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D 1.7 Final Review of EU/Global Initiatives Policies and Standards impacting ePIcenter

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List of Acronyms

Abbreviation/acronym	Description
3GPP	3rd Generation Partnership Project
A2A	Administration to Administration
ACS	Air Community Systems
ADR	The Agreement concerning the International Carriage of Dangerous Goods by Road
AI	Artificial Intelligence
AIS	Automatic Identification System
AISBL	International non-profit association
AR	Augmented reality
ATO	Automating Train Operation
B2A	Business to Administration
B2B	Business to Business
B2G	Business to Government
BOOSTLOG	Boosting the impact of freight transport and logistics EU funded research
CCL	Core Components Library
CCS	Cargo Community System
CEF	Connecting Europe Facility
CEF Digital	Connecting Europe Facility Digital
CEF II	Connecting Europe Facility
CINEA	European Climate, Infrastructure and Environment Executive Agency
CMP	Country Maritime Profile
CMR	Carriage of Goods by Road
CPu	Certified Pick up
CSW	Customs Single Window
DAC	Digital automating coupling
DAS	Driving Advisory Systems
DTLF	Digital Transport and Logistics Forum
DTLF	Digital Transport and Logistics Forum
DTO	Driverless GoA
EaP	Eastern Partnership
e-AWB	Electronic Air Waybill Resolution
EBS	Enterprise Service Bus
eCMR	Electronic Consignment Note
ECTRI	European Conference of Transport Research Institutes
EDI	Electronic Data Interchange
EEA	European Economic Area
EEIG	European Economic Interest Grouping
EFTA	European Free Trade Association
eFTI	Electronic Freight Transport Information
EGC	Enhanced group call
EGDH	Expert Group on Data Harmonization
EIB	European Investment Bank
ELETA	Electronic exchange of Estimated Time of Arrival information
EMSWe	European Maritime Single Window environment
eNOA/D	Electronic Notice of Arrival/Departure
ERTMS	European Rail Traffic Management System
ESWe	European Single Window environment
ETA	Estimated Time of Arrival
ETCS	European Train Control System component

EU	European Union
EUSPA	European Union Agency for the Space Programme
FAL	IMO Facilitation Committee
FFS	Freight Forwarding System
FRMCS	Future Railway Mobile Communication System
G20	Group of Twenty
G7	Group of Seven
GHG	Greenhouse Gas
GMDSS	Global Maritime Distress and Safety System
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite Systems
GoA	Grade of Automation
GPAI	Global Partnership on AI
HaDEA	European Health and Digital Executive Agency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICT	Information and Communication Technology
IDB	Inter-American Development Bank
IFCD	Interface and Functionality Control Document
IFTMCS	International Forwarding and Transport Contract Status
IIoT	Industrial internet of things
IMDG	International Maritime Dangerous Goods Code
IMG	Gdynia Maritime University
IMLI	International Maritime Law Institute
IMO	International Maritime Organization
IoT	Internet of Things
IPA	Global Europe and the Instrument for Pre-Accession Assistance
IPAH	International Association of Ports and Harbours
IPCSA	International Port Community System Association
ISMIT	Integrated Services for MSMEs in International Trade
ISO	International Organization for Standardization
ITCP	Integrated Technical Cooperation Programme
ITCP	Integrated Technical Cooperation Programme
ITU	International Telecommunications Union
IWW	Inland Waterways
KNV	Koninklijk Nederlands Vervoer
LCC	Life Cycle Costs
LRIT	Long-Range Identification and Tracking
LTE	Long-term evolution
MASS	Maritime Autonomous Surface Ships
MEPC	Marine Environmental Protection Committee
MIGs	message implementation guidelines
MSC	Maritime Safety Committee
MSI	maritime safety information
MSMEs	Micro-, Small and Medium-sized Enterprises
MSP	Administration for Maritime Safety and Port Management Montenegro
MST	Maritime Safety Terminal
MSTI	Maritime Safety Terminal Interface
MSW	Maritime Single Window
NDICI	Neighbourhood, Development and International Cooperation Instrument
NGO	Non-Governmental Organisation
NMSW	National Maritime Single Window

NMTP	National Maritime Transport Policy
NoTN	Network of Trusted Network
NSW	National single window
OASIS	Organization for the Advancement of Structured Information Standards
OSI	Open Systems Interconnection
PCS	Port Community System
PdA	Porto do Açu
PI	Physical Internet
PKP	Polskie Koleje Panstwowe Spolka Akcyjna
PMIS	Port Management Information System
POA	Port of Antwerp
PoM	Port of Montreal
PoV	Port of Vancouver
QZSS	Quasi-Zenith Satellite System
R&I	research and innovation
RFD	EU Reporting Formalities Directive
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
RNSS	Regional Navigation Satellite Systems
RR	Rotterdam Rules
SAR	Search and Rescue
SDG	Sustainable Development Goal
SES	Ship Earth Station
SG	Subgroup
SIP	strategy implementation plan
SMTS	Sustainable Maritime Transportation System
SOA	Service Oriented Architecture
SOLAS	International Convention for the Safety of Life at Sea
SPRINT	Semantics for Performant and scalable Interoperability of multimodal Transport
SSN	SafeSeaNet
SSP	Single Submission Portal
SSS	Short Sea Shipping
STO	Semi-automatic GoA
SW	Single Window
TBG	Trade and Business Processes Group
TCCA	Tetra and Critical Communications Association
TCT	Treaty of Establishment of Transport Community
TDCC	Transportation Data Coordinating Committee
TDs	Technology Demonstrators
TEN-T	Trans-European network for transport
TID	Track intrusion detection
TMN-T	Trans-Mediterranean Network for Transport
TMS	Traffic management system
TS	Trackside
TSI	Transport and Telecommunication Institute
TSW	Trade Single Window
TTFMMs	Trade and Transport Facilitation Monitoring Mechanisms
TTP	Trusted third party
UCENE	United Nations Economic Commission for Europe
UIC	International Union of Railways
UIRR	International Union for Road-Rail Combined Transport
UML	Unified Modelling Language

UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
UN/EDIFACT	United Nations rules for Elec-tronic Data Interchange for Administration, Commerce and Transport
UN/TDID	United Nations Trade Data Interchange Directory
UNCITRAL	United Nations Commission on International Trade Law
UNCTAD	United Nations Conference on Trade and Development
UNDAF	United Nations Development Assistance Framework
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNLK	United Nations Layout Key for Trade Documents
UNSMs	United Nations Standard Messages
UNTDED	United Nations Trade Data Elements Directory
UNTTC	United Nations Transport and Trade Connectivity in the age of pandemics
UTO	Unattended train operation GoA
VGTU	Vilnius Gediminas Technical University
VR	Virtual reality
VTIS	Vessel Traffic Information System
VTS	Vessel Traffic Services
WCO	World Customs Organization
WCO DM	World Customs Organization Data Model
WEF	World Economic Forum
WHO	World Health Organization
WTO	World Trade Organization
WWRNS	Worldwide Radio Navigation System
XML	Extensive Markup Language

Executive Summary

Deliverable 1.7 provides an updated summary and review of policy initiatives provided in D1.1, ongoing digitization and visibility initiatives, and relevant standards and regulation, which were initially provided in D1.1. The report will consider changes that have occurred during the project, with a view to informing the technical research direction, but also to understand the pace of change in the industry.
This deliverable builds upon the initial overview of these subjects that was provided in Deliverable 1.1 earlier in the project, which contained input from the entire consortium.

This deliverable contains the following chapters:

Policy Review
This chapter provides an overview of relevant policies. Like all chapters in this deliverable, it builds on the work started in Deliverable 1.1.
The chapter is split up into different sections focusing on EU policy initiatives, IMO initiatives, and other relevant enterprises in the field of maritime transportation. Finally, it looks at initiatives by ChainPORT and NxtPort.
The work on this sub-task was undertaken by VGTU and MSP.

Ongoing Digitalisation and Visibility Initiatives
The chapter provides overview of the major digitalization and visibility initiatives relevant for the ePIcenter project, already started in the ePIcenter Deliverable 1.1. – Initial Review of EU/Global Initiatives, Policies and Standards. In the chapter, authors focus on the main global solutions and selected European projects and funding mechanisms (putting special emphasis on initiatives supported by DTLF and ALICE platforms). Maritime Single Window and railway initiatives are described in the separate sub-chapters.

The chapter concludes with practical examples from selected ports that lead on digital innovations initiatives. These best practices showcase has been based on online interviews with port representatives conducted by the ePIcenter Consortium specifically for this Deliverable. DTLF representatives have also been interviewed.

The work on this chapter was coordinated by IMG.

Relevant International Standards and Regulations
This chapter contains applicable standards and regulations relevant for international multimodal containerised and large freight movements to ensure ePIcenter remains compliant. The focus lies on area's which are the most relevant to the ruse case studies within the ePIcenter demonstrators. This chapter builds upon the initial list provided in Deliverable 1.1 of the project.
This chapter is not intended as a detailed review of the standards and regulations, but as an input for the use cases to allow for compliance check where relevant.
The work on this sub-task was coordinated by PoA, input was gathered from the end-users and experts that are part of the relevant use cases, such as Den Hartog, DHL and Connectainer.

Because of the difference in topics, introductions and conclusions will be contained in the chapters, where applicable. The results contained in this report will be used as input for the ePIcenter demonstrators.

1 Policy Review

1.1 Introduction

In the case of a project as ambitious and broad in scope as ePIcenter, a great variety of policy initiatives, both existing and future, is relevant. While making sure all activities in the framework of ePIcenter comply with relevant European legislation, ePIcenter has the specific ambition to test various innovative concepts that can make a clear contribution to the EU's current policy agenda and even to inspire and influence the policy agenda of the future.

Moreover, since the time of submission of the ePIcenter application, several developments have greatlyimpacted and will continue to impact the sector of transport and logistics. Therefore, during the entire project's lifetime, the consortium will continuously monitor the impact of the significant events such as the COVID 19-crisis, Brexit, rising protectionism, climate change and trade disputes on its work. More recently, the Ukraine crisis has of course been added to this list of events that can be expected to have a significant impact on international transport and logistics. The diversity of our consortium and ambition to form a strong stakeholder community early in the project will allow us to monitor their impact from very different angles.

Like all chapters in this deliverable, this one builds on the work started in Deliverable 1.1 and complemented by review of latest transport policy documents.

1.2 Overview of relevant policy initiatives (EU)

1.2.1 The European Green Deal (COM (2019) 640 final)

This Communication sets out European Green Deal for the European Union (EU) and its citizens, resets and expands the EC's commitment to tackling climate and environmental-related changes that is this generation's defining task[1]. The atmosphere is warming, and the climate is changing with each passing year. One million of the eight million species on the planet are at risk of being lost. Forest and oceans are being polluted and destroyed [2][3]

The European Green Deal outlines ways to respond to these challenges. It is essentially an innovative growth strategy that aims to transform the EU into a fair and prosperous society with a modern, resource-efficient and competitive economy, with no net emission of greenhouse gases by 2050, and economic growth decoupled from resource use [1].

The document emphasises that the EU has the collective ability to transform its economy and society following the green course. Even more, the Green Deal declares that the EU must be at the "forefront of coordinating international efforts towards building a coherent financial system that supports sustainable solutions." [1] At the same time it must be appreciated that high environmental goals and ambitions cannot be achieved by the EU acting alone. The drivers of climate change are global and are not confined by national or regional borders. The EU should use its influence, expertise, and resources to mobilise its neighbours and like-minded partners to join it in implementing green course ambitions. A network of partners that is being developed based on Global Gateway [4] could also make a significant contribution to this.

Finally, the Green Deal is an integral part of the EU strategy to implement the United Nation's Agenda and the sustainable development goals [5]. It is obvious that the EU must be an active and important participant during environmental dialogues with other global economic powers.

It is necessary to note that Green Deal will accelerate the transition needed in all sectors of the economy. Transport accounts for a quarter of the EU's greenhouse gas emissions and this share is still growing. To achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050 [1]. The EC attaches great importance

to the development of multimodal transport to reduce transport pollution. It is foreseen that a large proportion of land transport out of the 75% that is now transported by road will shift to rail and inland waterways. Although this problem has not been successfully addressed for decades, optimism currently is based on a complex but not fragmented approach to solving the challenge. Connected multimodal mobility, smart traffic management systems and sophisticated digitalisation tools will be developed and used. Finally, ongoing revision of the TEN-T will also accelerate the deployment of zero and low-emission vehicles.

Ending note: the ePIcenter project will also contribute to the realisation of the Green Deal by developing and adopting innovative digitalisation tools and platforms in practice, as well as offering decision making support models for optimising and synchronising transport interaction between transport nodes in the global corridor.

1.2.2 Commissioner Valean's Speech: "EU strategy for mobility and transport: measures needed by 2030 and beyond", European Parliament, 03.02.2020

Commissioner Valean emphasized that a real market for green, digital solutions is emerging, and she expressed a strong hope that the EU would be a global leader in all areas – from blockchain, digital mapping and tracking, to connected and automated vehicles, trains, planes, and vessels. Also, she expressed the intention to secure the EU's position at a global level. For this it is necessary to serious investments in research and innovations, and to work closely with industry partners.

1.2.3 Joint Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank. The Global Gateway. JOIN (2021) 30 final. Brussels, 1.12.2021.

The Global Gateway strategy; declared in the Joint Communication to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank (JOIN (2021) 30 final); is a guideline for how European Union can construct more resilient connections and cooperation with the world. The European Union and other democracies must demonstrate their ability to deliver on today's global challenges. This is emphasised in the introduction of the document. One such current challenge is the ever-growing necessity for countries to invest in- and develop the infrastructure to create sustainable prosperity, jobs, and services for their local communities. According to G20 estimates, the global infrastructure investment deficit will reach 1.3 trillion euros by 2040. Given the global nature of this challenge, Global Gateway has the ambition to work around the world, adapting to the needs and strategic interests of different regions while remaining values driven.

Global Gateway will focus on physical infrastructure – such as fibre optic cables, clean transport corridors, clean power transmission lines – to strengthen digital, transport, and energy networks. Using all the financial and development tools at the EU's disposal and support from the EU Member States, Global Gateway will aim at mobilising investments of up to 300 billion Euros between 2021 and 2027 [8].

Global Gateway will deliver sustainable and high-quality projects, considering the needs of partner countries and ensuring lasting benefits for local communities. This will allow EU partners to develop their societies and economies. This is in line with the commitments of the G7 leaders from June 2021 to launch a values-driven, high-standard, and transparent infrastructure partnership to meet the current challenges of infrastructure development. These commitments are the first steps in a long-term partnership and G7 leaders invite other leaders to join in common work to narrow the infrastructure financing gap and improve the quality, sustainability, and resilience of infrastructure.

