. To mitigate the increased cyber vulnerability, minimum requirements should be made available to the contractors	FA, Ports	S	**Technical:** **Operational:** Make procurement, cyber, sensor and mechatronics experts available to draft the requirements. **Financial:** € | **Organisational:** SuAc	Safety, Economical transport	basic 0-5	CIS, Smart Shipping
data quality	**M63** Insight available data services Smart Shipping	Insight in the quality and availability of the data that is present for each part of the European inland waterway network.	FA, SWS, VoP, Sk, EP, Ports	M	**Technical:** provide availability of data/services for each part of EU fairway to users. provide accuracy or other quality parameter of data/information to users **Operational:** Details about accuracy/quality/availability are available to indicate how the users can deal with the data/information provided **Financial:** € | **Organisational:** SuAc	Safety, Economical transport, Reliability of supply	basic 0-5	Smart Shipping

6.6.2 Recommended measures in the thematic area of Technology (2/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
digital communication by default	**M72** digital communication by default	Vessels and infrastructure shall be able to coordinate their communication (intentions) digitally via standardised interfaces moving towards cooperative self-organised traffic management	FA, SWS, ES, VTM, VOw, VOp, Sk	XL	**Technical:** equip relevant waterway infrastructures with sensors and communication technologies to create a cooperative network together with vessels, Implement systems capable of digitally handling current voice communication. **Operational:** highly digitalised fairway infrastructure, Vessels can process digital information themselves, adapt processes involving voice communication to be able to handle pure digital communication **Financial:** €€€ | **Organisational:** Project-Programme	Safety, Economical transport, mitigate climate change, staff shortage	interim-advanced 5-10, 10+	CIS, Smart Shipping
digital twin	**M59** Create a holistic digital twin	A digital twin combines available data and information services, represents the reality with all related data flows and its development can grow gradually. A holistic digital twin is the conjunction of applications from all modes of transport. Its goal is to harmonise all modalities allowing the user to find the most efficient and sustainable mode of transport for the respective product.	FA, SWS, Ports, LSP, VTM, VOp, VOw, oA, Sk, ES	XXL	**Technical:** use the data exchange platform (e.g. EuRIS), the Smart Infrastructure and the predictive traffic model to create a Digital Twin of the waterway; also in collaboration with other transport modes **Operational:** the 'digital copy' of the actual waterway network enables new services and remote-control of the infrastructure. ensure secure access to DT. Sustain and expand (inter)national data quality improvements, Make subject matter experts available. **Financial:** €€€ | **Organisational:** Programme	Economical transport, Reliability of supply	advanced 5-10, 10+	Synchro-modality, CIS
fail-safe scenarios	**M51** Develop fall-back scenarios for non-safety related systems (internet services)	Alternative ways of retrieving correct data is important. Fall-back options must be foreseen and redundancy becomes important	FA, SWS	S-L	**Technical:** Implementation of alternative data connections and/or sources. This may require additional IT infrastructure and hardware (sensors, data access points) **Operational:** benefit: missing or incorrect (essential) data almost impossible **consequence:** Integrate fall back procedures into the mode of operation and conduct regular exercises to test and train them. **Financial:** €-€€ | **Organisational:** SuAc-Ac-Project	Economical transport	basic-interim 0-5, 5-10	CIS
fail-safe scenarios	**M64** Develop fall-back scenarios for sensor systems applied in autonomous or automated vessels	FA requires fall-back options for autonomous sailing based on smart sensors. Integrate a fall-back solution in sensor systems applied on e.g. automated vessels	FA, SWS, VoW, EP	S-M	**Technical:** create a reliable concept for redundant sensor systems, especially for positioning, provide availability of data/services for each part of EU fairway to users **Operational:** if implemented, likelihood of vessel positioning failure decreases **Financial:** € | **Organisational:** SuAc	Safety, Reliability of supply	basic-interim 0-5, 5-10	Smart Shipping
Information hub EuRIS	**M50** EuRIS expansion & enhancement	Expansion of data & service provision towards vessel operators and logistic service providers Enhance traffic management, el. reporting, corridor management services (reliable voyage calculations on actual and accurate data) Provide information on the overall availability of waterway network and objects taking data from different services such as the network, NtS, object status, operation times	FA, SWS, VOp, Sk, LSP	M-L	**Technical:** The services of EuRIS will be extended or improved, Many improvements in technologies and data structure. Define data quality KPIs per service **Operational:** benefit: more services, more accurate data and information **consequence:** Continued national effort to improve/maintain data quality and provide additional data. **Financial:** €€-€€€ | **Organisational:** Project	Economical transport, Reliability of supply	basic-interim 0-5, 5-10	CIS

6.6.2 Recommended measures in the thematic area of Technology (3/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
new system architectures	**M62** Introduce and establish new system architectures	A combination and integration of the mutually supportive system architectures is recommended resulting in the use of them in inland navigation as a standard for further technological improvements/ developments	FA	M	**Technical:** develop an architecture of the technical systems to support the implementation of new or other technologies **Operational:** Make subject matter experts available **Financial:** € | **Organisational:** SuAc	Economical transport	basic 0-5	CIS
New technologies	**M55** More detailed investigations on IoT, AI, Big Data, Digital Twin for usage in IWT	More investigations to gain practical experience (As M54 was deleted) Depending on the findings of the investigations, strive to create international standards for European inland waterways as a key element for harmonised implementation of 'New technologies'. Standards can be created through legal measures, through dedicated harmonisation efforts or through market pull. The latter is especially valuable since it focuses on the voluntary commitment of all stakeholders which allows for a much faster and harmonious implementation.	FA	L	**Technical:** better understanding of the technical feasibility and usefulness of their implementation **Operational:** Make subject matter experts available to participate in the investigations. Without subject matter experts to define the right use-cases there will be no usable output **Financial:** €€ | **Organisational:** Ac-Project	Economical transport, staff shortage	basic 0-5	CIS, Smart Shipping
New technologies	**M56** Ensure diligent use of AI	The combination of Artificial Intelligence and Big Data Analytics can be used to support the cyber defence. Artificial Intelligence can be employed to aid in the detection of anomalies/ irregularities indicative of cyberattacks. AI can be used to monitor and correct data in a reliable way, but a machine learning algorithm that uses irrelevant or faulty data as input, will not be able to solve tasks that become more and more complex. Therefore, it is critical to pre-process datasets before using them to train a machine learning model	FA, SWS	L	**Technical:** Appropriate integration of AI (needs Big Data and IoT) and careful use to process data **Operational:** benefit: AI supports making better decision and to improve data/information **consequence:** Make subject matter experts available to work on data quality and oversee AI results/training. Perform an AI impact assessment before embarking on an AI project **Financial:** €€ | **Organisational:** Project	Economical transport, staff shortage	interim-advanced 5-10	CIS, Smart Shipping
New technologies	**M60** Implement IoT, AI, Big Data for IWT	Technologies like IoT, drones, Big Data, AI will play a major role in the upcoming years for the development/digitalisation of IWT. Different use cases require a different combination of those.	FA, SWS	XXL	**Technical:** perform a transition to a Smart Infrastructure by implementing Smart sensor networks and other devices. save the data in databases or Cloud providers. implement AI to process the data **Operational:** increased cyber risk (needs countermeasures). more data to create improved information for fairway users. more infrastructure and devices to maintain **Financial:** €€€ | **Organisational:** Project-Programme	Economical transport, staff shortage	interim-advanced 5-10, 10+	Synchro-modality, CIS, Smart Shipping
New technologies	**M61** Create a migration path for technologies	Define specific stages regarding the harmonisation across the existing competent bodies of the IWT fairway & navigation domain towards migration path(s) from one acceptable intermediate solution to the next one. The migration path to increase the IWT digitalisation levels (IDLs) should include fall-back provisions. To ensure a harmonised development (in Europe) of the migration path, it is required to have a coordinating competent body. At the same time, the body should improve cooperation with other modes of transport.	FA, oA	M	**Technical:** a coordinated roadmap to implement new developments, coordinated by an international competent body **Operational:** benefit: harmonised implementation of technologies **consequence:** make sufficiently mandated subject matter experts available **Financial:** €-€€ | **Organisational:** SuAc-Ac	Economical transport, staff shortage	basic 0-5	Synchro-modality, CIS, Smart Shipping