Returning to the Global Gateway document, it is also necessary to note that its main provisions are aligned with the UN's Agenda 2030 and its Sustainable Development Goals and the Paris Agreement. Finally, due attention should be paid to the provision of the document which states that "in assisting others, the EU will also be contributing to the promotion of its interests, to strengthening the resilience of its supply chains, and to opening up more trade opportunities for the EU economy, in which approximately 38 million jobs are dependent on international trade."[8]

This would create opportunities for the EU Member States' private sectors to invest and remain competitive whilst ensuring the highest environmental and labour standards and sound financial management. However, meeting these objectives requires the concerted efforts of likeminded partners. In this context, it is time to take a closer look at the work done in developing partner networks and the key principles for future work. It should be noted that Global Gateway builds on the current achievements in implementing the 2018 EU-Asia Connectivity Strategy, the recently concluded Connectivity Partnership with Japan and India, and the Economic and Investment Plan for the Western Balkans, the EU Eastern Partnership, and Southern Neighbourhood.

Despite the provisions of the Global Gateway stating that this document is based, among other sources, on the 2018 Connectivity Strategy, some significant differences in the provisions of these above documents should be noted. Global political and economic developments drove them after 2018. This is especially true for the issues related to some important tasks of the ePIcenter project. The EC Joint Communication on Connecting Europe and Asia -Building blocks for an EU Strategy (Join (2018) 31 final) states that a partnership network between Europe and Asia should be based on three stands:

1) Contributing to efficient connections and networks between Europe and Asia through priority transport corridors, digital links, and energy cooperation at the service of the people and respective economies.
2) Establishing a partnership for connectivity based on commonly agreed rules and standards to enable better governance of flows of goods, people, capital, and services.
3) Contributing to address the sizeable investment gaps through improved mobilisation of resources, reinforced leveraging of EU's financial resources, and strengthened international partnerships [9].

Together with the document Join (2018) 31 final declared that the EU should work towards connecting the well–developed Trans-European network for transport (TEN-T) framework with networks in Asia, promoting EU experience in the development of connectivity which is sustainable, comprehensive, and rule-based. A diverse range of actors' dynamics set the parameters for cooperation in sustainable connectivity. To pursue connectivity effectively, the EU has the intention to strengthen the existing- and construct new bilateral, regional, and international partnerships.

Particular attention was paid to developing bilateral cooperation with Asia's economic powers. For instance, exceptional attention was directed towards China. Using the EU- China Connectivity Platform (as a specific instrument) established in 2015, both sides sought to enhance synergies between the EU's approach to connectivity, including the trans-European Transport Network (TEN –T), and China's Belt and Road Initiative (BRI). It was agreed that EU-China cooperation should include actions to:

- Share information, promote seamless traffic, flows and transport facilitation, and develop synergies between relevant initiatives and projects.
- Identify cooperation opportunities between their respective policies, including trans-European Transport Networks and the Belt and Road Initiative.
- Explore business and investment opportunities open to both the Chinese- and the European side.
- Create a favourable environment for sustainable and interoperable cross-border infrastructure networks in countries and regions between the EU and China [10].

Under the EU-China Connectivity Platform, annual Chairs meetings and Expert Group meetings are held to concretise actions developing transport connectivity between the EU and China. That there was much optimism at that time could be well illustrated by the documents adopted at the EU-China Summit, which took place in

Brussels on 8/9 April 2019. Many expectations were created by the decision to carry out the EU-China Joint study on a sustainable railway-based transport corridor between Europe and China. This commitment was endorsed by the Leaders of the EU – China Summit on 9 April 2019.

Paragraph 17 of the EU – China Summit Joint Statement declared that "two sides will continue to forge synergies between the EU Strategy on Connecting Europe and Asia as well as the EU trans-European Transport networks and China's Belt and Road initiative, and welcome the agreement, in the framework of the EU-China Connectivity platform, on the terms of reference for the joint study on sustainable Railway based Corridors between Europe and China. The two sides will enhance communications within the framework of the EU-China Connectivity Platform."[11]

It should be noted that EC Joint Communication on the EU-China – A strategic outlook has already presented (before the Summit) an assessment of China's specific characteristic as a partner, namely "China is simultaneous, in different policy areas, a cooperation partner with whom the EU has closely aligned objectives, a negotiating partner with whom the EU needs to find a balance of interests, an economic competitor in the in pursuit of technological leadership, and systemic rival promoting alternative models of governance. This requires a flexible and pragmatic whole-of-EU approach enabling a principled defence of interest and values. Looking from today's perspective, it could be argued that the underestimation of the first signs of the sharp increase of competition among the global economic powers as well as underestimating the specific features of China as partner, led to overly optimistic expectations for smooth cooperation in developing transport connectivity between the EU and China."[12]

Indeed, the EC Joint Communication (Join (2018) 31 final) is not focused on bilateral relations with China only. The document states that the EU should expand the dialogues on sustainable connectivity with other partners, including Afghanistan, India, Indonesia, Iran, Pakistan, Russia, the Republic of Korea, Turkey, countries of Central Asia, Australia, Japan, and the United States. Keeping in mind that bilateral cooperation with individual countries should be adapted to their specific situation. For instance, dealing with Japan, the EU should coordinate efforts to promote international standards and regional cooperation in Asia, notably by reinvigorating the EU-Japan dialogue. Also, connectivity is an essential aspect of EU enlargement and neighbourhood. Countries covered by these approximate or harmonise their approaches with the EU's. Sustainable connectivity is gradually being introduced in their legislation.

Nevertheless, priority was given to developing connectivity cooperation with China at the time. This is best illustrated by the steps taken later.

Thus, returning to the EC Joint Communication on Global Gateway (JOIN (2021) 30 final), China isn't mentioned among EU bilateral cooperation partners on connectivity. At the same time, it was emphasised that the EU has already concluded a Connectivity Partnership with Japan and India. It also intends to pursue a connectivity partnership with the Association of Southeast Asian Nations (ASEAN), building on the 2020 Ministerial Declaration. The EU will also seek further collaboration with the US and Canada, the Republic of Korea, and other like-minded partners. In detail, the Global Gateway will work in accordance with the following principles:

- Democratic values and high standards. The Global Gateway will offer a value-based option for partner countries to choose from when deciding how to meet their infrastructure development needs. This means adhering to the law upholding high standards of human, social, and workers' rights and respecting norms from international rules and standards, and intellectual property.
- Good Governance and Transparency. Delivering projects that work for people will require transparency, accountability, and financial sustainability. It will need open access to public procurement, a level playing field for potential investors, and a clear set of agreed deliverables to ensure that Global Gateway projects say what they will deliver and deliver what they promise.
- Security-focused. Secure infrastructure underpins the resilience of the global economy and supply chains – be it on digital, health, transport, or energy. Global Gateway projects will invest in infrastructure

to plug vulnerabilities, provide trusted connectivity, and build capacity in the face of natural or man-made challenges, physical-, cyber- or hybrid threats, and economic coercion for geopolitical aims.

- Catalysing private sector investment. Europe's World-leading industry, private sector knowledge and investment capacity give us a unique competitive advantage around the world, and Global Gateway must make full use of it to be a viable and attractive alternative for partner countries.[13]

Obviously, the principles of the Global Gateway listed above will cause serious challenges for some of the EU's potential partners. Therefore, some prior preparation is required to avoid problems when applying the Global Gateway principles to green and digital transformation projects in the Western Balkans, the EU Eastern Partnership region and Central Asian countries. Some of these countries are also in the research field of the ePIcenter project. Even though objectives and tasks of the ePIcenter project have been formulated to respond to the global challenges of the 2018/2019 period and global political and economic reality of that time, the project aims to make some contribution to the digital transformation of global transport corridors. New transport technologies and concepts such as Hyperloop, autonomous vehicles, multi-layered AI-driven technologies are foreseen to be used in the digitalisation of the transport corridors which interact with the new Silk Road corridors, or even ensure synchromodal planning along the new Silk Road routes (task 4.2 of the ePIcenter project). However, due to changing geopolitical circumstances, China (due to not sharing the same values as the EU) is not mentioned in the Global Gateway document. Of course, ePIcenter project partners must complete the planned project tasks. The interoperability problems between the BRI corridors and TEN-T corridors and hubs have not gone away. However, ePIcenter project partners must and will consider the key Global Gateway provisions in the final reporting.

1.2.4 Communication from the Commission to the European Parliament and the Council on the extension the trans-European transport network (TEN-T) to neighbouring third countries. COM (2021) 820 final, Brussels, 14.12.2021.

Having identified the need to extend the Trans-European Transport Network (TEN-T), the European Commission (EC) adopted plans and strategies to establish TEN-T in countries over the borders of EU. Therefore, according the recently passed "Communication from the Commission to the European Parliament and the Council on the extension the trans-European transport network (TEN-T) to neighbouring third countries", COM (2021) 820 in Brussels on 14th December 2021, the new corridors of TEN-T will comprehend South-East Europe, including Western Balkans and East Europe including Ukraine. The very fundament of TEN-T network is to make seamless, sustainable and effective transport across EU and neighbouring countries by social-, economic-, and territorial cohesion. The aim is to make a strong economic environment in whole Europe by implementation of developing projects related to transport infrastructure. The TEN-T network relies on EU plans and strategies to enhance the economic performance of all EU- and surrounding regions including exploitation of the market, production, transport, and potential of national states included in TEN-T corridors. In order to enhance market cohession, the EU needs to develop and improve the network of multimodal transport corridors, including road, rail and maritime transport modes, fostering regional and international connections based on common economic interests.

The EC has already adopted the TEN-T policy on 1996, set out in Regulation (EU) No 1315/2013 [14] ("the TEN-T Regulation"), and recently it has made a revision of this policy framework aiming to widen the transport network with other countries beyond EU boundaries, creating the appropriate infrastructure for economic collaboration between EU and developing regions.

Following Article 8(4) of TEN-T regulation, the extension of this network is intended to include:

- Ful coverage of the European Economic Area (EEA) and the European Free Trade Association (EFTA) [15],
- Western Balkans,
- Eastern Partnership (EaP) including Armenia, Azerbaijan, Belarus [16], Georgia, Moldova and Ukraine,
- Turkey with comprehended network included in TEN-T Regulation,

- South (Neighbourhood) Mediterranean Partners within Trans-Mediterranean network for Transport (TMN-T) comprehending North African and South-West Asian countries.

In order to realize the development of mentioned regiones and their transport network, the EU has adopted two important financial plans to support transport infrastructure building through international projects funded from: Neighbourhood, Development and International Cooperation Instrument (NDICI)-Global Europe and the Instrument for Pre-Accession Assistance (IPA) III. Such support is framed within the Economic and Investment Plans for the Western Balkans [17], the Eastern Partnership [18] and the Southern Neighbourhood [19]. In addition, the Connecting Europe Facility [20] (CEF II) may also be used for co-funding projects mainly located in the cross-border regions of the Union and neighbouring countries.

Therefore, by implementing the TEN-T extension policy, EU has established two main objectives:

1. Ensuring the interoperable and multimodal network between EU members, neighbours, and partner countries,
2. Union enlargement including financial support in mentioned regions geolocated in the European continent, which will enable these countries to become EU candidates, and for candidates states to gain faster access to the EU by interconnecting the transport corridors, market exchange and development investments.

Particularly, TEN-T is an enabler of trade facilitation and hence of economic integration, accelerating the convergence with the Union. Foreseen to be completed by 2030, the core network of TEN-T will provide high quality multimodal connections between all capitals and main transport arteries of the Union, as the cornerstone of the Single European Transport Area. This will be accomplished by implementation of hard infrastructure development and soft measures related to transport connectivity. The first one aims to identify and support infrastructure development projects and align them with TEN-T network parameters and objectives in the EU, e.g. contribution to decarbonisation of transport. This initiative will further accelerate EU funding and investments in infrastructure projects, enabling stronger economic and political connection, attraction of international financial institutions and building/maintenace the new infrastructure on the highest standards and requirements. Soft measures aim at the development of Intelligent Transport Systems (ITS) for all modes which will help to address safety issues and support transport sustainability.

Among the Union priorities, there is a goal to decarbonise transport including the limition of the climate change impact on the EU and neighbouring states. The TEN-T policy contributes to the objectives set out in the European Green Deal. To this end, all enlargement and other neighbouring countries should pursue the objective of the European Green Deal to provide for a 90% reduction in transport-related greenhouse gas emissions by 2050.

It is important to point out that the TEN-T initiative integrally covers regions under the EEA and EFTA with the fact that not just EU countries have core network corridors on their teritories, but also other strategically important countries such as Norway and Switzerland hold some parts of core network. E.g., Norway is a part of Scandinavian-Mediterranean Core Network Corridor, which is a crucial north-south axis for EU economy, while Switzerland is part of Rhine-Alpine Core Network Corridor as one of the bussiest freight routes in Europe.

Furthermore, the Western Balkans comprehending former Yugoslav republics and Albania are identified as one of the most important regions for extensions of the TEN-T network. This region represents significant transit area for distribution of European goods to other important surrounding markets, and it calls for further strenghtening of transport connectivity with the EU and other regions. One of the main achievements towards this goal is the Treaty of establishment of Transport Community (TCT), adopted in 2017. It aims to make the countries in the Western Balkans transpose and adopt EU transport aquis in national legislation, which will enable stronger integration of this region in the EU transport market and industry sector. The areas of TCT are technical standards, traffic management, safety/security, social policy and procurement, etc which will be further developed throught infrastructure projects aiming to contribute to TEN-T core and comprehensive networks. As stated in Communication (2021) 820 final, the Western Balkans are continually making progress in the

implementation of TEN-T policy and relevant development and investment projects in transport and industry sectors.

Emphasis was put on some transport projects that made excellent seamless connectivity between EU and neighbours including all transportation modes. It has been identified that from 70% of global trade with Europe only 5% of the total freight volume is transported by rail and the remaining 95% is transported by road. According to the elaborated document, from a transportation point of view, the Western Balkans region has many underused potentials concerning excellent geographic and strategic position for EU market extensions. To prove this, the related figures indicate that rail freight transport has dropped by 40% since 2009. The share of rail passenger transport of total passenger transport also remains in the single digits, with the exception of sub-urban transport in a few major cities. When it comes to transport by inland waterways, the region of the Western Balkans has great potential (with the Danube and Sava rivers network) for river transport taking over transport flows from road and railways. Also, this inland waterway network is underused and the EU has targeted it as a new sector for investment and development in order to extend freight transport and TEN-T beyond the EU's borders. Specifically in the Adriatic Ioanian area, there is a need to ensure coordination between national and regional bodies active in the development of the TEN-T.

Since the Western Balkans and the EU adopted the TEN-T policy and TCT entered into force in 2018, it has been concluded that TEN-T enlargement and its widened implementation should be accelerated to overcome the existing economic gaps between these regions and improve quality of transportation modes. The envisaged measures to meet these goals are utilisation of EU funding sources, i.e. implementation of infrastructure projects financed under Instrument for Pre-Accession through the Western Balkan Investment Framework. Furthermore, in 2020 the Commission adopted a comprehensive Economic and Investment Plan for the Western Balkans (EIP) [21] which aims to spur the long-term economic recovery of the region, support a green and digital transition, and foster regional integration and convergence with the Union. Also, the EU gives high priority to TEN-T projects due to its strategic interests and the huge potential to connect Western Balkans capitals within the region and the EU creating a complete, compliant and sustainable core network. This objective is oriented towards greater investments for infrastructure building projects, construction of new transport infrastructure (bridges and highways), promotion of sustainable green multimodal transport solutions and cross-border projects aiming to bring the exisiting infrastructure to TEN-T standards and requirements. One of the tangible examples of EU support to the Western Balkans region is the creation of the European Transport Corridor which will connect non-EU countries that share the borders with other EU countries (Croatia, Hungary, Romania and Greece) to have better interconnections and a resilient transport network.

Considering the other neighbouring regions of EU, the goal is acceleration of the indicative TEN-T network development through TEN-T related infrastructure projects and fostering the multimodal transportation sustainability. To enable this, the EU will undertake the following three main actions:

1. Achievement of a compliant indicative core network, which is multimodal, sustainable and resilient.
2. Support the promotion and deployment of digital technology to enable the interoperability of networks.
3. Give priority to TEN-T projects of strategic interest to the Western Balkans and the Eastern Partnership regions and to the Union, to better link enlargement and other neighbouring countries with the Union.

1.2.5 EU proposal for a Regulation of the European Parliament and of the Council on Union for the development of trans-European transport network amending regulation (EU) 2021/ 1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) 1315/2013

The problems addressed by the revision are insufficient and /or incomplete TEN-T infrastructure standards and a lack of integration of standards for alternative-fuel infrastructure on TEN-T with negative impacts on climate and environment. Also, the TEN-T network suffers from capacity bottlenecks and insufficient network connectivity to all regions that hamper multimodality.

Thus, the revision of the TEN-T Regulations is a key action of the European Green Deal and aims at reaching four main objectives:

1. It aims to make transport greener by providing the appropriate infrastructure to alleviate congestions and reduce greenhouse gas (GHG) emissions and pollution of air and water by making each mode more efficient and enabling increased use of more sustainable forms of transport. Focus is to be given to an increase in the share of rail, short sea shipping (SSS) and use of inland waterways (IWW). Specifically:
    - Rail freight traffic should increase its market share by 50% by 2030 and double it by 2050 [22].
    - Transport by IWW and SSS should increase its market share by 25% by 2030 and by 50 % by 2050 [22].
    - Traffic on high-speed rail should double by 2030 and triple by 2050 [22].
    - Scheduled collective travel under 500 km to be carbon–neutral by 2030 within the EU [22].
    - At least 100 climate-neutral cities in Europe by 2030 [22].
2. It aims at facilitating seamless and efficient transport, fostering multimodality and interoperability between the TEN-T transport modes, and better integrating the urban nodes into the network. Removing bottlenecks and missing links and improving multimodality and interoperability in the will contribute to the completion of the internal market. The EC document sets out the following obligations for the EU Member States to develop multimodality:
    - To conduct a market- and prospective analysis and submit an action plan for the development of the multimodal freight terminal network.
    - To have at least one multimodal freight terminal per urban node.
    - To have terminals equipped with at least one alternative fuel recharging station for heavy-duty vehicles.
3. It strives to increase the resilience of TEN –T to climate change.
4. It aims to improve the efficiency of the TEN-T governance tools, streamlining the reporting and monitoring instruments, and review the TEN-T network design [23].

At the same time, the EC's proposal for a revision of TEN-T presents a strategy its further development, namely:

- The trans-European transport network shall be gradually developed in three steps:
    1. The completion of the core network by 31 December 2030.
    2. Of an extended core network by 31 December 2040.
    3. And of the comprehensive network by 31 December 2050.

  It is emphasised that this shall be achieved by implementing a structure for the network with a coherent and transparent methodological approach, comprising a comprehensive network and a core and extended core network, with transport and urban nodes as connecting points between long distance traffic and the regional and local transport networks.
- The comprehensive network shall consist of all existing and planned transport infrastructure of the trans-European transport network as well as measures promoting the efficient, socially- and environmentally sustainable use of such infrastructure.
- The core and extended core network shall consist of those parts of the trans-European transport network, which shall be developed as a matter of priority for achieving the objectives.

It is very important for ePIcenter project partners to be aware of the newest EU provisions on TEN-T interoperability with networks of third countries. The EC document states that the EU intends to cooperate with neighbouring countries to connect TEN-T with their infrastructure networks, aiming to enhance economic growth and competitiveness, and to:

- Promote the extension of TEN-T network policy into third countries.
- Ensure the connection between the TEN-T and the transport networks of the third countries at border crossing points, to guarantee seamless traffic flows, border checks, border surveillance, and other border control procedures.
- Complete the transport infrastructure in third countries which serve as links between parts of TEN-T.

- Promote the interoperability between TEN-T and networks of third countries. It would be excellent if the latter provision could include and the requirement to assess the impact of third countries transport flows on the EU transport hubs when the TEN-T network is planned.

1.2.6 DTLF, including Regulation (EU) 2020/1056 of the European Parliament and the Council of 15 July 2020 on electronic freight transport information.

Technological progress impacts the economy and changes the living standards of the population. The transport sector is no exception to this trend. Modern technologies are radically changing the nature of mobility and connectivity. In this context, EU mobility policy is geared towards meeting current challenges through innovation, digitalisation, and decarbonisation.

The EC has adopted a comprehensive approach to ensure that the EU's mobility policy reflect the above priorities in the form of the "Europe on the Move" mobility packages. These will tomorrow's mobility system safe, clear, efficient, and more accessible for all EU citizens and European industry. This requires the full commitment of the EU institutions, member states and stakeholders.

Total freight transport in the EU is projected to increase by 51% during 2015-2050. A large amount of information accompanies all this transportation of goods, exchanged among various parties in both the private and public areas. A lot of this information is currently printed on paper in a variety of standard format documents.

Two main reasons for this were revealed, namely:

- A fragmented legal framework setting inconsistent obligations for authorities when accepting electronic information or documents, which determines different administrative practices.
- A fragmented IT environment characterised by an abundance of non-interoperable systems for electronic transport information and documentation exchange, both for B2B and B2A communication.

The Digital Transport and Logistics Forum (DTLF), established by DG MOVE in 2015, is an expert group of the European Commission bringing together public and private stakeholders from various transport and logistics communities. It supports the EC in promoting a digital transformation that facilitates cooperation between supply chain actors, enables better visibility and real-time management of cargo flows, leads to the reduction of administrative burden, and allows for better use of resources and infrastructure. DTLF's overall objective is full–scale digital interoperability and data exchange in a shared, secured, and trusted transport and logistics dataspace.[24] During the first phase (2015-2018) of its activity, the DTLF spits into two subgroups.

Within the framework of **Subgroup1 (SG1) on "Paperless transport"**, the experts focused on the legal and technical barriers preventing trusted, efficient, and secure exchange of information between the operators and public authorities. In 2016 SG1 prepared recommendations for the European Commission on actions in developing Paperless Transport, classifying documents used in the context of transport and logistics as follows:

- Documents concerning goods (freight documents) containing information representing goods and their transport. It covers both documents that serve the contract of carriage (waybills, consignment notes) and other documents serving various other purposes, such as declarations and dangerous goods certificates.
- Documents providing information on the means of transport from a safety perspective, usage and its nationality, certification, vehicle registration, insurance and, etc.
- Documents containing information on the qualification and nationality of the personnel operating a means of transport and/or personnel handling the cargo.

The priority was given to documents concerning goods (freight documents).

DTLF SG1 experts concluded that the legal framework (2016-2018) is dispersed, as it consists of international conventions, EU legislation and national legislation in the EU Member States. At the same time, it was noted that the EU legal framework is limited, as there were no specific EU rules concerning the electronic submission of transport- or goods related documents. EU rules determining how enforcement authorities of Member States should inspect transport documents are absent.

The legal survey conducted as part of the study commissioned by the Commission into the state of play and barriers to use of electronic transport documents for freight transport (up to 2018) made clear that none of the Member States that had provided information to the survey has a general rule that requires national authorities to accept transport documents in an electronic format for all available transport modes in all cases. A general "rule" is that enforcement authorities can accept electronic freight transport documents in a few member states. It showed that the legal landscape concerning the acceptance of electronic freight documents was very fragmented.

Moreover, not a single country was identified where general rules regarding the acceptance of electronic freight transport documents in all modes apply. The DTLF SG1 survey revealed that the most needed intervention at the EU level is adopting measures to ensure trust, confidentiality, and data security between different stakeholders.

Another important aspect is the quality of data. On paper changes can easily be written, and documents can be retyped. However, in the case of data being duplicated by messages between IT systems, data in multiple systems can become inconsistent. This decrease in data quality may lead to unnecessary delays in logistics chains. In this case, it is recommended to use technologies that could be applied to share data changes. In summary, it should be emphasised that SG1 recommendations have focused on the following three areas:

1. Acceptance of electronic transport documents by all stakeholders, and particularly by national authorities.
2. The harmonisation of these documents at the data element-level and across all transport modes.
3. The development of common IT infrastructure to support the electronic exchange of this data, both among private stakeholders and public authorities.[25]

In this area is recommended to collaborate and synchronise with current and future projects and initiatives, and other publicly or privately funded developments that strive to develop IT infrastructure for further digitalisation of exchanged information (B2A, A2A and A2B).

Within the ePIcenter project one of the objectives is to establish an interoperable living toolset of software tools, services and methodologies which can be rapidly deployed worldwide by public- and industry stakeholders to address the many current challenges related to multimodal freight transport systems and logistics operations This can make a significant contribution to the implementation of the DTLF SG1 recommendations. The ePIcenter project partners seek to contribute to the ongoing convergence of the "hard" transport infrastructure with the "soft" logistics and IT layers into integrated dynamic logistics, which is termed "the Enhanced Physical Internet-enabled Global –European Network".

It needs to be noted here that DTLF SG1 recommendations had an essential role in the preparation of the proposal of the European Commission for the Regulation of the European Parliament and Council on electronic freight transport information (COM (2018) 279 final 2). The Regulation (EU) 2020/1056 aimed at promoting the digitalisation of freight transport and logistics to reduce administrative costs, improve enforcement capabilities of competent authorities, and enhance the efficiency of transport and logistics was adopted on 15 July 2020 and entered into force on the twentieth day following that of its publication in the Official Journal of the European Union.[25]

It should also be noted that not all articles of Regulation (EU) 2020/1056 entered into force at the same time. Article 7 (on eFTI common data set and eFTI data subsets) is the article with a specific implementation term (21 February 2023). At the same time, it is one of those articles of the Regulation which has a potential interaction with the tasks of the ePIcenter project [26].

Article 7 (2b) states that the European Commission shall adopt delegated acts to ensure the interoperability of the eFTI common data set and eFTI data subsets with relevant data models accepted internally or on Union level, including multimodal data models. Implementing the above provision, potential contribution from the ePIcenter project can be expected. In of WP2, the project researches the current limitations of cloud-based Big Data repositories and identification of priority areas for new sources of structured data for government, authorities, and public research initiatives. Together, it is important to note that soft network architecture and Physical Internet models are among ePIcenter priorities also.

The outcomes and recommendations of the ePIcenter project can be assessed and hopefully will be considered in the implementation of Article 14 of the Regulation. Which the European Commission empowered to adopt delegated acts (related with an article with specific terms of implementation) for five years from 20 August 2020. Currently, the DTLF experts are assisting the Commission in exploring and preparing options for the implementation specifications of the Regulation (EU) 2020/ 1056 in four dedicated teams under the framework of SG1:

1. **Data Team** –aiming contribute to the definition of common eFTI data set and eFTI data subsets, in line with the information requirements established in the EU and national legal acts that fall under scope of the Regulation.
2. **Functional Team** – aiming to provide input to prepare the common rules and procedures for the authorities to access and process the eFTI data, the eFTI platforms where the economic operators will make the information available to the authorities, and the eFTI service providers.
3. **Technical Team** – aiming to provide advice on the technical aspects of the implementation specifications.
4. **Implementation and certification Team** – aiming to assist with setting up rules for the certification of the eFTI platforms and eFTI service providers. [24]

Lack of interoperability and fragmentation of various data sharing systems is an important challenge for supply chains and logistics stakeholders. Therefore, the **DTLF SG2 "Corridor Freight Information Systems"** was established to create a common framework for information sharing in multimodal transport and logistics chains. It is expected that this dataspace will integrate existing and emerging platforms into a federated network allowing private and public bodies to easily connect and share data in a neutral and trusted environment. SG2 experts are working on developing technical specifications for the data sharing framework and preparing relevant implementation guidelines from a public- and private sector perspective. The experts are grouped into four teams having the following specific tasks:

- **Plug and Play**: to provide concepts and procedures that allow individual stakeholders to connect and share data according to common agreements.
- **Technology Independent Services**: to produce the technology independent platform services supporting common processes, business interoperability, and business compliance with legislation.
- **Federation of Platforms**: to create (technical, functional, and business model) interoperability between different platforms, even when each platform is realised with different technology.
- **Trusted, Safe and Secure**: to establish a neutral governance structure ensuring trust, safety, and security for data sharing via multiple providers of platform services, including peer-to-peer solutions. Especially when it deals with development connectivity with third countries.[27]

Finally, it should be emphasised that the ePIcenter project, by fulfilling its objectives in the field of digitalisation of the international transport corridors, will also make some contribution to the development of interoperability between different platforms.

1.2.7 Strategic Plan 2020-2024. DG MOVE. Ref. Ares (2020) 4606354-04/09/2020

The Directorate-General for Mobility and Transport (DG MOVE) oversees the development of mobility and transport policies for the European Union

Transport has traditionally grown, as the EU and global economies and societies have become more integrated, until the COVID-19 pandemic reversed this trend and threatened connectivity. European transport also continues to change as new challenges such as environmental, climate neutrality and digitalisation are faced. DG MOVE sees transport as a very important part of the European Green Deal [6] and considers "investment, innovation and a clear regulatory framework as a core instrument driving change as the EU moves to decarbonise and digitalise its transport network to better serve the EU citizens, to protect the climate, to increase the competitiveness of the EU economy, to ensure the functioning of the internal market, and to maintain the EU's global influence. Issues and challenges associated require actions at the European and international level. No national government can successfully address them alone."[7] At the same time, during the preparation of the Strategic Plan 2020-2024, the EU economy and society were severely hit by the Coronavirus pandemic. Mobility and transport are among sectors hit the hardest and DG MOVE was at the forefront of delivering fast relief measures. On the other hand, transport and mobility hold the key to a swift economic recovery and building up resilience. Now DG MOVE will work to ensure that the EU transport policy contributes to economic recovery and re-establishment of connectivity for people and business, focusing on sustainability and digitalisation. The Strategic Plan 2020 -2024 (DG MOVE) identifies five priorities, with one or more objectives for each.