6.6.2 Recommended measures in the thematic area of Technology (4/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
PNT	**M67** Implement a shipboard PNT processing entity	The concept of Recognised PNT provision and a shipboard PNT processing entity can use multiple sources of PNT data from different sensors to provide reliable and resilient position information.	FA, ES, VOw	L	**Technical:** install a PNT processing entity on vessels **Operational:** vessel can use the concept of Recognised PNT for more reliable and accurate positioning **Financial:** €€ | **Organisational:** Project	Safety, Economical transport	interim-advanced 5-10, 10+	CIS, Smart Shipping
PNT	**M68** Define requirements for sensors and PNT used for automatic/ autonomous vessels	Define requirements for sensors and PNT used for automatic/ autonomous vessels. Especially Software-defined devices and the limited lifetime and support period of IoT devices need a more detailed assessment to keep the systems/network secure.	FA, SWS, ES, VOw, VOp	S-M	**Technical:** sensor minimum requirements for operation of autonomous/ remotely operated vessels & centres. Consider requirements of Smart Shipping and autonomous sailing in future revision of IWT standards. **Operational:** benefit: supplier provide sensors according to needs and minimum standards **consequence:** make subject matter experts available **Financial:** € | **Organisational:** SuAc	Safety, Economical transport	basic 0-5	Smart Shipping
predictive traffic model	**M57** Deliver accurate traffic predictions	Enable shift from decision support to decision making tools, by offering traffic predictions on the data exchange platforms. See establish predictive traffic model.	FA, SWS	L	**Technical:** Use AI to predict future traffic situations. improve predictive algorithms. EuRIS offers additional service to display future traffic situation **Operational:** Sustain and expand (inter)national data quality improvements **Financial:** €€ | **Organisational:** Project	Economical transport, Reliability of supply, mitigate climate change	interim-advanced 0-5, 5-10	Synchro-modality, CIS
predictive traffic model	**M58** Establish a predictive traffic model using AI	A predictive traffic model combines a multitude of information sources, and by using AI, is able to recognise patterns in historical and current data enabling predictions about the state of traffic. Such predictive model can "start" using EuRIS data, however, this will only be the base as also weather, events, other traffic, local infrastructure works, forecast on viral infections, availability of personnel etc. shall be taken into account for more reliable output.	FA, SWS	L-XL	**Technical:** use the data exchange platform (e.g. EuRIS), the Smart Infrastructure and AI to create a predictive traffic model. improve predictive algorithms **Operational:** benefit: predictive traffic model enables new services for fairway users and enables to optimise the planning of the voyage. sustain and expand inter(national) data quality improvements **Financial:** €€-€€€ | **Organisational:** Project	Economical transport, Reliability of supply, mitigate climate change	interim-advanced 5-10	Synchro-modality, CIS
reliable communication	**M70** Reliable connections, communication network coverage	Need of full coverage on all navigable inland waterways used for commercial transport of cargo. Connectivity and reliable communication links are seen as crucial backbone in future smart shipping applications. Provide AIS coverage and ensure mobile internet coverage on all navigable inland waterways used for commercial transport of cargo.	FA, ES, VOp, VOw, Sk	L-XL	**Technical:** more AIS base stations or use of other communication technologies. implement a concept of multiple communication systems, Equip all fairway sections with AIS base stations or use new solutions for tracking of vessels, also implement a backup system for vessel tracking **Operational:** benefit: reliable communication channels on all fairway sections, full AIS coverage of the fairway network, **consequence:** Chance process to include activities that cover connectivity gaps left by commercial network providers; Make resources available to acquire and possibly maintain alternative connectivity solutions. **Financial:** €€-€€€ | **Organisational:** Project	Economical transport, Safety	interim 0-5, 5-10	CIS, Smart Shipping
reliable communication	**M71** Ship-ship communication standards	A cooperative network where vessels (and VTS) are connected and share intentions is seen as a possibility to reduce complexity and allow for a safer (and easier) implementation of smart shipping. It is also recommended to investigate possible standards on intention sharing in other modes of transport as possible input for IWT standards.	FA, SWS, ES, VOw, VOp, Sk	M	**Technical:** new standard for communication technologies and protocol of Smart Vessels to share intentions, For FA: change systems to receive non-voice vessel communication in VTS centre **Operational:** Uniform digital communication of the vessels is enabled, (more) secure traffic behaviour when operating smart vessels, For FA: change VTS process to include non-voice vessel communication. **Financial:** € | **Organisational:** SuAc	Safety	interim 5-10	Smart Shipping

6.6.2 Recommended measures in the thematic area of Technology (5/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
reliable communication	**M73** Voicelesser communication	Adopt Nautical Datalink Communication for voiceless(er) communication as a basis for digital information exchange by default	FA, SWS, ES, VTM	M	**Technical:** implement the concept of Nautical Datalink Communication for data exchange **Operational:** codify voice communication processes. Adapt processes involving voice communication to be able to handle codified digital communication. **Financial:** €€ | **Organisational:** Project	Economical transport, Reliability of supply, staff shortage	interim 5-10	Smart Shipping
reliable communication	**M74** Consider satellites (for communication & as a sensor)	GNSS has become the primary PNT source for maritime and inland waterways navigation. The GNSS position is used both, for vessel navigation and as the position source for other onboard equipment such as Inland ECDIS and AIS. The usage of satellites will grow as costs get lower - that will increase the service portfolio from orbit	FA, SWS, ES,	S	**Technical:** investigation of available services and cost benefit analysis against other means. potential easier data gathering and processing than via conventional methods, Requires additional/suitable communication devices on board and/or additional on-shore processing when used as a sensor. **Operational:** may resolve need for local infrastructure and maintenance of those, may be used as a fall-back technology in case of failure of terrestrial technology **Financial:** €€ | **Organisational:** Ac	Safety, Economical transport	interim 5-10	CIS, Smart Shipping
reliable communication	**M75** Adopt communication technologies like SECOM, VDES, R-mode, 5G, VLC, Recognised PNT Provision or NDLC to Inland Shipping	Solutions for a reliable and secure communication need to be found also considering backup channels (automated vessels cannot rely on only one communication link). Further investigations could go towards a so-called heterogeneous network as a communication system.	FA, SWS, ES,	XL	**Technical:** further investigate these communication technologies, adapt them to the requirements of the IWT. implementation of useful communication technologies, Requires additional communication devices both on board and on shore and/or modifications to existing hard- & software plus additional on-shore processing **Operational:** new or additional communication channel, make experts available to analyse and specify required changes. Adapt processes to handle additional or changed technology applications **Financial:** €€-€€€ | **Organisational:** Project-Programme	Safety, Economical transport, staff shortage	basic-interim 0-5, 5-10	CIS, Smart Shipping
smart infrastructure	**M69** Introduce Smart Sensors/sensor technologies/ infrastructure	Smart sensors can be used for various tasks on vessels or infrastructure as part of a network. But also, existing sensors can be used in a smart way adding post-processing or AI to it (e.g. infrastructure health monitoring).	FA, Ports, VOw, Sk, SWS, ES	L-XL	**Technical:** create a network of sensor and smart sensors, harvest , store and distribute data, Requires storage of large amounts of data and Big data tools to process **Operational:** infrastructure creates more data, make subject matter experts available to add "smartness" (interpretation of data and rules for automated handling) and data science resources to process, clean and manage the data. **Financial:** €€-€€€ | **Organisational:** Project-Programme	Economical transport, Reliability of supply, mitigate climate change	interim 0-5, 5-10	CIS, Smart Shipping

6.6.2 Recommended measures in the thematic area of Technology (6/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
smart infrastructure	**M76** Implementation of smart infrastructures	In the upcoming decade, a portion of the system of waterways can be developed into a smart infrastructure ("Infostructure"). It will facilitate the use of smart vessels and (underwater) drones. In this context, technologies such as smart sensors, IoT, etc. will be used. Ultimately moving towards prepardness for autonomous infrastructure.	FA, SWS, ES,	XXL	**Technical:** a coordinated roadmap to implement new developments, coordinated by an international competent body. Technical implementation may vary by object type and nationality but information provision shall be identical, Requires additional devices on shore and/or modifications to existing hard- & software plus additional on-shore processing **Operational:** that varies from information availability for better planning to assistance systems for (semi) automated vessels, Requires changes to processes to facilitate harvesting of additional data, storage and processing of this data, maintenance of the data collection and distribution devices. Including a data provision paragraph in contracts helps contractors of infrastructure to provide smart infrastructure data to FA. **Financial:** €€€ | **Organisational:** Programme	Safety, Economical transport, staff shortage, mitigate climate change	advanced 0-5, 5-10, 10+	Synchro-modality, CIS, Smart Shipping
smart infrastructure	**M77** Develop IWT Site architecture for Smart Infrastructure (Smart Hectometre Stone, Smart Bridge)	It supports at least the following use cases: - Co-operative position determination of the vessel passing by the IWT infrastructure site - Upload of data relevant for navigation from IWT infrastructure to vessel - Download of vessel data to IWT infrastructure - may be used as an alternative for internet connectivity	FA, SWS, ES,	M	**Technical:** Requires deployment of additional hard- and software to investigate, test and verify ship-shore data exchange on board and on shore **Operational:** Make experts available to develop concepts and plans. **Financial:** €-€€ | **Organisational:** Ac-Project	Safety, Economical transport	interim 5-10	CIS, Smart Shipping
standardisation	**M78** Promote test standards	to ensure the unambiguous interpretation of the required functions and their correct implementation. It ensures a common understanding of the requirements and the intended characteristics of the product by developers, manufacturers, test houses and users	FA, SWS, ES,	S	**Technical:** create test standards and provide them to suppliers **Operational:** every country or supplier implements new standards in the same way **Financial:** € | **Organisational:** SuAc	Economical transport	basic 0-5	CIS, Smart Shipping