A European Green Deal. Objective 1: A sustainable transport area that reduces transport impact on the environment, provides healthier and cleaner alternatives to mobility, and increases the uptake of sustainable alternative transport fuels for land, waterborne and air, both in the EU and globally.

Contributing to this objective, DG MOVE will lead efforts to significantly reduce emissions from the transport sector by supporting the uptake of sustainable alternative fuels in all modes of transport, promoting the least polluting modes, and carbon-neutral transport. A cornerstone of the DG MOVE strategy will be to better integrate the different modes and facilitate multimodal transport and mobility. This requires further development of an infrastructure network that is fit for purpose, interoperable, multimodal, supporting digitalisation of transport and making the use of alternative modes of transport possible and efficient. The ongoing revision of Regulation for TEN-T is aimed at contributing to the development of seamless connectivity and clean mobility. The Connecting Europe Facility (CEF) work programme 2021-2023 has dedicated a significant part of its funds to support sustainable and smart transport infrastructure in line with the European Green Deal objectives.

A Europe fit for the digital age. Objective 2: A smart and innovative transport sector that makes the most of digitalisation and automation, supported by adequate funding.

As automation and digitalisation play an increasing role in modern transport, DG MOVE has a strong commitment to support the EU transport sector to remain at the forefront of technological innovation for the benefit of all users. DG MOVE seeks to provide European transport with the right regulatory and financial support promoting the digital transition. DG MOVE will continue to work on building and strengthening the Common European mobility data space, accelerating efforts to make more datasets accessible in an interoperable manner. It will establish a trusted digital environment to enable all actors, including businesses, to share data with one another safely and efficiently. Sharing information on schedules, delays, or the location of vehicles and cargo will help our transport sector to optimise freight and passenger operations, cut congestion and waiting times, and ultimately reduce fuel use and emissions. In this context, it is important also to establish a neutral data sharing environment, integrating independent digital data platforms into a federated network. The Digital Transport and Logistic Forum (DTLF) works productively in assisting to achieve these tasks. The ePIcenter project research on current limitations of cloud – based Big Data repositories and identification of priority areas for new sources of

structured data for governmental organisations, authorities and public institutions is likely to enrich knowledge in this area and should contribute to the implementation of the Specific objective 2.

An economy that works for people. Objective 3.1: A fully integrated and connected trans-European Transport Network (TEN-T) with appropriate funding for robust and modern European transport infrastructure with fully restored connectivity.

In the Strategy it is pointed out that TEN-T development is a key priority for DG MOVE. Due to TEN-T policy keeping up with the latest developments and unprecedented challenges - including sustainability, user-driven mobility, and technological progress - is key to ensure a future-oriented, sustainable transport system. The ePIcenter material on TEN-T issues is provided in a specific chapter of this report.

Objective 3.2: An effective and accessible internal market for transport that drives economic recovery and is governed by clear rules that are applied and enforced consistently.

This part of the Strategy stresses the enforcement of existing rules and updating them where necessary, with a strong drive towards reducing unnecessary administrative burden. The next steps to be given towards an integrated transport management system, with safety at its core.

A stronger Europe in the world. Objective 4: A European Union that acts united in cooperation with key players and neighbours to improve connectivity links, open new market opportunities and promote high safety and security standards.

The TEN-T network is defined as an important instrument to improve the EU's connectivity with key partners. The EU will work to extend the TEN-T Network to neighbouring partner countries to ensure direct connections between EU networks and EU's neighbouring countries. ePIcenter worked intensively in this area up to the Russian invasion of Ukraine. The war stops this activity.

Promoting our European way of life. Objective 5: High transport safety and security levels are ensured. New security and safety challenges are addressed.

Implementing this objective, DG MOVE is working with the different EU Agencies and all stakeholders seeking to implement and enforce the highest safety and security standards for all modes of transport, including cybersecurity. One of the cornerstones of the EC and EU Members States' efforts in this area is the Vision Zero objective of reducing the number of fatalities and serious injuries in road transport by 50% by 2030 and to near zero by 2050 (as is stated in the Strategy).

1.2.8 Europe on the MOVE (Sustainable Mobility for Europe: safe, connected, and clean) COM (2018) 293 final

Technological change is touching all parts of society and the economy and transforming the lives of EU citizens. Transport is no exception to this trend. New technologies are radically changing the mobility landscape. They are disrupting conventional transport business models and industries, bringing new opportunities in the form of new players, but also challenges. The labour market and the required skills are quickly evolving, and the EU must remain competitive in the face of intense global competition.

The EU has already begun to prepare the ground, for example with the adoption of strategies on cooperative intelligent transport systems and future 5G communications technology. The EU is also well advanced on data protection rules that frame the single digital market.

However, more needs to be done. Technology is moving fast, and there is a strong need for a coordinated approach and setting priorities for funding research, demonstration, and deployment activities at European and national levels to make the most of the ongoing and future programmes, to maximise the concerted efforts of public and private investment, and to fully exploit synergies between connectivity and automation.

This Third Mobility Package also includes two proposals to establish a fully digital and harmonised environment for exchanges between transport operators and authorities. The proposed Regulations on a European Maritime Single Window Environment and on Electronic Freight Transport Information complement each other and will allow electronic and simplified exchanges between business and authorities along the transport routes from the point of entry in EU ports to the goods' destination (COM (2018) 278 andCOM (2018) 279). These two proposals will cut red tape and facilitate digital information flows for logistic operations, providing better connections between different transport modes, thus contributing to multimodalsolutions. See also:

https://www.europarl.europa.eu/legislative-train/api/stages/report/current/theme/resilient-energy-union-with-a-climate-change-policy/file/electronic-freight-transport-information

The problems occur in subsequent official procedures due to multiple entries of the same data in several diverse applications where errors often occur during repeated data input. Data is still duplicated using paper and electronic means (inputting the same data in different systems). Therefore, it is necessary to develop a Port Community System (PCS), which represents a neutral platform for electronic data exchange between all stakeholders of the port process. By harmonising Maritime National Single Windows and Port Community Systems the goal would be achieved, which is the elimination of data duplication so that,once entered, data is visible to all stakeholders of the seaport system resulting in more efficient and more effective business processes.

Infrastructure is an indispensable tool for the deployment of clean, safe, digital, and connected solutions in the transport system. The TEN-T network is Europe's transport infrastructure backbone. It has a strong influence on the mobility patterns for freight and passengers by setting common requirements, generating quality infrastructure projects and innovations. To this end, this Third Mobility Package includes a proposal for a Regulation aiming to facilitate the implementation of the TEN-T core network and promote multimodality.

The ePIcenter project partners seek to contribute to the development of multimodal transport along international transport corridors. In fact, innovative tools and models are being developed and adopted with focus on the optimisation and synchronisation activities of key hubs along global transport corridors (Asia-Europe), including those where trans-European Transport Network (TEN-T) 'core' corridors interact with BRI networks. It is understandable, that ambitious goals for the future transport systems can only be achieved if new ideas, concepts, and tools can be developed, tested, and implemented in close interaction with EU policy and its regulatory framework.

Therefore, ePIcenter partners seek to comply with provisions of the EUROPE ON THE MOVE (COM (2017) 283 final, COM (2018) 278 final) when introducing new models and tools for the development of multimodality of the transport network in both the EU and third countries. The importance of digitalisation has been emphasised above. Data is increasingly seen as 'the new fuel of transport' that drives the development of new innovative transport services [35].

To support the digitalisation process, the EC has set up the Digital Transport and Logistics Forum (DTLF). This Forum focuses on the digitalisation and acceptance of transport documents and the establishment of management systems. Corridor information and management systems aim to facilitate data sharing between all stakeholders along transport and logistics chains in given corridors through data exchange platforms. The work involves all logistics chain actors, and there is a need to agree not only on technical solutions and rules for data accessibility, exchange, ownership, quality, and protection but also on financing and governance.

The outcomes of the ePIcenter project's research on current limitations of Big Data repositories and identifications of priority areas for new sources for governmental organisations and research institutions can be expected to contribute to meeting the challenges of database and infrastructure development.

At the same time, it should be noted that DTLF activity is focused on the needs of the EU and the resolution of problematic issues through the appropriate development of the legal framework. However, when research on global transport corridors is carried out in the framework of the ePIcenter project, the issue of digitalisation becomes particularly sensitive. More so as the specific research carried out in this project is not limited to

countries that can be identified as sharing common values with the EU. There are some countries that do not meet the declared principles of the EU Global Gateway [36].

1.2.9 Artificial intelligence (AI)

As artificial intelligence (AI) advances across economies and societies, policymakers and AI actors around the world seek to move from principles to practice. Countries are at different stages of developing and implementing national AI strategies and policies. Some countries, such as Canada and Finland, developed their national AI strategies as early as 2017, closely followed by Japan, France, Germany, and the United Kingdom in 2018 [37]. The European Commission launched the development of its AI strategy in 2017. Currently, the United States is the world leader in AI, with China is catching up fast. The EU plays the role of an evolving one.

Artificial Intelligence systems have been slowly integrated into transport and logistics throughout the past years. This process has accelerated drastically, with AI pervading these sectors. AI will help boost efficiency for transport and logistics by improving internal processes, the digitalisation of enterprises, and the overall operations. Through traffic management and better route planning, it can help eliminate congestion. Efficiency gains could lead to a 10% increase of GDP for the sector on average by 2030, greatly benefitting EU businesses [39].

Together with the benefits, many challenges lie ahead. Among the obstacles to the full deployment of AI in transport is the lack of harmonised AI rules among the Member States [40][41][42][43]. With a focus on harmonisation, the EU defines problems the use of AI systems can create [41]:

1) Safety and security.
2) Fundamental rights and acceleration of the probability or intensity of the existing risks.
3) Make it hard for enforcement authorities to verify compliance with- and enforce the existing rules.
4) Legal uncertainty for companies.
5) Potentially slower uptake of AI technologies by businesses and citizens, due to a lack of trust.
6) Regulatory responses by national authorities to mitigate possible externalities risking the fragmentation of the internal market.

To address those problems and to ensure the proper functioning of the single market, it is required to create conditions for the development and use of trustworthy AI in the EU. Specific objectives are:

1) Ensuring that AI systems placed on the market are safe and respect the existing law on fundamental rights and EU values.
2) Ensuring legal certainty to facilitate investment and innovation in AI.
3) Enhancing governance and effective enforcement of existing laws on fundamental rights and safety requirements applicable to AI systems.
4) Facilitating the development of a single market for lawful, safe, and trustworthy AI systems and prevent market fragmentation.

International cooperation to promote the beneficial use of AI and address its challenges is a priority for many countries. Cooperation for the development and adoption of AI and AI governance is being conducted at the bilateral, plurilateral, regional and international levels. Moreover, many inter-governmental organisations with complementary mandates are engaged in AI initiatives and projects. International cooperation on AI is taking place in fora including the Council of Europe, the EU, the Global Partnership on AI (GPAI), the Group of Seven (G7), the Group of Twenty (G20), the Inter-American Development Bank (IDB), the International Telecommunications Union (ITU), the OECD, the United Nations, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Bank.

1.2.10 Connecting Europe Facility (CEF), REGULATION (EU) No 1316/2013

An important objective of the Connecting Europe Facility (Programme) is to deliver increased synergy and complementarity between the transport, energy, and digital sectors. Enabling digital communication to be accessed is a common interest in the field of energy and transport.

Actions contributing to projects of common interest in digital connectivity infrastructure shall deploy the best available and suited technology for the specific project, which proposes the best balance between state-of–the art technologies in terms of data flow capacity, transmission security, network resilience and cost efficiency, and should be prioritised by way of work programmes considering criteria set out in this Regulation.

Among other issues, the General Secretariat of the Council document 7207/1/19 states, that to favour an integrated development of innovative cycle it is necessary to ensure complementarity between the innovative solutions developed in the context of the Union research and innovation framework and the innovative solutions deployed with support from the Connected Europe Facility. The exchange of information and data between Horizon Europe and the Connecting Europe Facility will be facilitated, for example by highlighting technologies from Horizon Europe with a high market readiness that could be further deployed through the CEF.

This important provision applies directly to the ePIcenter project. Because we have an ambitious goal to create a new logistics concept and tools (with the possibility to adopt them in the different areas) that allow end users to benefit from technology without massive investment in hardware or infrastructure. Also, these tools will promote a high level of collaboration between different stakeholders. Together it would be rational to include macro-regional programmes in addition to the CEF and Horizon Programme for the exchange information on innovations. At joint events promotion of innovations could be organised.

At the same time ePIcenter will also contribute to the implementation of the specific objectives in the transport sector, including development of efficient, interconnected, multimodal networks and tools and promotion of smart, interoperable, sustainable, inclusive, accessible, safe and secure mobility.

1.3 Relevant IMO initiatives

1.3.1 Maritime Transport Policy initiatives

As a demand derived function at a global trade market, maritime transport and related sea-borne trade is one of the main engines to global economy growth and development. Maritime transport is an essential part of the blue economy, which has great potential in promoting economic growth and social inclusion, ensuring the economy and sustainability of ocean and coastal areas. It is a vital element in achieving the sustainable development goals. However, many countries are not sufficiently prepared to take advantage of this potential. They should invest in development of technical infrastructure on the national level, become effective stakeholders in the blue economy, and utilise the opportunities offered therein.

Taking all this into consideration, national authorities should create a coherent and coordinated National Maritime Transport Policy (NMTP) which comprehends more guidelines for actions that will enable national governments in achieving the planed maritime vision. These actions may vary among regulations in transport flows, volumes, trade, maritime safety measures, environmental protection principles, prevention of sea pollution, port management regulations, port and maritime sector agencies competition rules, state aid for development of facilities and infrastructure, operation and organization of national maritime administrations and agencies as well as inter/national maritime market relations and governance. To make this policy viable and coherent there is a need to involve many relevant entities at the national level such as ministries of Transport, Environment, Economy/Finance, Defence, port authorities and administrations, coast guards, ship-owner/leisure boats association, fisheries and sea economic exploitation actors, NGO, private sector and finally maritime experts planning divisions which include drafting and adopting the legal documents, regulative, and taking implementation actions. The representatives of these institutions need to identify and assess the country's

national maritime interests and initiatives within the legal and economic environment. The status in the maritime sector, gaps, where the country is and where it wants to be in 10 to 20 years should be investigated. Many countries need to draft the legislation towards achieving the goals set in maritime policy. After that begins the process of detailed implementation the guidelines, law, and policy enforcement, monitoring the progress of implemented actions and finally assessment and validation of taken actions in terms of accomplished results.