6.6.3 Recommended measures in the thematic area of Process & Organisation

6.6.3 Recommended measures in the thematic area of Process & Organisation (1/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
cybersecurity	**M24** Create awareness regarding cyber security (material & training)	New Technologies, IoT networks and Smart sensor systems/networks need cybersecurity measures to mitigate new risks. Applications connected to the Smart Sensors or applications using the data of these sensors must also comply with appropriate cybersecurity measures	FA, SWS, ES, LSP, Ports, VTM	S-M	**Technical:** **Operational:** employees work with awareness of possible cyberattacks, provide general information about cyber risks in IWT, provide possible measures against cyber attacks, offer training for users and employees, implement process which keeps awareness up to date (recurring awareness activities) **Financial:** €-€€ | **Organisational:** Project-Programme	Safety, Reliability of supply	basic 0-5	Synchro-modality, CIS, Smart Shipping
cybersecurity	**M42** Certify automated/ remotely operated vessel IT and centres (cybersecure)	A cybersecurity certification for vessels and remote-control centres should be performed, before they are allowed to operate on European waterways	FA, oA, SWS, ES, VOp	L-XL	**Technical:** the systems of each automated vessel has to be checked regarding cybersecurity before certified/authorised for operation on the waterway **Operational:** benefit: in the future, every Smart Vessel on the waterway can be assumed as highly (but not completely) cybersecure **consequence:** Make experts available to set up certification process and requirements, building compliance checking capabilities and positioning compliance checking with inspection authorities. **Financial:** €€-€€€ | **Organisational:** Programme	Safety, staff shortage	interim-advanced 0-5, 5-10, 10+	Smart Shipping
cybersecurity	**M43** Perform cyber risk assessment	monitor the trade-off between increased functionality and increased risk, perform a risk assessment for each new development and define and implement mitigating actions. The risk assessment should also have a focus on the privacy aspect.	FA, SWS, ES, VOp	M	**Technical:** any new development to be implemented, requires an assessment in terms of cybersecurity and privacy **Operational:** benefit: in the future, every implemented new development can be assumed as highly (but not completely) cybersecure. This also means that the level of cyber security of the entire system remains (almost) the same. **consequence:** Make cybersecurity resources available. Include cyber risk assessment as a standard step in the development process **Financial:** € | **Organisational:** Ac	Safety	basic 0-5	Synchro-modality, CIS, Smart Shipping
cybersecurity	**M44** Implement ISMS	The Information Security Management System is not only highly recommended, it should be a necessity to be able to follow-up on the implementation of an organisation's security controls. It provides a structured way to keep track of the overall state of an organisation's state of security.	FA, SWS, VTM, Ports, Vop, LSP	L-XL	**Technical:** implementation of an ISMS for the digital infrastructure of an organisation **Operational:** benefit: The organisation is (to a great extent) able to detect cyber attacks and is prepared in case of incidents **consequence:** make cybersecurity resources available **Financial:** €€ | **Organisational:** Project	Safety, Reliability of supply, staff shortage	basic 0-5	Synchro-modality, CIS, Smart Shipping
cybersecurity	**M45** Install a dedicated cyber security team	The main responsibility of that team is to monitor the continuously evolving cyber threats. Based on their expertise the team will be able to formulate practical implementations of controls. Furthermore, a strategic, tactical or operational plan will need input from this team as things evolve.	FA, (Ports), SWS, ES	M	**Technical:** Employ a cyber security team that specifically takes care of the security of the systems/networks through implementation of sufficient controls. They are also responsible for a proper backup for the restart of the systems after a major cyber attack **Operational:** benefit: Increased cybersecurity of the systems of an organisation **consequence:** Make cybersecurity resources permanently available. Include cyber security activities as a standard step in the processes **Financial:** €-€€ | **Organisational:** Project	Safety, Economical transport, Reliability of supply	basic-interim 0-5, 5-10	Synchro-modality, CIS, Smart Shipping

6.6.3 Recommended measures in the thematic area of Process & Organisation (2/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
EU competent body	**M29** Establish an overarching body dealing with digitalisation & harmonisation	To ensure a harmonised development (in Europe) of the migration path, it is required to have one coordinating competent body. At the same time, the body should improve cooperation with other modes of transport. make sure that all privacy aspects taken care of.	FA, Ports	M-XL	**Technical:** an overarching body guides the technical developments, New authority responsible for privacy issues and secure communications **Operational:** requires diplomats, experts and intermediaries to actively engage national and EU policy makers, privacy is ensured to a higher degree, secure communication channels are provided **Financial:** €-€€ | **Organisational:** Project-Programme	Economical transport, Safety, mitigate climate change, Reliability of supply	advanced 0-5, 5-10, 10+	Synchro-modality, CIS, Smart Shipping
EU competent body	**M38** Harmonise the vision on Smart Shipping	There does not seem to be an overarching vision among the European fairway authorities regarding (support actions for) Smart Shipping. Uncertainty is likely to lead to postponement of investments by commercial operators except for a few early adopters. Examples are clear and harmonized minimum crew requirements for testbeds.	FA, LSP, VOp, Sk, VOw	L-XL	**Technical:** **Operational:** Coordinate and harmonise the future developments regarding Smart Shipping. Make legal and subject matter resources available to draft vision and obtain support from stakeholders **Financial:** € | **Organisational:** SuAc	Economical transport, Safety, mitigate climate change, reliability of supply, staff shortage	basic 0-5	Smart Shipping
fail-safe scenarios	**M49** Design graceful degradation and fall-back arrangements	The advance of digitalisation includes an increasing reliance on technology for safety and business continuity. To mitigate vulnerability, fall back should be designed in advance	FA, SWS, ES	M-L	**Technical:** Plan for the phasing out of legacy technologies. Falling back on legacy technology should be still possible for a certain period of time **Operational:** benefit: No major downtimes in the event of technical incidents of new implemented technologies **consequence:** Integrate fall back procedures into the mode of operation and conduct regular exercises to test and train them **Financial:** €€-€€€ | **Organisational:** Project-Programme	Safety, Economical transport, staff shortage	basic-interim-advanced 0-5, 5-10, 10+	CIS, Smart Shipping
harmonised APIs	**M33** Harmonise information services	Harmonised information services on international level need to be provided in order to achieve the potential benefits of RIS. Agree on an official, short and realistic time frame for the update cycle of data. Special focus is put on harmonised data provision for smart shipping.	FA	XL	**Technical:** Harmonise all information services, reporting services, value-added services, etc. along a corridor or on the Eu. Fairway network. **Operational:** benefit: harmonised services using standardised data **consequence:** Make data entry resources on a national and international level available to close data and service provision gaps. **Financial:** €€€ | **Organisational:** Project-Programme	Economical transport, Reliability of supply	basic-interim-advanced 0-5, 5-10, 10+	Synchro-modality, CIS, Smart Shipping
improve cooperation	**M25** Cooperation with PPP & private initiatives on new technologies, data sharing, governance	FA should consider to cooperate with private and PPP initiatives, because private digital initiatives are driven by user and market demands and are often able to develop digital solutions in a quick and agile way	FA	L	**Technical:** Cooperation with private companies in the development of new systems/concepts **Operational:** Resources must be made available; Processes allowing cooperation under mutually beneficial terms are required **Financial:** €€-€€€ | **Organisational:** Project-Programme	Economical transport	basic-interim 0-5, 5-10	Synchro-modality
improve cooperation	**M27** Maintain coordination on policy level to ensure financial support	Maintain coordination on policy level for the further harmonised development and operation of River Information Services in Europe	FA	M	**Technical:** - **Operational:** requires experts and intermediaries to actively engage national and EU policy makers and issuers of funds **Financial:** €-€€ | **Organisational:** Ac	Economical transport, Safety, mitigate climate change, reliability of supply, staff shortage	basic 0-5	CIS