To make this process easier and more accurate, the International Maritime Organization (IMO), as globally competent maritime entity, provides support to countries to define the maritime transport policy goals, make the analysis/assessment of current state in national/regional maritime affairs environment and suggest realistic steps to take towards achieving compliance with international standards. IMO provides help in aligning the national maritime transport policy with international regulation, convention, and treaties which regulate essential aspects of sea-borne trade and navigation. Also, it is expected that these national maritime transport policies will lead to better implementation of IMO conventions, which means that IMO provide help and expertise to all interested countries in establishing the national maritime transport policy. Within the training packages for governmental officials and senior personnel the IMO assists the countries to shape their own maritime policy compliant to international regulations and conventions with the aim of paving the way for modern maritime governance, timely application of new ICT technologies, enhanced maritime safety and security, environmental protection, adequate maritime education and training, helping these countries be an effective participant in maritime industry sector and utilise all the economic potential of the sea.

Specifically, NMTPs are not only important for the development of the maritime transport sector but could also be crucial for the implementation of the United Nations Sustainable Development Goals (SDGs), particularly at the country level as these policies, together with the utilization of the Country Maritime Profiles (CMPs), could serve to mainstream IMO's technical assistance work on the SDGs. Through NMTPs and CMPs, the IMO could assist Member States in the development of their national plans to reflect the maritime sector in the SDGs' implementation. This would also allow them to source the United Nations Development Assistance Frameworks (UNDAFs) at the country level. In that regard and with a view of enhancing the assistance to Member States in the development, adoption, and review of NMTPS, maritime transport policy training is once again being included in the IMO Integrated Technical Cooperation Programme (ITCP) global programme for capacity building and training. This should enable the Organization to favourably respond to the increasing number of related technical assistance requests from Member States[44].

It is evident that NMTPs strengthen maritime capacities and contribute to the achievements of the SDGs at state level. Together with the Country Maritime Profiles (CMPs), they could facilitate the inclusion of the maritime sector and industry in national development plans when formulating the United Nations Development Assistance Frameworks (UNDAFs) at the country level. Member States are thus encouraged to embark on the formulation and adoption of NMTPs to manage and develop the maritime sector in a sustainable manner.

Since 2015, when the Secretariat introduced the concept of aiding Member States in the formulation of NMTPs and initiated related action through the delivery of related training events, a total of 14 national and regional workshops and seminars have taken place worldwide. Furthermore, three seminars on maritime transport policy were delivered to the students pursuing post-graduate studies at the IMO International Maritime Law Institute (IMLI)[45].

In anticipation of the development of Sustainable Development Goals (SDGs), IMO developed a concept of a Sustainable Maritime Transportation System (SMTS) in 2013 and dedicated the theme for the 2013 World Maritime Day to sustainable shipping. On December 2015 the 29th session of the IMO Assembly adopted a resolution on the Strategic Plan for the Organization which considered implementation of the 2030 Agenda, within the IMO's Strategic Plan for the six-year period 2016-2021. One of the Strategic Directors states:

„IMO will actively promote its role as the primary international forum on matters within its competence, and ensure and strengthen the linkage between safe, secure, efficient, and environmentally friendly maritime

transportation, the development of global trade, the world economy, and the realization of new United Nations development agenda and the Sustainable Development Goals (SDGs)".

The aim of 2030 Agenda for Sustainable Development is to integrate the Country Maritime Profile, General Maritime Policy, Maritime Transport Policy. Particularly, among all SDG, we highlight the Goal 14 which states: *„Conserve and sustainability use the oceans, seas, and marine resources for sustainable development "*. Therefore, according the goals set up, marine sectors are expected to expand dramatically in the coming years, with most doubling or quadrupling in size by 2030 and other growing to ten times or more their current size or larger (e.g. estimated blue economy growth in coastal tourism and oil and gas industry for 2 times, respectively, offshore wind plants 40 times, shipping industry and fisheries 4 times, respectively, sea-bed mining 10-100 times, etc.).Therefore, It is important to showcase some key facts emerging from Blue Economy development, as depicted in the figure below[46].

The potential Role of IMO (the Organization) for SDG implementation and follow-up could be mapped for contribution in advancing adoption of maritime-related indicators for SDG implementation. IMO will support implementation and monitoring of the maritime-specific targets of the 2030 Agenda in national and regional context. Further to this, IMO will provide support to countries in conducting baseline assessments, share experiences with monitoring indicators, identify data gaps, encourage whole of government approaches, feed into global and thematic review and monitoring structures.

Maritime policy in general, and beside the transport commercial aspects, comprehends important dimensions covering the maritime safety and security provisions for fleet, navigation, communication related to maritime Search and Rescue, data harmonization and trade/transport facilitation directives, which will be elaborated in detail in following sessions.

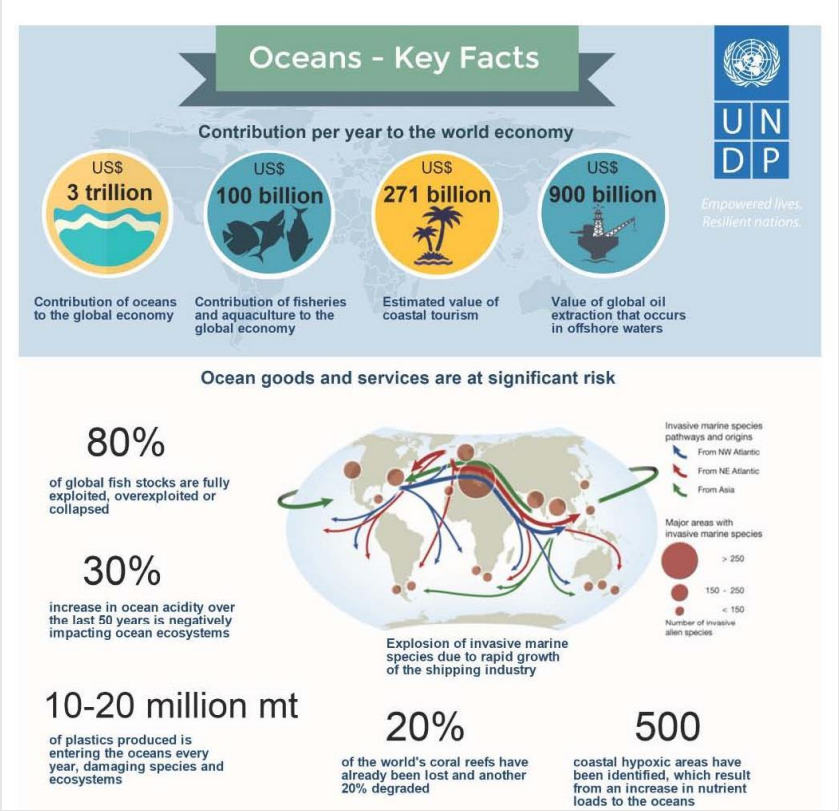

Figure 1. Oceans and blue economy essential facts[46]

1.3.2 Maritime and fleet safety provisions

Following the analysis of maritime transport policy provisions, the maritime safety in transport and navigation represents one of the major concerns of IMO. The international conventions that most clearly address safety at sea, such as the SOLAS Convention, focus on the relationship between private parties (usually carriers) and public authorities. That is obviously an essential part of any solution to the problem of casualties related to cargo fires. But in the context of cargo fires, a party's ability to fully comply with safety regulations is often dependent on the relationship between a carrier and the shipper or other cargo interests. The Rotterdam rules (RR) govern that contractual relationship, and thus complement the work of conventions such as SOLAS.

The Rotterdam rules were designed to modernize the international regime governing contracts for the carriage of goods by sea and they do so in several different ways. The Rotterdam rules recognize the importance of each party providing timely and accurate information, and it facilitates the most efficient method for doing so. Because onboard fires often result from a shipper's failure to provide timely and accurate information to the carrier - or even a carrier's failure to provide timely and accurate information to the shipper - having a regime that requires and facilitates the timely exchange of information is an important factor in addressing the problem.

Turning to the specifics, multiple provisions in the Rotterdam Rules explicitly require the exchange of timely and accurate information. Article 29(1)(a) goes beyond the existing carriage conventions (such as the Hague-Visby and Hamburg Rules) to require a shipper to "provide to the carrier in a timely manner" the "information, instructions and documents" needed for "the proper handling and carriage of the goods, including precautions to be taken by the carrier or a performing party," whether the goods have been recognized as dangerous in the IMDG Code. In countries where local authorities have enacted safety measures in addition to the international requirements, article 29(2) preserves their force and article 29(1)(b) requires the shipper to timely provide the carrier with the "information, instructions and documents" needed to comply with those local regulations.

More importantly, the Rotterdam Rules extend the traditional requirement to furnish information at the beginning of the process. Article 28 establishes a new procedure to enable either the carrier or the shipper to obtain information or instructions from the other whenever necessary during the process. If a problem arises in the middle of a voyage, for example, or if a carrier develops suspicions about an unusual shipment, article 28 - unlike any of the existing carriage conventions – provides a mechanism that enables the carrier to obtain the information or instructions that it needs to avoid a serious incident.

It is also important to mention that The Rotterdam Rules promote safety by facilitating electronic commerce. In addition to its safety-specific provisions, the Rotterdam Rules would help solve the underlying problem that the Correspondence Group is addressing in a second, less obvious, way. Everyone recognizes that the non-declaration or misdeclaration of dangerous goods is a principal cause of the increasing number of casualties related to container fires. But even if a shipper properly declares the cargo, the information must still be conveyed to operational personnel in a timely manner if it is to be effective. In a system that relies heavily on paper documents information may be conveyed inaccurately, it may not be accessible to those who need it, or it may not be available in time. Inaccurate, inaccessible, or untimely information also causes serious incidents.

The obvious solution to the over-reliance on paper documents is to instead use electronic equivalents. If the ocean shipping industry used a system based on blockchain, for example, everyone who needed to know the information or instructions furnished by the shipper would almost immediately have access to that information in the form furnished by the shipper – even if the goods pass through multiple intermediate parties before reaching the ocean carrier. Unfortunately, the industry has been slow to adopt electronic equivalents to traditional shipping documents. A principal reason is that the existing carriage conventions do not provide the necessary legal framework to support electronic commerce. The Rotterdam Rules, in contrast, were specifically designed not only to accommodate electronic commerce but to facilitate it. Indeed, the original proposal to undertake the project came from the United Nations Commission on International Trade Law (UNCITRAL) E-Commerce Working Group[47].

Apart from commercial and technological aspects described in RR, another important aspect of maritime and fleet safety is related to the Maritime Safety Information exchange process which requires integration with a mobile-satellite system, based on a specific SOLAS provision. Therefore, SOLAS regulation IV/12.2 states that "*Every ship, while at sea, shall maintain a radio watch for broadcasts of maritime safety information on the appropriate frequency or frequencies on which such information is broadcast for the area in which the ship is navigating*".

In 2013 a submission was made to the Maritime Safety Committee (MSC), at its 92nd session, for evaluation of the Iridium mobile-satellite system against the criteria for provision of mobile satellite communication systems in the Global Maritime Distress and Safety System (GMDSS). In 2018 the MSC, at its 99th session, adopted resolution MSC.451(99) on Statement of recognition of the maritime mobile satellite services provided by Iridium Satellite LLC, including Iridium's enhanced group calling service. It was noted an operational manual, like the International SafetyNET Manual, was necessary. Since then, the Iridium enhanced group call service has been named "Iridium SafetyCast".

At its 101st session (5 to 14 June 2019), the Maritime Safety Committee approved the Interim Iridium SafetyCast Manual. This Manual has been produced to describe the Iridium system and its capability for promulgating

maritime safety information (MSI) and search and rescue (SAR) related information. The Iridium SafetyCast service is a satellite-based service for the promulgation of MSI, navigational and meteorological warnings, meteorological forecasts, SAR related information and other urgent safety-related messages to ships. The Iridium SafetyCast service fulfils an integral role in the Global Maritime Distress and Safety System (GMDSS) developed by the (IMO) and incorporated into the 1988 amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, as a requirement for ships to which the Convention applies. The Iridium SafetyCast service provides shipping with navigational and meteorological warnings, meteorological forecasts, shore-to-ship distress alert relays, SAR related information and other urgent information in accordance with SOLAS requirements. It provides an automatic method of broadcasting messages to both fixed and variable geographical locations in all sea areas, including the means of disseminating MSI to coastal warning areas not covered by the International NAVTEX service. It is suitable for use in all sizes and types of ships. The components of this system and its links are shown in the figure below.

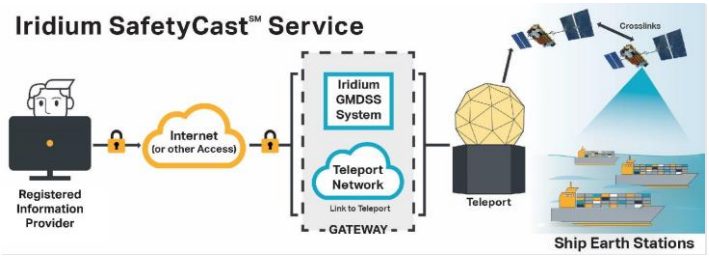

Figure 2. Basic concept of the Iridium SafetyCast service[49]

The Iridium SafetyCast service offers the ability to direct a message to a given geographical area. The area may be fixed - as in the case of a NAVAREA/METAREA or coastal warning area - or it may be a user-defined area (circular or rectangular). A user-defined area is used for messages - such as a local storm warning or a shore-to-ship distress alert relay - for which it is inappropriate to alert ships in an entire NAVAREA/METAREA[48]. Messages are submitted by registered information providers via an Iridium gateway, which is a central system responsible for managing GMDSS communications within the Iridium Network. Messages are broadcast according to their priority - i.e., distress, urgency, or safety. Aboard ships messages are received by type-approved Iridium Ship Earth Station (SES) EGC receivers[49].

Further to the document related to Iridium SafetyCast service, the IMO - The Maritime Safety Committee, at its 101st session (5 to 14 June 2019), also approved the *Interim guidance on technical requirements for Fleet Safety*, prepared by the Sub-Committee on Navigation, Communications and Search and Rescue. Some basic telecommunication elements of this guidance should be clarified. The key one is the Global Maritime Distress and Safety System (GMDSS), which represents a radiocommunication system based on satellite and terrestrial technology designed to improve communications related to distress and safety of life at sea. It is the responsibility of national Administrations to determine whether a radio installation onboard a ship meets the SOLAS requirements. Furthermore, National Type Acceptance testing for SOLAS equipment is usually based on GMDSS specifications and procedures prepared by IMO and the International Electrotechnical Commission (IEC) on their behalf. Other national or regional specifications may be invoked as well.

Another important element is the Enhanced Group Call (EGC) acting as a broadcast of coordinated maritime safety information and search and rescue-related information to a defined geographical area using a recognized mobile satellite service. The Inmarsat SafetyNET (II) system allows terrestrial information providers to broadcast messages or data to an approved Inmarsat SES with EGC receivers. An EGC receiver is defined as a receiver function in the Maritime Safety Terminal (MST) connected to the FleetBroadband Terminal via the MST interface

(MSTI). This MST provides an EGC capability in addition to ship-to-ship and ship-to-shore messaging capabilities. The mandatory capabilities of EGC receivers for SOLAS applications are[50]:

1) Continuous reception of a broadcast channel and processing of the information according to the EGC message protocol.
2) Automatic recognition of messages directed to fixed and defined absolute geographical areas and service codes as selected by the receiver operator or based on input from navigational equipment.