6.6.3 Recommended measures in the thematic area of Process & Organisation (3/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
improve cooperation	**M28** Increase & sustain cooperation (project) between IWT parties	Utilise synergies in the further development of RIS Corridor Management and to maximise the benefits for the stakeholders. Continue international harmonised cooperation, ideally in common projects	FA, VTM, LSP, VOp, VOw, Sk	M	**Technical:** - **Operational:** benefit: more efficient development activities **consequence:** Make sufficiently mandated experts available **Financial:** €-€€€ | **Organisational:** Project-Programme	Economical transport, Safety, mitigate climate change, reliability of supply, staff shortage	basic 0-5	Synchro-modality, CIS
improve cooperation	**M35** Establish a close cooperation between RIS authorities, EU commission and CESNI/TI when upgrading, replacing, designing, operating, maintaining, …. registries for IWT	This is expected to increase the overall efficiency, level of adoption and general level of satisfaction related of the Data Registries and create a multi-level benefit for the IWT community at large. Another suggestion would be to consider using EuRIS as a gateway between the RIS Authorities and the ERDMS, and possibly allow EuRIS, in its role as a single-stop-shop for a wide range of IWT information, to act as a cache of the ERDMS data. Furthermore, there should be more cooperation between standardisation bodies and logistics to avoid individual reference codes. It is recommended to start in CESNI/TI with the task TI-21 to clarify from an organisational point of view where location codes are maintained and by whom. Cooperation with CESNI & Member States should be strengthened to enable active participation in the design and development of the CESNI/TI Work Programme. Increase cooperation with departments that build and maintain the infrastructure, and the departments that digitise it (GIS data)	FA, oA	L	**Technical:** requires technical changes to EuRIS and potentially ERDMS **Operational:** benefit: standard data registries will be available for IWT **consequence:** make sufficiently mandated experts available **Financial:** € | **Organisational:** Ac	Economical transport, paperless transport	basic 0-5	CIS
improve cooperation	**M47** Facilitate innovation	Facilitate developments from innovative companies (with a level playing field) which create value for IWT. Establish permanent digital innovation teams to foster the continuous development of new applications with a focus on advanced technologies. Utilise existing projects or use cases involving New Technologies by identifying them (see recommendation about knowledge management platform) and assessing their level of maturity. The Authorities should make use of these experiences and align the various activities.	FA, SWS, ES, VTM	S-M-L	**Technical:** Information and communication technologies are continuously evolving defining the technical consequences. Size and budget of permanent digital innovation teams determine effort. Common understanding of how 'New Technologies' can be and should be integrated in IWT **Technical** standard for implementation **Operational:** Special teams for the development and integration of new technologies/innovations, harmonised approach of implementation of 'New technologies' **Financial:** €€ | **Organisational:** Programme	Safety, Economical transport, staff shortage, mitigate climate change	basic-interim 0-5, 5-10	Synchro-modality, CIS, Smart Shipping
improve cooperation	**M93** Compliance by the member states to standards	Verification and enforcement of compliance by the Member States with European regulations and (data quality) standards by the European Commission. This can be supported via EuRIS (e.g., verification of compliance when service is present and active in EuRIS). A European Control Body could be tasked to monitor data quality and compliance with the standards.	FA, oA	S	**Technical:** EuRIS could be the means to evaluate compliance **Operational:** Adapt internal processes currently obstructing compliance **Financial:** €-€€ | **Organisational:** Ac-Project	Economical transport, Reliability of supply, paperless transport	basic 0-5	CIS, Smart Shipping

6.6.3 Recommended measures in the thematic area of Process & Organisation (4/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
Information hub EuRIS	**M26** EuRIS sustainment actions	Ensure continued operation of EuRIS including maintenance & hosting and the partnership Ensure the sustainable operation of services and applications developed in (European) projects after the end of the project. This includes organisational, legal and financial aspects.	FA	M	**Technical:** ensure continuous operation, maintenance and hosting, evolution (new features/services) **Operational:** benefit: one central access point for relevant fairway information, **consequence:** sustainment of national data provision processes **Financial:** €€€ | **Organisational:** Programme	Safety, Economical transport	basic 0-5, 5-10, 10+	CIS
Information hub EuRIS	**M34** Include commercial services	The FA platforms could be extended with a separate hub area for commercial data exchange; considering blockchain technology as a mechanism for document security, reliable user administration, and data security. This system area may also be operated by a neutral user group entity including stakeholders and their associations. Alternatively, EuRIS could provide access points for commercial enterprises to make their services known and integrate them with EuRIS.	FA, oA, Ports, LSP, VOp, SWS, ES	L	**Technical:** include additional data hub areas on the information platforms for data of commercial parties. system area potentially operated by a neutral user group **Operational:** benefit: commercial data on EuRIS available **consequence:** requires agreements regarding use of EuRIS for commercial services and organisational body to manage this. **Financial:** €-€€ | **Organisational:** Ac-Project	Economical transport, Reliability of supply	basic-interim 0-5, 5-10	CIS
Legal regulations	**M36** Establish EU-wide harmonised regulations for Smart Shipping	To enable the new developments and technologies, existing rules have to be partially or stepwise adapted and new rules have to be created. As a consequence of an existing EU rule, a special authorisation for remote operation is required. It is open whether this should be effective in general or only for a specific vessel-control station combination. Nautical traffic experts should consider to what extent new traffic regulations are needed for platooning units. Furthermore, it needs to be considered whether platooning can also be operated within the EU or from abroad. It is also required to have a uniform regulation for keeping the logbook in order to document the time a vessel belonged to a platoon.	FA, oA	XL	**Technical:** Regulations will likely require and result in technical prerequisites for safe operation. The data of remote operation (skipper, steering position, etc.) must be fully documented and available to the authorities. **Operational:** Make legal and subject matter resources available to draft regulations and conditions. Make resources available to gather support for and guide proposals towards EU/CCNR backed regulations. During remote operation, it has to be ensured that a skipper is assigned to the vessel and that a steering position is assigned to the skipper. Cooperation between the national authorities has to be intensified. Otherwise, it would be almost impossible to monitor shipmasters in remote operation. A contact person must be available to perform checks or address police actions. The enforcement of police measures must be ensured in favour of safety. A logbook has to provide the information when a vessel belonged to a platooning convoy. **Financial:** €-€€€ | **Organisational:** Programme	Economical transport, staff shortage	interim-advanced 5-10, 10+	Smart Shipping
Legal regulations	**M37** Adapt regulations to facilitate automated vessels	To enable the new developments and technologies, existing rules have to be partially adapted and new rules have to be created focusing on national/regional test/pilot areas as described in the 4.2 report	FA, oA	M-L	**Technical:** Regulations will likely require and result in technical prerequisites for safe operation **Operational:** adapted regulations or exemptions for test/pilot areas. Make legal and subject matter resources available to draft regulations and conditions **Financial:** € | **Organisational:** Project	Economical transport, staff shortage	basic 0-5	Smart Shipping
Legal regulations	**M40** Uniform crew requirements and qualifications for automated vessels	The advancement of smart shipping requires uniform crew requirements and crew qualifications to create rules and regulations. Developments in maritime (MASS) should be closely followed.	FA, oA, ES	M-L	**Technical:** technical consequences for automated vessels depend on the outcome of the requirements **Operational:** Make legal and subject matter resources available to draft requirements and obtain support from stakeholders. **Financial:** € | **Organisational:** SuAc	Safety, Economical transport, staff shortage	basic-interim 0-5, 5-10	Smart Shipping

6.6.3 Recommended measures in the thematic area of Process & Organisation (5/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
Legal regulations	**M41** Resolve liability issues for automated vessels / introduce strict liability	In the event of an accident, the liability of the parties involved is primarily governed by the national law of the member states of EU. In the absence of harmonization, national laws on liability can vary widely in structure and content. Providing clarity on liability regarding automated or remotely operated vessels will stimulate smart shipping. Strict liability for the vessel owner should be considered, as well as a compulsory liability insurance.	FA, oA, ES, VOw	L	**Technical:** - **Operational:** Resolved liability issue for automated vessels is important in case of accidents, Make legal and subject matter resources available to draft requirements and obtain support from stakeholders. The location of the skipper must be identifiable and localisable. **Financial:** €-€€ | **Organisational:** SuAc-Ac	Safety, staff shortage	basic-interim 0-5, 5-10	Smart Shipping
Legal regulations	**M94** Regulating administrative assistance for remote operation of non-EU countries	In case, remote operation of vessels shall be possible from other EU countries, a regulation is needed to allow administrative assistance of the water police. In case, remote control is permitted from third countries (non-EU country), a regulation is needed to ensure administrative assistance and right to inspect files.	FA, oA	L	**Technical:** Is likely to require technical means to acquire remote access by police to remote operation centre logs and other data. **Operational:** Make legal and technical experts available to draft regulation and law enforcement resources to test operation **Financial:** €€-€€€ | **Organisational:** Project	Economical transport, Reliability of supply, paperless transport	advanced 10+	Smart Shipping
relevance of all users	**M30** Take non-professional fairway user into account	Consider all fairway users for a smooth and safe traffic management. Also, to stimulate commercial use and increase the attractiveness of EuRIS.	FA, VTM, SK	S	**Technical:** solutions for reliable tracking of small boats and other fairway user are needed, display their position on the charts of the information portals, add features in EuRIS specifically for recreational fairway users **Operational:** establish data provision or sharing with organisations responsible for data which is of interest for recreational fairway users **Financial:** €-€€ | **Organisational:** Project	Safety, Economical transport	basic 0-5	CIS
reliable communication	**M39** Coordinate Smart Shipping ship-shore & ship-ship interaction	Communication from, to and between smart vessels requires standardisation on several levels in order to be able to be clearly received and understood by the intended recipient and thus not threaten safety or hamper development of solutions	FA, SWS, VOw, ES	M-L	**Technical:** Define communication technologies/profiles for Smart vessels, draft technical requirements for safe and standardised information exchange **Operational:** Make sufficiently mandated experts available. **Financial:** € | **Organisational:** SuAc	Safety, Economical transport, staff shortage	basic-interim 0-5, 5-10	Smart Shipping
service catalogue	**M32** Define a digital service catalogue	Take the operational services in PIANC extended with the services of RIS COMEX as the baseline. Provide information on which service is available on which (part of) the fairways	FA	S	**Technical:** Create a complete catalogue of all digital services available (or upcoming) in IWT. Provide such information via EuRIS **Operational:** benefit: Overview of services or available data/ information **consequence:** implement national processes to keep the service catalogue up to date **Financial:** € | **Organisational:** SuAc	Economical transport, Reliability of supply, staff shortage	basic 0-5	CIS, Smart Shipping