EGC receivers are a function of the MST that is connected to a FleetBroadband terminal. FleetBroadband terminals permanently monitor the broadcast system information based on a dynamic allocation of channel frequencies.

1.3.3 Navigation, Communication and Maritime Search-and-Rescue

At MSC 99 Session, it was decided to consider Quasi-Zenith Satellite System (QZSS) as a further part of WWRNS (Worldwide Radio Navigation System) to develop performance standards for a shipborne satellite navigation system receiver equipment in a functional and generic way (MSC 99/22). QZSS is an independently operated Asia-Oceania regional satellite navigation system operated by Japan. It is compatible and inter operable with other navigation satellite systems. QZSS consists of the satellite system and the ground system (master control stations, tracking stations and monitoring stations). The QZSS 4-satellite constellation has been in full operational capability since November 2018 and three satellites will be added in a 4-satellite constellation and the operation of the 7-satellite constellation will be started in Japan from 2023 or later. The presented approach supports seamless integration and harmonization of receivers for other and future radio-satellite navigation systems and technologies into one common performance standard.

The proposed performance standards consider the strategic direction - SD 2, to integrate new and advancing technologies in the regulatory framework (Resolution A.1110(30)). SD 2 urges the Organization to review existing instruments to ensure that the application of new technologies to international shipping are conducted in a manner which continues to ensure the highest practicable standards for maritime safety, efficiency of navigation and prevention, and control of marine pollution from ships. Further the proposal is based on the E-navigation strategy implementation plan (SIP) – update 1 (MSC.1/Circ.1595), where e-navigation is intended to meet present and future user needs through harmonization of marine navigation systems.

In the last decades, a variety of performance standards for radio-navigation equipment have been developed and adopted by the Organization to ensure that IMO instruments are keeping pace with emerging user needs and technological progress: BeiDou receiver equipment in 2014 (resolution MSC.379(93)), multi-system shipborne radio-navigation receivers in 2015 (resolution MSC.401(95)), an amendment in 2016 (resolution MSC.432(98)), and Indian regional navigation satellite system (IRNSS) receiver equipment (resolution MSC.449(99)) in 2018.

Recognizing that Global and Regional Navigation Satellite Systems (GNSS and RNSS) are subject to evolution to meet current and emerging user needs, and that the updating and adjustment of performance standards for radio-navigation equipment becomes a recurring task, a practical approach is needed to perform this in a more efficient manner. The purpose of these performance standards is to specify requirements of shipborne satellite navigation systems receivers (referred to as "radio-navigation receiver") that provide position, navigation, and time data and associated information to bridge teams and shipboard applications (e.g., ECDIS and AIS). These performance standards establish a framework for the specification of general and specific requirements, considering differences in installed equipment and implementation options, measuring principles, supported functionalities, signal sources as well as usability in specific regions. These performance standards summarize and harmonize the requirements for shipborne radio navigation receivers providing position-, navigation-, and time data, and associated information[51].

Following the global requirements in maritime safety, it is important to highlight the consideration of the use of public mobile broadband communication and related technical standardization in the context of maritime safety.

The 3rd Generation Partnership Project (3GPP) - consisting of several telecommunication standard development organizations - has approved TS (Technical Specification) 22.119 (TS stage 1 document for release 16) in December 2018, which includes service requirements for maritime 5G mobile communication. Delegations at the 15thmeeting of the Joint IMO/ITU (International Telecommunication Union) Experts Group held in July 2019, agreed that IMO should be more actively involved in the work of the 3GPP on technical standardization for public mobile networks. In this regard, the Group invited IALA to provide relevant information to IMO. It has also been noted that public communication equipment is becoming increasingly widely used by non-SOLAS ships, such as leisure boats and fishing boats. As a result, IALA submitted an information document to NCSR 7 (NCSR 7/INF.6) on the international standardization status.

The international community is advancing in a new direction of maritime safety and marine environment protection by combining ICT technologies such as e-navigation and Maritime Autonomous Surface Ships (MASS). To introduce these new technologies, it is necessary to consider ways to utilize new digital communication technologies in addition to the existing maritime communication systems. Public mobile communication equipment is being widely used by non-SOLAS ships such as leisure boats and fishing boats.

Up until now, public mobile communication technology has been widely used mostly for commercial purposes at sea and there has been no in-depth discussion or review at the IMO level. However, now is the time for IMO and ITU experts to review and discuss the use of various new digital communication technologies, such as LTE (long-term evolution) and 5G, as ICT and public mobile communication technologies are being actively introduced internationally in the fields of maritime and shipping.[52]

1.3.4 Data Harmonization and FAL Documentation

Two main directions of efforts toward increasing the data harmonization and digitalisation transition that we consider here are the electronic certificates for bunkering and mandatory reporting documents related to vessel information submitted to state maritime and port authorities.

Norway has started to develop a digital solution for issuing electronic CLC and Bunkers certificates under the International Convention on Civil Liability for Oil Pollution Damage of 1992, and the International Convention on Civil Liability for Bunker Oil Pollution Damage of 2001, respectively. Currently, the process of issuing the above-mentioned certificates starts with the shipowner's insurance company sending the Blue Card to the shipowner, who then requests the NMA to issue certificates to his ship or ships in a Norwegian register. The purpose of these certificates is to guarantee that the insurer has the financial capacity to meet the requirements of the relevant conventions. At present, these certificates are issued manually, and the process requires a high degree of human accuracy. The process is also time-consuming, in that the companies must relate to both their insurance company and the flag State to be issued with a certificate. The new proposed solution involves a machine-to-machine validation and processing of the applications. In the outlined new scheme, the process of issuing and signing certificates and the format should be digitalized. This also means that the communication between insurers and the flag state will be digital and largely automated. Additionally, the electronic certificates must be issued in accordance with the Guidelines for the use of electronic certificates (FAL.5/Circ.39/Rev.2). The new digitalized solution for issuing CLC and Bunkers certificates will require less work for shipping companies, insurance companies and the flag state. The solution will also increase the quality and data security, and result in faster production, issuance, and distribution. The main benefit for all parts is that information is registered only once, and that this data can be reused. The individual interested parties will, inter alia, get the following benefits from a digitalized solution[53]:

- For shipping companies:
    - The NMA can provide certificates for the shipping companies 24/7, including weekends.

    - Timesaving, avoiding many manual processes.
    - The company does not need to apply to the flag state for CLC/Bunkers certificates (which they do today).
- For flag states:
    - Increasing the efficiency of work processes (saving time, but also material costs such as postage and paper).
    - Timely issuance of certificates, high quality of data.
    - Prevention of detentions due to missing or inaccurate certificate.
- For Port States:
    - Simple way of verifying that a certificate is valid (through QR code and website). Real-time update if a certificate is cancelled.

The second meeting of the Expert Group on Data Harmonization (EGDH) held from 5 to 9 October 2020, prepared the draft data set on "Acknowledgement receipts'' and made substantial progress in the consideration of the data sets on "Stowaways'', "Information of Ship Certificates" and "Ship reporting systems (Resolution A.851(20))" (EGDH 2/17, paragraphs 10.1.1, 10.1.2, 10.1.3, 10.2.2). In addition, FAL 44 had noted that the modelling of the "Maritime Declaration of Health" data set was not finalized and would be discussed at the next session of EGDH, as well as potential improvements to the modelling (EGDH 2/17, paragraph 2.1.1). Following EGDH 2, the modelling team met twice to work on the modelling and mapping of the new data sets. The modelling of the data sets "Maritime Declaration of Health" and "Acknowledgement receipts" was finalised and will be reported to FAL 45[54].

The Compendium on Facilitation and Electronic Business (Compendium) serves as a reference manual for creating and harmonizing the systems needed to support transmission, receipt, and the response of information required for the arrival, stay and departure of the ship, persons, and cargo via electronic data exchange. The Compendium - extended by FAL 42 to include additional e-business solutions beyond those related to the FAL Convention - also addresses port logistics operational data for digital exchange between the port and the ship.

In the Compendium, the Facilitation Committee constructs the IMO Data Set to identify and define all the data elements related to reporting information requirements and the IMO Reference Data Model to establish the underlying hierarchical data structure used in electronic data exchange.

The IMO Data Set combined with the IMO Reference Data Model promote harmonization among the relevant international standards used for electronic business from the World Customs Organization (WCO), the United Nations Economic Commission for Europe (UNECE), the International Organization for Standardization (ISO TC 8) and other organizations. Harmonization stimulates the implementation of the single window concept as a high-level priority of the Organization and supports interoperability among single window systems. Single window processes enhance efficient international trade by simplifying communications among stakeholders and creating an electronic information environment that promotes accountability, transparency, and informed decision-making.

The Facilitation Committee standardizes the nature and scope of information to be submitted and processed as required by the annex to the Convention on Facilitation of International Maritime Traffic, 1965 (Convention). The Maritime Safety Committee (MSC) standardizes the security-related information submitted as required in SOLAS regulation XI-2/9.2.2 through MSC/Circ.1305, Revised guidance to masters, companies and duly authorized officers on the requirements relating to the submission of security-related information prior to the entry of a ship into port. The Marine Environmental Protection Committee (MEPC) standardizes the information submitted for waste delivery in port through MEPC.1/Circ.834/Rev.1, appendix 2, Standard format of the Advance Notification Form for waste delivery to port reception facilities. A Compendium is a tool for efficient, electronic transmission of all this vital information in a way intended to minimize the burden on shippers, crews, agents, port authorities, and other stakeholders.

This Compendium promotes and supports electronic data exchange conducted using standardized data models and their implementation guidelines. Electronic business has clear, quantifiable benefits over a paper-based environment in most cases. These globally accepted benefits led to the requirements for electronic reporting in the annex to the Convention. The holistic value of electronic data exchange is an equally important part of the philosophy promoted in this Compendium. The data submitted through electronic data exchange leads to wisdom, defined for the purposes of this Compendium as "the willingness and ability to take the most appropriate action based on what is known". That is, data leads to good decision-making by the port authority, Administration, or other organization that receives the data. This decision-making could relate to a range of topics beyond the usage in the Convention, such as targeting ships for port state control examinations, assigning resources, identifying trade trends, and developing public policy.

Common definitions promote harmonization - ordering information with common structures - promotes interoperability and directing knowledge with common values creates communities with shared goals. These communities might be the agencies in an Administration, collections of ports, or regional and international groups. Harmonization, interoperability, and community are crucial to the Organization's goals of leveraging technology, minimizing burdens on mariners, promoting the implementation of the single window, and helping stakeholders meet international standards. Ship reporting necessitates electronic transmission of sensitive, private, and proprietary information including - but not limited to - ship location and destination, cargo types and amounts, passenger names and identity data, and security-related information[55].

The Group responsible for data harmonization noted the following decisions adopted by FAL 45 (1 to 7 June 2021):

1) the Committee had approved the new version of the IMO Compendium on Facilitation and Electronic Business (FAL 45/WP.5, annex 2).
2) FAL 45 had approved the revised working procedures (FAL 45/WP.5, annex 3); the revised priority list of data sets (FAL 45/WP.5, annex 4), and the terms of reference of EGDH (FAL 45/WP.5, annex 5).

The Group recalled that this data set covered mandatory ship reporting when a ship enters a sea area as set out in Resolution A.851(20) ‘General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants’ and that progress had been made on the data set already in EGDH 2 and EGDH 3.

During the discussion mentioned above, the Group noted that it was very important to limit the changes to existing data elements of the IMO Reference Data Model and that these changes should be backwards compatible to allow standard organizations to finish their mappings and keep them up to date. The Group discussed at length whether there was a use case to include the data elements ‘radio station name’ and ‘radio station frequency’, related to voice communications in the IMO Data Set. In this context the group also discussed the possibility to include an additional data element related to MMSI number. Since the purpose of the IMO Compendium was to facilitate electronic data exchange machine to machine or ship to shore through a maritime single window, the Group agreed to delete these data elements from the data set since this information was not transmitted electronically and therefore it was not relevant in the context of the IMO Compendium.

The Group noted that BIMCO was developing an electronic Bill of Lading standard that could later be considered for the IMO Compendium since it was important to digitalize maritime trade. The Group also noted that UNECE had developed a maritime Bill of Lading data set as part of the UN Transport and Trade Connectivity in the age of pandemics (UNTTC) initiative. The Group however recognized that the bill of lading was not related to the data set under consideration.

The Group supported in general the inclusion of the data set related to “Ballast Water arrival reporting” in the IMO Compendium and agreed to follow the 2017 Guidelines for ballast water exchange (G6) adopted in resolution MEPC.288(71) when considering the data set.[56]

On 8 April 2019, the IMO FAL Convention mandatory requirement for national governments to introduce electronic information exchange between ships and ports entered into force. In June 2020 IAPH, together with major international port and shipping industry associations, issued a call for action towards the acceleration of digitalization in the maritime trade and logistics area. Port community interactions comprise physical interactions - such as cargo handling operations, vessel-related services and supplies, and multimodal transfers - as well as exchanges of data that facilitate the clearance of cargo between jurisdictions. Being part of larger transport and logistics supply chains and representing clusters of companies and businesses in themselves, ports are well-placed to fully grasp the potential generated by the latest wave of technological innovation and integration, so that physical and data interactions occur in a safe, secure, efficient, and sustainable manner. The call for action, circulated by IMO Circular Letter No.4204/Add.20, sets nine priority areas for accelerating digitalization. We give some of them as follows in the summarized form[57]:

- Enforcement of already mandatory requirements defined in the International Maritime Organization's Facilitation (IMO FAL) Convention to support transmission, receipt, and the response of information related to arrival/departure, cargo, persons, and documentation via electronic data exchange, making the transition to full-fledged Single Windows.
- Harmonization of data standards beyond the IMO FAL Convention to facilitate sharing of port- and berth-related master data for just-in-time operation of ships.
- Introduction of Port Community Systems and secure data exchange platforms in the ports of all Member States of IMO.
- review existing IMO guidance on Maritime Cyber Risk Management and discuss cyber risks in ports.
- Facilitating the implementation and operationalisation of digital port platforms under secure data sharing protocols connected with the hinterland Supply Chain.
- Setting up a capacity-building framework to support smaller, less developed, and understaffed port communities.

The FAL Convention includes in its Standard 2.1 a list of documents which public authorities can demand of a ship and recommends the maximum information which should be required. Public authorities shall not require additional information. For all the data sets below, and for only those, national governments are required to implement systems for enabling their electronic transmission as of 8 April 2019. The aim is to facilitate the clearance of vessels, cargo, passengers, and crew[58]:

- IMO General Declaration (FAL Form 1),
- Cargo Declaration (FAL Form 2),
- Ship's Stores Declaration (FAL Form 3),
- Crew's Effects Declaration (FAL Form 4),
- Crew List (FAL Form 5),
- Passenger List (FAL Form 6),
- Dangerous Goods Manifest (FAL Form 7).