6.6.3 Recommended measures in the thematic area of Process & Organisation (6/6)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
training/education	**M48** Training and education of users working with specific technologies	Users need to know the intended purpose, the expected results/output and certainly the vulnerabilities of the sensors or systems. The result of the training should be awareness. Research is needed to find out how to increase the awareness of users and providers of data regarding quality. Need of closer cooperation with departments that are building and maintaining the infrastructure (asset management data).	FA, Ports, VTM, VOw, VOp, Sk	S	**Technical:** no training in itself has no significant technological impact **Operational:** benefit: Employees learn how to use the (new) technologies, Employees develop awareness of risks and usefulness **consequence:** make educational resources available **Financial:** € | **Organisational:** Ac	Safety, staff shortage	basic-interim-advanced 0-5, 5-10, 10+	CIS, Smart Shipping

6.6.4 Recommended measures in the thematic area of Data Sharing

6.6.4 Recommended measures in the thematic area of Data Sharing (1/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
align with maritime	**M15** Align with maritime	Develop a vision for future integration of fairway/port/PCS platforms with complete coverage of a corridor including connecting to the 'Maritime Connective platform'. Furthermore, adoption of technologies, standards and legal framework shall be in focus. This includes investigation of interesting aspects of S-421 in light of intention sharing. The developments under the umbrella of Maritime Autonomous Surface Ships (MASS) shall be considered in IWT with specific relevance for mixed traffic areas.	FA	M	**Technical:** Coordinate a common/shared vision with maritime in areas where it is necessary and put focus on technologies, standards and legal framework **Operational:** available experts to bridge the standardisation bodies in maritime and IWT ideally including Customs, Rail, Road **Financial:** €€ | **Organisational:** Project	Economical transport, Reliability of supply, staff shortage	interim 5-10	Synchro-modality, CIS, Smart Shipping
harmonised APIs	**M5** Use existing / create new standards/API for harmonised data exchange	APIs allow stakeholders to easily extract data, enabling their own planning systems to be more useful. Data exchange via APIs will be crucial which also requires agreed semantics, harmonised interfaces and language.	FA, SWS, VOp, Ports, VTM	M	**Technical:** Create a standardised data set for data exchange, develop APIs and a common understanding of the information, provide easy (technical) access for the user **Operational:** Extra effort for stakeholders to make experts available to do the work **Financial:** € | **Organisational:** Ac-Project	Economical transport, Reliability of supply	interim 5-10	CIS, Smart Shipping
harmonised APIs	**M13** Fix missing links to other transport modes	Assess what is missing and implement connections. Very relevant links to other transport modes can be transhipment locations. Investigate missing services and data according to business requirements and aligned definitions. Implement missing services, close data gaps. Develop required APIs.	FA, Ports, LSP, SWS	L	**Technical:** implement APIs after identifying needs in a stepwise approach **Operational:** benefit: better decision making, transport planning along supply chain **consequence:** make experts available to engage with stakeholders **Financial:** €-€€€ | **Organisational:** Project-Programme	Economical transport, Reliability of supply, mitigate climate change, paperless transport	basic-interim 0-5, 5-10	Synchro-modality
Information hub EuRIS	**M6** EuRIS as data registry / ERDMS gateway	EuRIS can be used for reference data management between RIS authorities and ERDMS. EuRIS may also be able to support up-to-dateness of EHDB and ECDB information. DG Move could foster these changes (provide financial and other incentives)	FA, SWS	M	**Technical:** Agree on EuRIS as the harmonised data source, Requires technical changes to ERDMS **Operational:** easy availability of harmonised and up-to-date data at one platform. Data maintenance process changes for RIS index data. Shifts towards EuRIS **Financial:** €-€€ | **Organisational:** Ac-Project	Economical transport, Reliability of supply, paperless transport	basic 0-5	CIS
Information hub EuRIS	**M10** Closely follow & investigate Federated data sharing developments	Closely follow the federative developments under DTLF (e.g. projects FeDERATED, FENIX) and the impact on our fairway information services (EuRIS). There is a great potential that the future international information system is federated as it seems unrealistic that there will be a central one-stop-shop for everything also due to the grown nature. Follow and contribute to DTLF/eFTI initiative (potentially the framework for harmonised transport documents for ERI)	FA, oA	S	**Technical:** (re-)assess the technical feasibility and usefulness of the current state of the federative developments for the systems in IWT. Ensure interoperability between standards **Operational:** new possibility for data sharing. Make experts available to follow developments **Financial:** € | **Organisational:** SuAc	Economical transport, Reliability of supply, paperless transport	basic 0-5	CIS
Information hub EuRIS	**M11** EuRIS as connectivity platform / EU dataspace	The potential of EuRIS as a connectivity platform in IWT needs to be investigated. Validate the conformance of EuRIS with the European Data Spaces requirements and to promote the role of EuRIS as an inland waterway transport Data Space.	FA, oA	M	**Technical:** investigate the technical potential of EuRIS as a Connectivity platform **Operational:** new possibility for data sharing. Make experts available to engage with EU stakeholders **Financial:** € | **Organisational:** SuAc	Economical transport, Reliability of supply	interim 5-10	Synchro-modality, CIS

6.6.4 Recommended measures in the thematic area of Data Sharing (2/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
Information hub EuRIS	**M12** Secure Cloud providers	Choose a provider/data centre which hosts the data that protects the data confirming the European privacy laws (GDPR), and the planned EU Cloud Rulebook. Also check if the provider has information security related certifications such as ISO 27001, ….	FA, SWS	M	**Technical:** assess the cyber risks of a potential Cloud providers / Hosting providers **Operational:** secured systems against cyber attacks, safeguard against failures. Make cybersecurity experts available for assessment **Financial:** € | **Organisational:** SuAc	Safety, Economical transport	basic 0-5	CIS
Interconnect ports	**M7** Interconnect EuRIS with Port Community Systems	Optimise and digitalise processes along the waterway by improving data exchange. Investigate the need of Single-sign-on using multiple systems	FA, Ports, SWS	M	**Technical:** Requirements analysis of port data needs vs FA data provision, develop/change APIs, harmonise data, connect the systems **Operational:** Introduce EuRIS at all inland/seaports (roadshow) and investigate (data) cooperation, data sharing between EuRIS and PCS, define new processes and workflows. Possible legal agreements required between port and FA, make experts available to engage with stakeholders, **Financial:** €-€€ | **Organisational:** Ac-Project	Economical transport, Reliability of supply	basic 0-5	Synchro-modality
Interconnect ports	**M16** Connect fairway-port-maritime	Ports will be the digital connection nodes between modalities	FA, Ports, LSP	XL	**Technical:** identify the need of APIs, implement APIs, Investigate on a translation service to support automated exchange of ETA/RTA information between maritime and inland domain (to support efficient transhipment at terminals) **Operational:** benefit: data exchange with ports and maritime; better decision making **consequence:** make experts available to engage with stakeholders from maritime & ports ideally including Customs, Rail, Road **Financial:** €€ | **Organisational:** Project	Economical transport, Reliability of supply	interim 5-10	Synchro-modality
Interconnect ports/terminals	**M8** Expand data exchange with ports	Develop API/interface standards to facilitate data exchange with local port authority systems/PCS platforms, forwarding barge voyage information	FA, Ports, SWS	M	**Technical:** Requirements analysis of port data needs vs FA data provision and vv., connect the systems, harmonise data **Operational:** data exchange with ports, define new processes and workflows. Possible legal agreements required between port and FA **Financial:** €-€€ | **Organisational:** SuAc	Economical transport, Reliability of supply	basic 0-5	Synchro-modality
paperless transport	**M1** Ensure harmonised eFTI<->ERI alignment	ensure and enable data exchange between eFTI<->ERI	FA, VOp, SWS	M	**Technical:** mapping data elements, investigate ERI/eFTI mapping, ensure that eFTI is considered upon revision of the RIS Directive (-> DG Move) **Operational:** less paper work for ECOP **Financial:** €€ | **Organisational:** Ac-Project	Economical transport, paperless transport	basic 0-5	CIS