Three additional declarations entered into force on 1 January 2018:

- Security-related information as required under SOLAS regulation XI-2/9.2.2,
- Advance electronic cargo information for customs risk assessment purposes,
- Advanced Notification Form for Waste Delivery to Port Reception Facilities.

To examine the implementation of electronic information/data exchange and the current conformity level with the FAL requirements, IAPH has launched a large survey for all port operators and responsible governmental bodies, which was supervised by the IAPH Technical Committee on Data Collaboration, during the month of October 2020.

Most respondents struggle to conform to the mandatory requirement on electronic data exchange under the FAL Convention. Approximately a third of the global sample of ports has not commenced the process of

implementing respective electronic data exchange systems. Of those that have, another third is either designing or implementing their system with only the final third being operationally active.

The survey confirms the complexity of clearance processes in ports due to the number of different authorities involved - each with their roles, responsibilities, and data needs. The major barriers to conform with the FAL requirement for electronic data exchange are twofold: firstly, multi-stakeholder interests in port communities and established practices and cultures need to be addressed to enable the sharing and reuse of data, which is key for achieving efficient electronic reporting and clearance of vessels, cargo, crew, and passengers. Secondly, the legal framework is a barrier as it can depend on competing and/or overlapping public administrations and governmental agencies at the municipal, state, or national level[59].

1.4 Relevant initiatives in maritime transportation

1.4.1 IPCSA Mission and Overview

Among the worldwide relevant institutions in the field of maritime affairs, IPCSA (International Port Community System Association) plays a very important role in shipping and port logistics concerning the port community systems of users. This organisation is competent for developing and supporting the initiatives for trade facilitation and greater transparency in supply chain and logistics flows. Among these initiatives IPCSA prioritises new emerging technologies with maritime applications: Blockchain Bill of Lading, a logistic visibility task force and Network of Trusted Network – NoTN.

Officially, IPCSA was launched on 15th June 2011, and is classified as European Economic Interest Grouping (EEIG) governed by EEC Regulation 2137/85 (the EEC Regulation) and by the laws of England. Meanwhile, the association has significantly increased its membership, which contributed to the image of the organization and raises its capacity in providing high-quality consultancy services and expertise in electronic exchange of maritime information and data, seaborne trade digitalisation and cargo flow reporting and documentation. This community gathers about 50 members among the single window operators, port- and cargo community system operators, seaport, and airport authorities and provides consultative services to IMO and UNECOSOC. The mission of IPCSA is defined as follows:

> *"To act in the common interest of IPCSA members to influence public policy at the international level, in order to promote the electronic exchange of information to enable seamless and efficient trade logistics processes. This will be achieved through lobbying, practical initiatives and projects, as well as engagement with the global, regional, and national logistics communities and relevant public bodies." [60]*

In broader sense, IPCSA provides guidelines, information sharing and exchange of knowledge concerning the new ICT technologies implementation in port operation and commercial sector. To extend its scope of competencies and strengthening its relations IPCSA collaborates with various organisations involved in international trade and maritime transport such as customs, international organisations, public agencies, and authorities, forwarding companies, port- and terminal operators, and other relevant stakeholders. Also, IPCSA gives a guidance and consultative/informative support to regulatory bodies, funding organisations, inter-governmental agencies, and private sector organisations within maritime community. The focus of IPCSA is related to international standards and technologies, harmonization, single window development, trade facilitation, port community system advancing, cooperation with air communities, and protection of all group interests. For this reason, IPCSA uses a collaborative approach together with international bodies such as the World Customs Organisation (WCO), the International Maritime Organization (IMO), UN/CEFACT, the International Standardisation Organisation (ISO) and the International Civil Aviation Organisation (ICAO).

IPCSA has three main areas in which it participates and takes specific actions for: Port Community System (PCS), Single Window (SW) and trade initiatives. The PCS is a standardized electronic communication platform with intelligent-, reliable-, and secured information exchange services; enabling the wide connection of involved key players in port and maritime logistics such as authorities, shipping companies, and cargo agencies. This platform is a modular system comprehending various ports with different sizes and capacities to integrate all necessary functions and information and to provide it with a port business environment. Developed according to the port users' needs, a PCS collects and delivers data related to exports, imports, transhipments, hazardous- and other cargo types, maritime statistics, and consolidation and reporting of all activities. The main benefits of a PCS are higher business efficiency, speed of operations in ports, reduction of long procedures, electronic handling of all information regarding import and export of containerised goods, customs declarations, fast EDI-based information exchange, processing of dangerous cargo, and statistical processing of realized cargo throughput. The modern maritime industry - and especially big world ports - fully implement the PCS as an IT logistic

infrastructure for hosting the information from many stakeholders through which the exchange of mandatory data with authorities is conducted in easier and more efficient, reducing a frequency of contact moments for each container or cargo unit. Analogue to PCS, there are Air Community Systems (ACS) and Cargo Community System (CCS) in the airfreight industry, ensuring the timely distribution of cargo and its relevant data.

Furthermore, these systems and platforms represent the base for development of advanced and more practical networking platform - known as the Single Window - designed by national governmental authorities for mandatory submission of reports from shipping/forwarding/port operator companies via single entry-point for vessel- and cargo data. IPCSA provides the expertise and knowledge on practical implementation of customs rules to ensure their adequate inclusion in information flows about the cargo movements from one transportation mode to another, i.e., in sea- and airports. Regarding the Single Window implementation, IPCSA provides support and advice in phased introduction of a SW system in the administrational structures, its creation, design, and practical daily operations. Therefore, the participation of this Association is relevant in constituting the Global and Regional Guidelines for the Single Window as well as the European Single Window environment (ESWe) for the European Union.

Furthermore, IPCSA participates in the definition of suitable terms of references for experts' engagement for the development and introduction of SWs in national legal- and operational frameworks. Regarding the air communities, IPCSA enables interconnectivity among air cargo and hinterland logistics with linkage of airports among themselves. One of the most important roles of IPCSA is the general protection initiative which means that this organisation defines, identifies, monitors, develops, and reviews the Port standards for authorities with protection of developed ITFDGN, BERMAN and WASDIS EDIFACT messages.

Also, IPCSA supports administrative institutions with assistance in the implementation of relevant regulations covering the trade of goods and transport facilitation. This is made through Single Window platforms which can be designed to host data structured in the form of mandatory reports obtained by several parties in maritime trade and navigation, customs procedures, land transportation, and forwarding business.

1.4.2 UN/EDIFACT Standard and XML messages

There are multiple international data standards in use in maritime trade. Among many of these protocols, we will elaborate the two most relevant ones: UN/EDIFACT and XML.

First, it is necessary to introduce the top UN institution, United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), responsible for the launching, development, and governance of communication standards and protocols between various entities in the world trade business. UN/CEFACT's mission is to improve the ability of business-, trade-, and administrative organizations - from developed, developing and transitional economies - to exchange products and relevant services effectively. Its focus is on facilitating national and international transactions through the simplification and harmonization of processes, procedures, and information flows - and so contribute to the growth of global commerce. UN/CEFACT does not have a legislative role in international shipping, but it develops and maintains specifications that are referenced in legislation and other standards. The most relevant work for shipping is the work on UN/EDIFACT and related standards, e.g., the "Technical Note on Terminology for Single Window and other electronic platforms" which implies five key elements of the definition of a single window:

1) parties involved in trade and transport.
2) standardized information and documents.
3) single entry point.
4) fulfilling regulatory requirements; and
5) single submission of individual data.

This includes a comprehensive data model covering all modes of transport: the Multi-Modal Transport Reference Data Model. This data model not only covers all the potential needs of the transport and logistics industry but also provides links to all other sectors of the international supply chain including regulatory procedures.[61]

The global dimension of international trade entails a need for global Electronic Data Interchange (EDI) applications. The coordination process for the development of EDI can be especially elaborate and time-consuming as it is generally based on consensus and requires the cooperation of a wide range of entities. Thorough analysis of business transactions of the private sector clearly shows the very complex character of most of the transactions which usually contain several elements related to public administration and vice versa. This complex interrelationship between the many parties involved in every single business transaction implies a need for further improvement of the information flow by use of modern techniques, such as Electronic Data Interchange (EDI). This represents the electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data. In this form, the EDI Message means an approved, published, and maintained formal description of how to structure the data required to perform a specific business function, in such a way as to allow for the transfer and handling of this data by electronic means.

A clear tendency can be observed in the development of EDI standards, following user requirements, from proprietary solutions to standards, from sector-specific to inter-sectoral, and from local, national, and regional to international standards. The neutrality of the United Nations (between nations as well as business sectors), accompanied by a global coverage, might have been decisive for the fact that UN/EDIFACT (International Standard Syntax Rules, Trade Data Interchange Directory and UN Standard Messages – UNSMs) is being developed and maintained within a United Nations organization. It could be defined that UN/EDIFACT is a user application protocol for use within application systems for data to be interchanged compatible with the Open Systems Interconnection (OSI) model, with a purpose for electronic data interchange for administrations, commerce, and transport amongst stakeholders. Standardisation of international administrative and commercial procedures addresses economic issues of a general and far more complex nature than most of the other standardisation areas.

Considering all the facts mentioned above, it is recommended that Governments should use the UN/EDIFACT standard for international applications of electronic data interchange EDI) among different parties within the public sector as well as between public authorities on the one hand and parties of the private sector on the other hand. National, regional and local governments as well as executive bodies of economic regions and central administrations of international or intergovernmental organisations should generally promote the use of the UN/EDIFACT standard for international transactions in both the public and private sector, with the aim to make administrative and trade procedures more efficient[62].

The international community of EDI users - including commercial parties deciding to use Electronic Data Interchange in connection with international trade transactions – applies the Model Interchange Agreement for the International Commercial Use of Electronic Data Interchange as set out below to increase the legal security of their trading relationship. The Model Interchange Agreement for the International Commercial Use of Electronic Data Interchange is incorporated into Part 3 of the United Nations Trade Data Interchange Directory (UN/TDID) and is part of the recommendations relating to UN/EDIFACT. An interchange agreement is made between trading partners setting out the rules they will adopt for using Electronic Data Interchange (EDI). The agreement also details the individual roles and legal responsibilities of the trading partners for transmitting, receiving, and storing electronic messages. Because of differences that are involved with the use of EDI in commerce, addressing these topics as they relate to a new electronic trading environment reduces the legal uncertainty that electronic trading might raise and enhances the confidence with which the technology is employed.

Interchange agreements between trading partners are an entirely voluntary arrangement. However, as the extensive list above indicates, a company will need to consider several very important issues before starting to use EDI to communicate with trading partners. An interchange agreement gives a structured framework for

considering and formalizing these basic issues. Following this fact and according to the UN Recommendation 26, Model Interchange Agreement is particularly suitable for international trade. It has been developed considering the different national legal systems and offers practical solutions for overcoming any difficulties these might cause. It is intended to be sufficiently flexible to meet the requirements of all the business sectors involved in international trade. Users may also find it useful for preparing interchange agreements relating to purely national or regional EDI commercial activity.

The increasing use of EDI is fundamentally changing international trading practices by replacing traditional paper-based trading with electronic alternatives. Instead of sending and receiving original written documents with handwritten signatures, traders transfer structured business data from one computer system to another by electronic means, including the increasing use of electronic signatures[63]. Finally, these standards and techniques lead to legal and functional establishment of single submission platforms design and to its further development phase, manifested as National Maritime Single Window, particularly in electronic port clearance, what is described in IMO FAL Compendium (2002).

UN/EDIFACT messages are by far the most widely used, however XML and other formats are also now in use, particularly in administrations. Currently, Extensive Markup Language (XML) is commonly used in electronic messaging. XML is a markup language with extensive support in common office automation tools and off-the-shelf or public-domain computer software. An information system which adopts the XML format for EDI is relatively simple compared with traditional EDI systems that adopt a UN/EDIFACT format. However, the relative ease with which new variants of XML can be created has led to many different and partly competing standards. This also applies to ship clearance, although the use of XML for this purpose is not widely implemented. Some relatively well-known examples are: PortNet in Finland; the (Electronic Notice of Arrival/Departure (eNOA/D) system by the United States Coast Guard (http://www.nvmc.uscg.gov/); and SafeSeaNet in Europe (http://www.emsa.europa.eu/)[64].

Specifically for National Maritime Single Window, several international standards may be considered for implementing the system interface (UN/EDIFACT, the WCO data model, and the ISO standard on electronic port clearance - ISO 28005). To ensure that the same information can be reported to the NSW regardless of the standard used, it is necessary to guarantee the interoperability between the messaging systems implemented by the NSWs. In addition, a mapping with EDIFACT messages can be made using the IMO FAL Compendium. For the exchange of information through SSN it is important to note that the digital format of the messages to be used within national SafeSeaNet systems shall be established in accordance with Article 22a of Directive 2002/59/EC, as amended. Member States shall comply with the harmonised XML messages and the technical standards developed for exchanging information through SSN and which are included in the XML Reference Guide prepared for SSN V3[65].

1.4.3 Single submission recommendations

A Single Submission Portal (SSP) is an access point that allows traders to exchange information in a standard format and related to a specific activity with relevant parties, including government agencies. SSPs will cover Business to Business (B2B) processes such as contracting for transport, logistics, and financial services. SSPs will often also facilitate regulatory processes through Business to Government (B2G) information exchange, in cooperation with- or within the context of a Single Window (if one exists). As the business processes covered can be as varied as the types of stakeholders that can exist in an international supply chain, there are several types of SSPs.

Some examples of SSPs today include Port Community Systems, Cargo Community Systems, Data Pipelines, Customs Clearance Systems, and Integrated Services for MSMEs for International Trade. As SSPs can provide the same or similar trade facilitation mechanisms as a National Single Window, some countries may want to study either how to capitalize on such systems as a viable alternative to a National Single Window or how to exchange effectively with them to streamline procedures for both economic operators and government agencies.

SSPs are defined as being electronic systems—keeping in mind that the main objective should be the facilitation that can be achieved, not the electronic system itself (i.e., the electronic system is a means to achieve trade facilitation). Being electronic, the use of internationally recognized and defined standards is paramount to ensure interoperability between systems and the common understanding of individual pieces of information between sender and receiver.

Considering the above, at its twenty-fifth Plenary session on 8-9 April 2019 in Geneva, UN/CEFACT recommends the following:

a) Governments should put in place the legally enabling environment to allow the establishment and the free-market operation of SSPs.
b) Governments should encourage the automated exchange of information in administrative systems (Single Window, customs and all other administrative electronic systems related to trade).
c) Private sector operators should consider putting in place SSPs to streamline and facilitate trade.
d) All actors should use internationally recognized standards and harmonized business processes, ideally using the models provided by UN/CEFACT.