6.6.4 Recommended measures in the thematic area of Data Sharing (3/3)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
paperless transport	**M2** Enhance ERI	Harmonise Reporting services in Europe in order to establish a Reporting only once with single entering of data to fulfil all reporting requirements for any transport along the European inland waterway network based on full cross-border exchange between systems / authorities. With regard to synchromodal transport and new requirements some information as included in the HERmes message should also be considered in the next revision process of the ERI messages.	FA, VOp, Sk, SWS, Ports	L	**Technical:** collect all European reporting requirements, harmonise data sets, implement all ERI messages, develop (or improve) the Reporting service, Standardise not yet standardised ERI Messages, if required (e.g. WASDIS, CUSCAR/ERIMAN, INVRPT, ERIINFO, BERMAN) **Operational:** skippers or vessel operators only need to report one time for whole voyage **Financial:** €€-€€€ | **Organisational:** Project	Economical transport, Reliability of supply, paperless transport	basic-interim 0-5, 5-10	CIS
paperless transport	**M3** Stay involved in eFTI developments	The eFTI regulation shall be implemented in 2025. The impact of improving existing reporting applications to certified eFTI Service Providers shall be evaluated. Stay closely involved in the elaboration and finalisation of the eFTI architecture and certification process. Consider transforming existing ERI-systems into eFTI compliant service providers	FA, Ports, VOp, SWS	M	**Technical:** participate in the meetings (in the upcoming years), provide input, make sure responsible national experts attend the review and implementation process **Operational:** - **Financial:** € | **Organisational:** SuAc	Reliability of supply, paperless transport	basic 0-5	CIS
paperless transport	**M4** Elaborate legal basis for paperless transport	As a precondition for synchromodality, paperless processes have to be supported by legislation, under the scope of eFTI phase 2: after revision 2029: inclusion of other documents than cargo related only (certificates of competence, ea)	FA, oA, Ports, VOp	L	**Technical:** **Operational:** less paper work for ECOP, lower administrative burdens and costs for logistic operators. Extra effort for fairway authorities, customs, law enforcement to make experts available to do the work. **Financial:** €€ | **Organisational:** SuAc	Reliability of supply, paperless transport, staff shortage	basic 0-5, 5-10	Synchro-modality, Smart Shipping
paperless transport	**M9** Support digital freight docs	Support initiatives to establish digital cargo/freight documentation in IWT (e.g. eFTI, e-CMR), which could be enabled by platforms functioning as a standard communication channel for cargo documentation.	FA, Ports, VOp, Sk, SWS	M	**Technical:** Collaborate with initiatives to define a common digital freight documentation (e.g. eFTI, e-CMR), collaborate with competent authorities. Develop digitised procedures for digitally available information for routines required by authorities (e.g. inspections) **Operational:** establish new workflows. Extra effort for stakeholders to make experts available to do the work **Financial:** € | **Organisational:** SuAc	Economical transport, Reliability of supply, paperless transport	interim 5-10	Synchro-modality, Smart Shipping
performance standards	**M18** Standards for suppliers	There is a lack of performance standards (e.g. equipment such as sensors and PNT). The components present are often not intended to function in an integrated system with components from other suppliers	FA, ES, SWS	L	**Technical:** Apply existing standards or create new standards for technical and functional requirements of sensors/ devices/other components **Operational:** benefit: harmonised standards for suppliers of software and equipment **consequence:** make experts available to draw up standards **Financial:** € | **Organisational:** SuAc	Safety, Economical transport, Reliability of supply	basic 0-5	CIS
privacy	**M17** Privacy assessment for new developments	Before applying new developments, possible conflicting interests in collecting personal information (e.g. through video surveillance) have to be evaluated. Alignment with NIS-2 regulation is envisioned.	FA	S	**Technical:** investigate the technical developments for possible violation of privacy **Operational:** benefit: Implemented new developments avoid privacy issues **consequence:** Requires resources to handle privacy impact assessments and other GDPR issues **Financial:** € | **Organisational:** SuAc	Safety	basic 0-5	CIS, Smart Shipping

6.6.5 Recommended measures in the thematic area of Harmonisation of modalities

6.6.5 Recommended measures in the thematic area of Harmonisation of modalities (1/1)

	Measure	Description	Stake-holders	Effort	Consequences	Contribution to	Ambition/ Time (years)	Pillar
harmonised APIs	**M20** Identify standards & interactions with other modalities & logistics	independent terminals are interested in closing the standardisation gap between different types of modalities. Common standards for data exchange are needed. EU favours open data exchange. The European rail sector is going to develop a new single platform named 'DP-Rail' for (standardised) data exchange between all involved parties in a rail transport. Some services will be valuable for multimodal transport.	FA, LSP	M	**Technical:** identify similarities and differences in data / data structure, services and future needs. harmonise data models behind the forms and certificates. investigate the possibilities for data exchange with the future data hub of the rail sector **Operational:** benefits: multimodal standards; simpler multimodal data exchange **consequence:** make expert available to analyse interactions **Financial:** €-€€ | **Organisational:** Project	Economical transport, Reliability of supply, paperless transport	basic 0-5	Synchro-modality, CIS
harmonised APIs	**M22** Proper specification of interfaces	A standard for interfaces / communication protocols could provide the framework for harmonised transport documents (see DTLF/eFTI)	FA, SWS	L	**Technical:** create specifications of the interfaces and communication protocols to other transport modes or ports **Operational:** benefit: prerequisites are defined for the development of interfaces **consequence:** stakeholders make experts available **Financial:** €€ | **Organisational:** Ac-Project	Economical transport, Reliability of supply	basic-interim 0-5, 5-10	Synchro-modality, CIS
improve cooperation	**M19** Strengthen multimodal collaboration	Strengthen multimodal collaboration to benefit from the interdependencies between different stakeholders and modalities. A competent and sufficiently mandated coordinating body on EU level is needed	FA, Ports, LSP, VTM	XL	**Technical:** identify similarities and differences in data / data structure, services and future needs. **Operational:** benefit: multimodal coordinated processes **consequence:** Implementation of a (multimodal) coordinating body; requires resources **Financial:** €€-€€€ | **Organisational:** Project-Programme	Economical transport, Reliability of supply	interim-advanced 5-10	Synchro-modality
improve cooperation	**M21** Improve cooperation with ports & fairway authorities	Improve cooperation with ports & fairway authorities to optimise and digitalise processes	FA, Ports	M	**Technical:** adaptation needs on both sides **Operational:** benefit: coordinated future developments with ports; compatible systems **consequence:** requires resources (intermediaries) to be made available **Financial:** € | **Organisational:** Ac	Economical transport, Reliability of supply	basic 0-5	Synchro-modality, Smart Shipping
multimodal services	**M14** Harmonised multimodal corridor management services	Identify open issues, actions, potential developments, etc. which would have to be realised by fairway authorities and other organisations or initiatives and to share the findings with responsible parties and initiate the necessary actions	FA, Ports, LSP, SWS	XL	**Technical:** identify similarities and differences in data / data structure, services and future needs, align data definitions **Operational:** multimodal data sharing, better decision making, Synchromodality is possible **Financial:** €€-€€€ | **Organisational:** Project-Programme	Economical transport, Reliability of supply, mitigate climate change	interim-advanced 5-10, 10+	Synchro-modality, CIS
promote services	**M23** Promote & incentivise data service use	The use of synchromodal transport planning and operations by logistics services providers in Europe can be facilitated through a more intensive use of inland waterway data. With the deployment of EuRIS and expansion of the data services most of the needed data services to facilitate this will be in place. Effort is foreseen helping logistics service providers to recognize and use specific data services.	FA, LSP, Ports, SWS	M	**Technical:** provide information and data available on the EuRIS portal to multimodal/synchromodal transport planning tools (Optimise & tailor API to stakeholder usage whilst limiting variants) **Operational:** benefit: IWT data is used for other services **consequence:** Make experts available to promote API use and assist usage (helpdesk). Measure use and success of promotion/incentives via questionnaires and other means. **Financial:** €-€€ | **Organisational:** SuAc	Economical transport, Reliability of supply	basic 0-5	CIS

DIWA Masterplan

07 Outlook & next steps

In this chapter, possible ambition levels concerning measure implementation are outlined together with a reflection of already planned follow-up activities both on an international and national level.

The Masterplan DIWA contains numerous recommendations, spanning several thematic areas. All recommendations are envisioned to contribute to the overarching IWT policy goals:

- → Safety of people/IWT
- → Economical transport/navigation
- → Mitigate and adapt to climate change
- → Reliability of supply/resilient supply chains,
- → Adapt to staff shortage/human resource challenges

Reaching a higher digitalisation maturity level through actual implementation of the recommendations does however depend on the level of ambition of fairway authorities and other stakeholders. This also applies to the role of the fairway authorities. Apart from the current and traditional (limited) role of the fairway authorities, measures and activities belonging to areas beyond the current role were explored within the Masterplan DIWA project. These are to be considered as options for fairway authorities that strive for a higher ambition level.

Basic			Intermediate			Advanced		
Smart shipping	Connected Information Services	Synchro modality	Smart shipping	Connected Information Services	Synchro modality	Smart shipping	Connected Information Services	Synchro modality
Invest in connectivity			Invest in alternative connectivity & fallback			Implement alternative connectivity & fallback		
Invest in cyber security						Certify vessels & remote operation		
Sustain & expand standardisation & data quality efforts								
Share data						Establish EU-wide regulations	Harmonise information services	
Expand & enhance EuRIS								
Elaborate a joint legal framework	Elaborate a joint legal framework (paperless)		Invest in smart infrastructure			Implement smart infrastructure & new technologies		
			Develop & implement (ship-ship, ship-shore) standards			Overarching IWT Europe digitalisation body		
Elaborate require-ments						Holistic digital twin		
			Invest in Predictive modeling & traffic predicttions					
Investigate & monitor new tech and developments (eFTI)			Switch to digital by default					

Figure 15: Overview of the main measures plotted over the thematic areas and ambition level

In order to aid decision making, each recommendation was linked to one of three ambition levels *:

→ **Basic**: contains measures required to at least keep up with digitalisation developments in IWT;
→ **Intermediate**: additional measures to become part of the frontrunners in IWT digitalisation.
→ **Advanced**: contains activities added on top of the intermediate package in order to take the lead in IWT digitalisation.

The separately provided master recommendations table (of which extracts are presented in chapter 6) allows filtering and grouping of the recommendations on each of the ambition levels. Measures were linked to an ambition level depending on the estimated effort and time box of the respective measure. The three scenarios are summarised in Figure 15, where the prominent labels used in the master table are plotted on ambition levels. Items that stretch across multiple ambition levels in the figure contain measures of increasing impact and ambition (e.g. EuRIS can be expanded with basic, intermediate or very advanced features). In addition, a high-level picture is provided in Appendix 1: Overview of measures in the "road to the sun" approach compiling the complete set of measures.

7.1 Next Steps

In order to ensure that the digital transition of IWT evolves along the recommended maturity path, it is required to carefully monitor the implementation of proposed measures on a regular basis. This is of crucial importance especially for the detailed recommendations elaborated by the individual sub-activities. Due to rapidly evolving technological developments, it is highly recommended to consider revising the DIWA roadmap and action plan, if necessary, in the upcoming years.

Anchoring points are given with the following envisioned projects and ongoing initiatives:

→ The multi beneficiary CEF2 project COMEX 2 as successor of RIS COMEX 1 shall play a major role in following and executing a majority of the proposed measures in the DIWA masterplan in the upcoming years (project still to be approved for funding). With a total project budget of up to 40M€ the focus lies on:

    ↳ Assessment of EuRIS and Electronic reporting related requirements as well of European initiatives like the DIWA or eFTI results to come up with a concept for implementation
    ↳ Evolution of EuRIS as European information hub in the context of technical, functional, geographical, organisational. contractual and legal aspects. Data quality and completeness will enable data sharing with all relevant stakeholders.
    ↳ Enable and implement the "reporting only once" principle in Europe to diminish administrative burden considering the eFTI and federated developments
    ↳ Harmonise and standardise the reference data basis and its usage for common systems. Renewal or upgrade of national systems and interfaces to serve as data basis for common systems as well as active contribution to the evolution of RIS technical services.

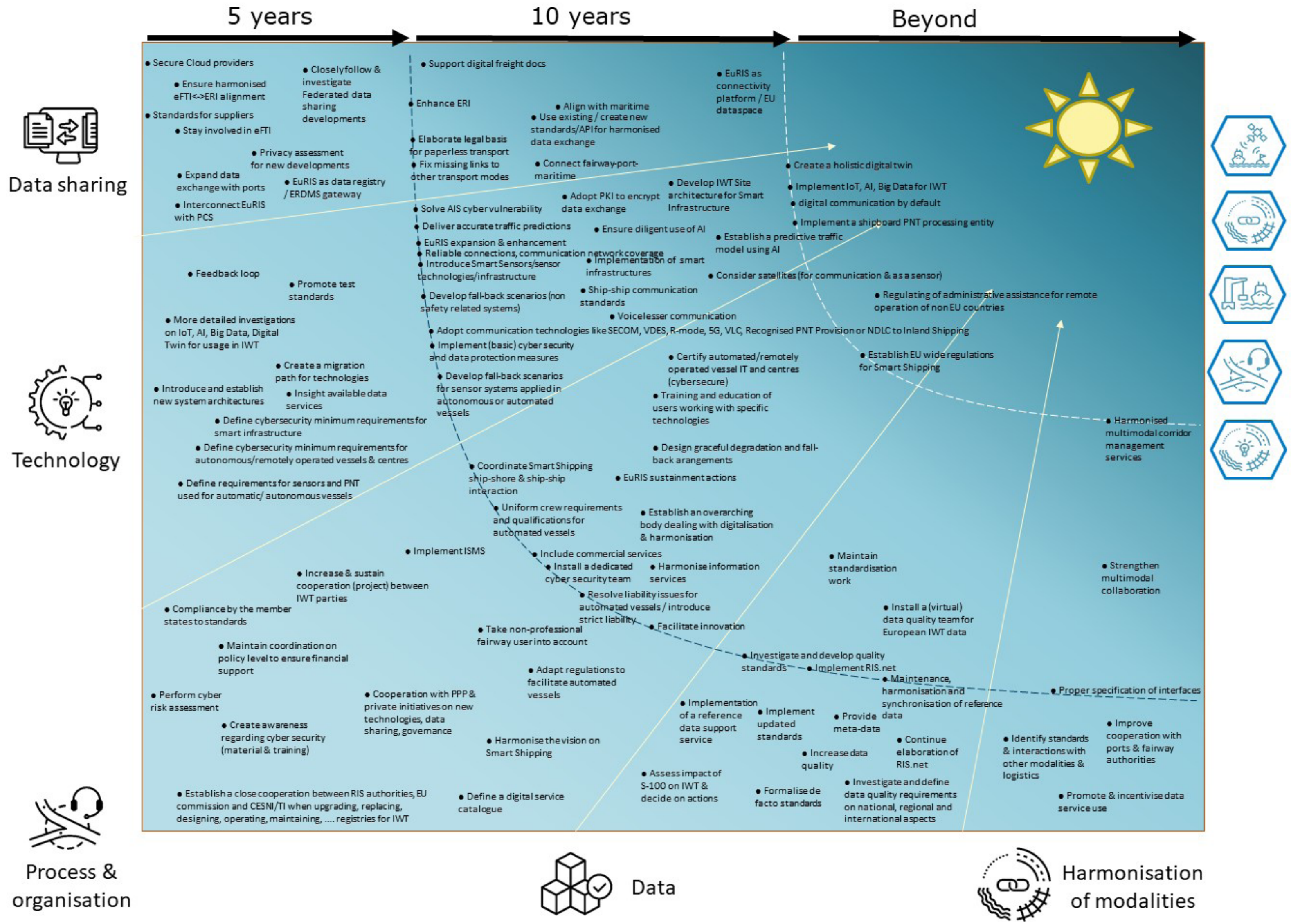
→ The mobility data space initiatives on European level take shape in its form and boundaries. EuRIS and CEERIS as potential data spaces for IWT are recognised in the inventory and shall be further evaluated in the follow up actions of DG MOVE.
→ Developments in smart shipping and smart infrastructure will play a crucial role in the upcoming years – not only from technical and functional but also legal point of view. River Commissions like CCNR are working on legal and qualification requirements which need to be intensified. Testing and evaluating semi-autonomous vessels in different pilot areas on European waterways is envisaged by the fairway authorities under the umbrella of co-financed European projects (e.g. AUTOSHIP, EU Space Data for Autonomous Vessels in Inland Waterways).
→ Active work and contribution within CESNI-TI shall serve as platform to further develop existing (de-facto) standards of RIS technical services and harmonisation of maritime originating developments.

* Implicitly there is of course a fourth ambition level which can be classified as the "stay behind" scenario. Choosing not to implement any of the DIWA recommendations will result in the implicit choice for this scenario.

DIWA Masterplan

08 Appendix

8.1 Overview of measures in the “road to the sun” approach



8.2 List of figures

8.3 List of tables

8.4 Image credits

De Vlaamse Waterweg (p. 18, 25, 30, 58)
Voies navigables de France (p.26, 47)
Rijkswaterstaat (p.13, 15, 36)
Microsoft Bing (AI generated with https://www.bing.com/images/create/) (p.1, 3, 8, 22, 28, 29, 40, 54, 60)

8.5 List of abbreviations

Ac	Activity (of the DIWA project)
SuAc	Sub activity (of the DIWA project)
AI	Artificial Intelligence
AIS	Automatic Identification System
API	Application Programming Interface
AtoN	Aid-to-Navigation
AV	Autonomous vessel or Automated vessel
CESNI	European Committee for drawing up standards in the field of inland navigation (FR: Comité européen pour l'élaboration de standards dans le domaine de la navigation intérieure)
DINA	Project "Digital Inland Waterway Area"
DIWA	Project "Masterplan Digitalisation of Inland Waterways"
EC	European Commission
eFTI	Electronic freight transport information
ERDMS	European Reference Data Management Service
ERI	Electronic Ship Reporting International
ERTMS	European Rail Traffic Management System
ES	Equipment Supplier
ETA	Estimated time of arrival
EU	European Union
EuRIS	European River Information Service (information portal)
FA	Fairway Authority
FEDe-RATED	Project "Federated Network of Platforms
FENIX	Project "European Federated Network of Information eXchange in LogistiX"
GHG	Greenhouse gas
IDL	IWT Digitalisation Level
IMO	International Maritime Organisation
IoT	Internet of Things
IT	Information Technology
ITS	Intelligent Transport System
IWT	Inland Waterway Transport
KPI	Key Performance Indicator
LSP	Logistic Service Provider
MASS	Maritime Autonomous Surface Ships
MDS	Mobility Data Space
NDLC	Nautical Datalink Communication
oA	Other Authority
PNT	Position Navigation Timing
RIS	River Information Services
RIS.net	RIS waterway network
RIS COMEX	RIS Corridor Management Execution
ROV	Remotely operated vessel
Sk	Skipper
SWs	Software Supplier
VHF	Very high frequency (radio communication)
VOp	Vessel Operator
VOw	Vessel Owner
VTM	Vessel Traffic Manager

8.6 List of definitions

Adaptability Grade	A metric that states the ease (or difficulty) to adapt a technology to Inland Shipping. The grades ranges from 'Not adaptable' to 'seamless adaptability'.
Automated Shipping	An automated vessel doesn't have the level of intelligence or independence like an autonomous vessel. There is still a certain degree of human intervention needed. The shipvessel is following orders about route and destination. Only some adoptions to lane-keeping or following guidance are performed.
Automation levels	Defined levels of automation for inland vessels by the CCNR (see www.ccr-zkr.org). The definitions provide a clear understanding of automation in inland shipping and subsequently allow the adoption of regulations as a base for technical requirements and developments.
Autonomous Shipping	This topic describes vessels that is navigating autonomously without human interactions. Instead, it is performed by ship-board machinery using an appropriate system (hardware, software) as the intended regular case. As part of the contingency response, an AV may fall back to become an ROV or even a traditionally operated vessel (a minimum crew is required).
Clean energy hub	An energy hub including a traditional generation plant, a low-carbon generation plant and a plant for sustainable energy generation (wind energy, solar energy, hydro power, etc.).
Connected, Cooperative and Automated Mobility	A transport system where vehicles interact directly with each other and with the infrastructure. The users of the infrastructure and the traffic managers share information and use it to coordinate their actions. This approach shall significantly improve safety, traffic efficiency and comfort, by supporting the users to make the right decisions and adapt to the current traffic situation.
Connectivity platform	A reliable basic communication framework providing an infrastructure enabling efficient, secure, seamless electronic information exchange between all authorised stakeholders across all available communication systems.
Data architecture	The data architecture defines the data along with the schemas, integration, transformations, storage and workflow. These things are necessary to meet the requirements of the needed information.
Data Quality	The extent to which data is suitable for the purpose for which it is used. Therefore, data should pursue all or some of the defined data quality parameters. The quality of data has an impact on the quality of the services using these data.
Data sharing platforms	Data sharing or connectivity platforms aim for enabling data sharing and poviding services for transparent data pooling and processing, while adhering to all relevant legislation.
Digital goods	Products that exist in a digital form. They can be offered an sold on online platforms/ marketplaces. A digital good has a physical counterpart.
'de-facto' standards	Many national and international standardisation bodies are developing numerous technical standards. Industry standards are developed within the industry and are so-called de-facto standards. Some of the de-facto standards (e.g. RIS Index, VisuRIS COMEX Reference Network Model, ERINOT 1.2 XML, Exchange of Object Status Information, ERIVOY) are not official standards.
Digital inland waterway area	The digitalisation of inland waterway transport by providing (real-time) waterway and vessel traffic data on RIS platforms. Data can be exchanged or shared. These are used by barge operators and shippers for transport planning.
Digital multimodal nodes	The Physical Internet is a new paradigm based on intelligent cargo technology. Cargo is routed through a self-organizing multimodal transport network. Intelligent/digital multimodal hubs or nodes ensure that cargo is routed to its destination allowing for optimizing cargo flows between these hubs.
Digital single market	Secure, high-speed and trustworthy infrastructure to provide an international (or even European) environment for digital networks and services supported by appropriate regulatory conditions.
Digital transformation	The adoption of digital technology by an organisation. Common goals for its implementation are to improve efficiency, value or innovation.
Digitalisation maturity model	A maturity model pre-given by the DIWA project framework that is based on the much more elaborate Capability Maturity Model but simplified and adapted to the needs and specifics of IWT.
Digital Twin	A virtual representation of the reality. It aims at copying all relevant attributes and parameters of any given object or entity and tries to embody them digitally. The ideal digital twin is an exact replica of the real object, with all its intricacies. There is a flow of data between the physical asset and the digital and also the other way around. Like a digital shadow, the physical can control the digital, but in this case the digital twin also interferes with the physical.
European Mobility Data Spaces	A single European market for data that will ensure global competitiveness and data sovereignty. It shall ensure the availability of more data for use in the economy and society, while keeping the ones who generate the data in control. It also requires the setting of clear and fair rules on data access, use and governance across sectors.
IDL impact	A metric that states the potential of a technology to contribute to reaching a certain IWT Digitalisation Level.
Information model	It is used for models of things like facilities, buildings, process plants, etc. This model is an integration of a model of the facility with the data about the facility. It is usually an abstract, formal representation of entity types that can include their properties, relationships and the operations that can performed on them. The entity types can be real-world objects, such as devices in a network or occurrences.
Intelligent Transport Systems	A transport system that uses telematics to track, process and display vehicles and transported goods. The data generated along the supply chain supports the coordination within and/or between transport systems.

Internet of Things (IoT)	A network of physical objects ("things"), such as sensors, software or other technologies, which are interconnected with other devices and systems via the internet so that data can be exchanged between the objects.
IWT Digitalisation level	The degree of digital transformation an entity or system has acquired. This metric is defined for the IWT fairway & navigation domain. The different levels are (from the lowest to the highest) 'Reactive', 'Organised', 'Digitised', 'Connected' and 'Intelligent'.
Multimodal (transport) hubs	An infrastructure to seamlessly switch between transport modes respectively to tranship the cargo to another transport mode.
Multimodal corridors	A transport corridor (European, regional or local) consisting of parallel transport routes of different transport modes. These corridors require a strong leadership as well as a greater coordination between the ministries and agencies for each transport mode. Multimodal corridors are the prerequisite for Synchromodality.
Multimodal trans-European Transport Network	TEN-T is a key for the development of a coherent, high-quality and multimodal transport infrastructure in Europe. It includes transport modes, like rail, road, water (inland, maritime) as well as ports, terminals and airports.
'New Technologies'	Emerging technologies that radically alters the way something is produced or performed, especially by labour-saving automation or computerisation. Within the scope DIWA, these are technological innovations that are not yet proven industrial standards, meaning they have not been established for three years or more.
Paperless freight transport	Full acceptance of execution of the transport processes with electronic transport documents.
RIS-net	This concept combines information from the RIS Index and the VisuRIS COMEX Reference Network Model, adding also capabilities for services not yet included in EuRIS. The concept needs technical validation and defined maintenance procedures.
Smart buildings	A building using advanced and integrated technology systems. These systems include building automation, life safety, telecommunications, user systems and facility systems. The measured or gathered data from the building or the area in or around enable a management of the building or its space.
Smart Infrastructure	An infrastructure that uses modern information and communication systems. These systems apply sensor systems and artificial intelligence for an autonomous control of processes.
Smart Mobility Strategy	This strategy aims to provide a seamless multimodal transport using digital solutions to unleash the full potential of existing data. It also contains the development and deployment of connected, cooperative and automated mobility services.
Smart Sensor (networks)	In addition to the base sensor, a Smart Sensor also contains a microprocessor, on-board diagnostics and is communication-capable. They can perform self-assessments and self-calibration. The communication capabilities enable them to be connected to a private network or to the internet (as an IoT device).
Smart Shipping	A vessel using on-board technology to operate fully or at least largely autonomous. Data collected by sensors support the vessel to manoeuvre autonomously or prompt the crew to act. This topic also includes the design of ports and waterways.
Smart transport	A transport system that incorporates modern technologies. This includes cloud computing, wireless communication, location-based services, and other tools to enhance processes.
Smart waterways	Inland waterways extensively equipped with Information- and Communication technology (ICT) to connect the infrastructure for improved and extended river information services, inland navigation, barge and logistic planning. The created Smart infrastructure should enable the utilisation of Smart Ships as well as the execution of automated or even autonomous processes.
Sustainable transport	A transport process that does not rely (too much) on the world's natural resources to power it. The main goal is to reduce the negative impacts on the environment by reducing the production of dioxide ($CO2$) or other emissions.
Synchromodality	A synchromodal freight transport is an intermodally planned transport with the possibility to decide at any time during the journey to switch to the currently best transport mode (depending on the current state of the traffic and the infrastructure of the respective transport mode). The decisions are made in real-time. Finally, it is possible that all transport modes were used, but also only one.
Technology Readiness Level	A metric that states the inherent readiness of a technology to be deployed in Inland Shipping. The readiness metric ranges from 'invention' to 'market expansion'.
Virtual AtoNs	It enables to information and display of the position of a virtual buoy for all vessels equipped with AIS and electronic charts. In case of incidents, virtual buoys can be implemented a lot faster than real buoys. However, this information is not available for vessel without AIS and ECDIS. The virtual AtoN also increases the data load on the AIS data link.