Multiple SSPs could coexist within a single economy as they are private sector driven and presumably motivated by economic interest. Free market competition should be allowed to encourage the development of new, high-performance services and it is possible that only those SSPs which provide the most positive economic benefits to their users will survive.

SSPs can offer many functions among which we highlight[66]:

a) Facilitate the submission of data for single transactions by companies (MSMEs).
b) Improve interoperability between MSMEs and Single Windows.
c) Electronically link government agencies that are involved in the trade process.
d) Provide tangible cost savings for business and government.
e) Expedite cargo release and clearance by controlling agencies through the simplification of trade-related processes and procedures.
f) Provide benefits to the trading community by eliminating duplicated processes.
g) Enable world-class trade facilitation practices by providing a fully transparent and predictable border environment.
h) Enhance transparency and impartial treatment in the fiscal and customs framework.
i) Eliminate corruption by improving methods to counter dishonest practices and by reducing discretionary decisions.

Standardizing the information contained in its data flows is very important in an SSP as it is the key element in linking together different parties and government agencies—as well as parties within different countries (i.e., achieving cross-border connectivity). The success of an SSP depends heavily on the ability to exchange messages in a format that the systems on both sides (private sector parties and government agencies) can understand and manage. This is called “semantic interoperability”. This implies a common data reference model which serves as the logical model for the information used in cross-border trade.

The goal of data harmonization is to eliminate redundancies, duplications in data, culminating in a set of standardized data requirements and standardized messages. The outcome of data harmonization is the definition of national requirements, the mapping of these document requirements to international standards; and the harmonization of data requirements across documents based on the comparison of the national trade requirements with international standards (e.g., UNECE Trade Facilitation Recommendations and UN/CEFACT standards). Another important outcome of data harmonization is the alignment of documents to international standards, the usage of internationally accepted codes for trade data, and a reduction in the number of documents. International standards which can be used include the United Nations Trade Data Elements Directory (UNTDED)[67] and the UN/CEFACT Core Components Library (CCL)[68].

An SSP can offer trade benefits thanks to the opportunities it provides for data sharing and reuse of information in the supply chain, including in multimodal transport. Currently, many of these opportunities are already provided by services that facilitate electronic information exchange between business partners. The operators of these B2B services usually take a neutral position and facilitate an intelligent and secure exchange of information that respects the business relations of their clients and does not disturb free market processes.

Administrations can benefit from the existence of SSPs due to a combination of features an SSP brings to the Single Window environment. This combination of SSP features leads to more comprehensive, streamlined, and automated business compliance with governments' legislative and regulatory requirements than without an SSP. Consequently, as both SSPs and the SWs include the terms of international trade treaties, this will also improve the efficiency of Single Windows.

Some possible types of Single Submission Portals (SSP) are:

- Port Community System (PCS),
- Cargo Community System (CCS),
- Customs clearance systems,
- Freight Forwarding System (FFS),
- Integrated Services for MSMEs in International Trade (ISMIT).

1.4.4 International maritime transport and trade facilitation, data simplification and standardization

Maritime transport documents are issued to cover the contract of carriage and refer to a specific consignment of goods moved between seller and buyer and complement the physical movement of goods. These documents fulfil two key functions:

a) to act as evidence of the contract and its terms and conditions.
b) to act as evidence that the contracted carrier has received the goods for shipment and evidence of their apparent condition.

There are two basic types of maritime transport documents:

- Sea waybill: a non-negotiable document that evidences the contract of carriage and that the carrier has received the goods for shipment, and that identifies the person to whom the carrier is to deliver the goods.
- Bill of lading: a document that similarly evidences the contract of carriage and that the carrier has received the goods for shipment. However, this document fulfils the third function as it is also a document of title that must be surrendered to the carrier to take delivery of the goods.

Developments in information and communication technologies, allowing for secure electronic equivalents of documents, attempt to solve the difficulties created by the paper-based bill of lading. An electronic message or data transaction may, however, not be effective to replicate the legal characteristic of negotiability linked with the physical possession of a paper document.

Two types of e-business systems try to resolve the problem so that the bill of lading can be handled electronically. One system replaces the paper bill of lading with a register of titleholders held by a trusted third party (TTP). Contact with the TTP is authorized by secure electronic messaging and unique codes known only to the current titleholder and the Registry.

Electronic equivalents of the sea waybill are already widely used. Based on the document aligned to UN Recommendation No.1 – United Nations Layout Key for Trade Documents (UNLK) – the UN EDIFACT International Forwarding and Transport Contract Status ('IFTMCS') message exists with message implementation guidelines

(MIGs) to facilitate the efficient exchange of data between computerized business systems. The transition of the sea waybill to the electronic environment has been made much easier here, in comparison with the bill of lading, where the document of title aspect adds complexity and creates obstacles. Electronic documentation offers significant benefits for the preparation and use of maritime transport documents. Advantages include increased efficiency through a more accurate and speedier process with the reduction (or elimination) of errors and the ability to reuse data from other trade documents. Benefits may include reduced costs in demurrage charges and container hire fees, greater visibility and transparency of the supply chain, better customer service and enhanced competitiveness[69].

UN/CEFACT, at its twenty-third Plenary session in April2017 in Geneva, recommended the following:

- Governments and trade should establish national Trade and Transport Facilitation Monitoring Mechanisms (TTFMMs).
- Governments and trade should consider undertaking the following measures to ensure the sustainability of TTFMMs.
- Build national capacity to ensure that TTFMM activities, whenever possible, are carried out by national experts and teams.
- Institutionalize TTFMMs: A body overseeing the functioning of a TTFMM should include representatives of all, or key, stakeholders in trade and transport facilitation; and National Trade Facilitation Bodies, whenever possible, should be fully utilized to lead the activities under a TTFMM.

There is a need for countries to establish sustainable national Trade and Transport Facilitation Monitoring Mechanisms (TTFMMs) to measure and assess progress in trade and transport facilitation and assist in formulating, updating and prioritizing recommendations for trade and transport facilitation. Stakeholders in trade and transport facilitation within the territory covered by a TTFMM should be invited to participate. The private sector may play a very active or leading role in trade and transport facilitation monitoring.

The scope of monitoring should be decided by a country according to its specific situation. Two different countries may have different priorities for monitoring. For instance, a landlocked country may be eager to monitor the procedures at land border posts, while an island country may be most concerned about the performance at ports and shipping connectivity.

Data collection, including (among others) the types of data and data collection methods, should be defined within, and at the same time as, the scope of monitoring. The methods for data collection, calculation, and aggregation (whenever possible) should be selected, aligned, and harmonized to maximally facilitate national, regional, and international comparisons. The executive body of a TTFMM, such as an NTFB, should develop, maintain, and update a national TTFMM database. The database should include the following data whenever possible[70]:

- Trade process descriptions, process flows and related rules/regulations for each, trade & transport procedures for selected processes/products along with selected corridors.
- Time, cost, and number of documents for each process/procedure and number of total processes.
- International trade and transport facilitation indicators whenever appropriate.

On the top of these facts, and within the preparation of necessary infrastructure and conditions for establishing the adequate environment for Single Window concept, UN/CEFACT was delegated by (UNECE) Symposium on Single Window Standards and Interoperability held in May 2006, to provide supplementary Recommendations with guidelines on the way government information requirements could be harmonised and standardised, and the legal issued to be considered when planning and implementing a Single Window facility.

Therefore, it has made and adopted the Recommendation 34 – Data Simplification and Standardisation for International Trade which answers these requests by recommending a simple, easy-to-use, and cost effective 4 stage process to achieve the objective of a national simplified and

standardised dataset. The outcome of the process should be a more efficient and effective exchange of information between Trade and Government. When undertaking the simplification and standardisation exercise, Government should have a clear objective for the way in which the National Data Set will be used, whether to meet purely domestic trade needs or for incorporation into a national Single Window facility or utilisation in any regional trade agreements, bilateral arrangements, or other trade protocols.

Further, UN/CEFACT recommends that when creating a simplified, standardized national dataset, Governments should involve the trading community and other relevant stakeholders from the earliest possible moment within the data harmonisation initiative. In international trade, the use of non-standard (i.e., country specific and/or agency specific data) is highly inefficient in terms of cost and accuracy. This is also true in the case paper-based systems where traders are required to provide multiple and redundant forms. The solution to this problem is the simplification and standardization of data elements required for international trade. This is an iterative process of capturing, defining, analysing, and reconciling government information requirements, and then mapping this simplified data to international standards. The objective is to eliminate redundancies and duplication with the goal of defining one standard set of data and messages that traders and transport operators will provide to meet all governmental information requirements related to import, export, and transit.

The best way to start the simplification and standardisation process is to form a team dedicated to the task. The team should include a person to serve as a liaison with the Governmental authorities and border agencies, serving as a conduit for information to and from the lead agency. In turn, each Governmental agency must identify a primary contact for organizing the data inventory and the simplification and standardisation process. Also, the key data simplification and standardization steps, are as follows:

a) **Capture.** The start of the exercise is the preparation of a National Trade Data Inventory. This involves capturing individual Governmental agency information requirements through identifying and listing the data elements. This is accomplished in several ways such as a review of agency forms, automated systems requirements, regulations and administrative processes, and an examination of the documents used by the business community to conduct trade transaction with a review of the commercial records and business systems operated to initiate, reconcile, and fulfil the sales contract, either domestic or cross-border. This information can be organized in a spreadsheet or other software tool.
b) **Define.** This step includes recording the data element name, definition, representation (format or code), when the information is required (release, declaration, inspection, pre or post control) and the citation (legal base) of the relevant agency to demand, collect, view, and retain (archive) the information.
c) **Analyse.** The next step is the analysis of the information requirement for each data element. Establishing the need and use of the information requirement is essential. The process of analysing the information consists of gathering similar data element names and having a full understanding of the definition and the information required. The models for the export and import of key national goods and services, and the main modes of transport should be based on approved modelling techniques such as such as the UN/CEFACT Modelling Methodology that is based on the Unified Modelling Language (UML).
d) **Reconcile.** The final step is the consolidation of the defined and analysed trade data inventory into a rationalised data set through the process of reconciliation. This involves the agreement to use one data element name with a common definition and (or) common coding and reconciled with the United Nations Trade Data Elements Directory (UNTDED). Equally the reconciliation should consider other standards defined such as the World Customs Organization Data Model (WCO DM). This approach provides a range of options for the development of data models and syntax implementation.

The standard data set must cover all data used for information exchange for import, export, and transit, all modes of transport (air, maritime, road, rail, etc.), and the requirements of all governmental agencies. Logistically it would be impossible to require all the data for any one trade transaction. As noted in the "place of discharge" example used in guidelines for data simplification, the elimination of redundancy and duplication resulted in a net reduction. Six elements were reduced to one and similarly three coding schemes were reduced to one code.

One problem that data simplification and standardization projects may encounter is the effect of the use of international standards on legacy systems. For example, if a country uses proprietary coding for locations, legacy systems (for risk management, screening, targeting, and accounting) are based on the proprietary scheme. Until such time as there is an overall conversion to the new data element names and coding, countries and traders may have to implement translation capabilities.[71]

1.5 ChainPORT and the NxtPort platform

Ports all over the world deal with huge number of different agencies with many activities and specific level of expertise. These individual companies tend to increase their market potential and competencies in the business environment and for this purpose it is necessary to make a unique data sharing platform which will handle all kinds of relations between them. This platform is a cloud based integrating the stakeholders from all components of Supply Chain, its relevant data regarding transport capacities, information of cargo, ship types, main features, available space and tonnage, port of call and previously visited port. Here we will briefly consider the NxtPort and ChainPORT platforms as most relevant modern digital solutions/initiatives in ports.

Specifically, in Port of Antwerp has established and developed a comprehensive data utility platform called NxtPort that will assist in data exchange, management, and collection from various stages of transport flows and supply chain. This data is used to create overall growth and foster actions towards sustainable solutions in the maritime and land transport sector, aiming to increase efficiency of operations and raise the level of business connectivity. This platform enables scheduling the vessels arriving in the port, its allocation of berths and anchorages, arrivals and allocation of trucks and terminal vehicles, cranes, and cargo handling equipment. Related to container yard management, NxtPort helps in minimizing the container stacking moves and storing the containers on the most optimal mode and destinations with respect to time and costs efficiency. These capabilities unlock the potential for development of various software applications making logistics more efficient and provide optimal management of cargo flows. It is expected that these improvements also affect the other related sectors such as customs by increasing the digital solutions' efficiency in customs procedures, and storing the data related to material safety and environment risks.

Also, the opportunity emerges to use data for monitoring the volume of transport flows and cargo trade in the global/regional market and to make the process of data exchange among involved partners more transparent, unlocking the great potential and market value of collaboration. The NxtPort platform follows the concept of Smart Ports trends and technology which, according to industry 4.0, needs to have integrated intelligent structures, automation to facilitate knowledge development, optimize port and cargo operations on the base of enhanced ICT technologies, lead to sustainable development goals accomplishment, increase port resilience and enable safe and secure activities in all port spaces and environment. Therefore, the main goal of NxtPort is to enable partnering up via a highly developed integration platform which will connect data from relevant stakeholders such as customs, PCS, independents software vendors, SME, shipping companies, forwarders, and other industry partners[72].

Among its capabilities, the NxtPort platform coordinates all key events covering vessel stay in the port, electronic import consignment, managing the modes of terminal transport, giving green lights for next operations, performance of VISIGIP (Scanning), various terminal events and finally certified release. Subsequently, NxtPort covers export procedures until the exit confirmation step. Regarding cargo types, with NxtPort it is possible to manage the digital shipment of steel, digital cleaning documents, digital tanker visits and control of the overall supply chain. One of the most important capabilities of this platform is Blockchain technology compliance as well, which has been realized by implementation of Model 3, that is previously supported by Model 1 (EDI interfaces between systems) and Model 2 (Common data backbone).

It is important to mention that NxtPort, among others, is introduced and operated in the Port of Antwerp for the purpose of data sharing actions between relative communities[73]. The data utility platform NxtPort was created

to facilitate data-sharing practices among the users of the Port of Antwerp. NxtPort addresses the data transfers that were not covered by other community systems. It was set up as a private company and it aims mainly, but is not limited, to integrating data from terminal operators. NxtPort is expected to increase the operational efficiency of port stakeholders by overlapping a new layer of data on existing information. Furthermore, the platform seeks to create added value for data owners and users by allowing market applications to be built on existing data. Data can be uploaded to NxtPort in different formats (e.g., EDIFACT or XML). Data owners and platform users can share information with supply chain partners but also build applications on top of NxtPort according to their information needs.[74] NxtPort is acting as the connected platform for external services, which integrates services by third- party developers into the PCS (such as LOGIT ONE). Currently, three applications and multiple APIs from external developers are offered on the NxtPort platform. NxtPort and C-Point stick out with a novel concept of data governance. Additionally, Antwerp's PCS platform allows stakeholders to allocate a value to the data they share to the data exchange rules. On top of the usual transaction, monthly recurring, and on-boarding fees for using the platform, NxtPort introduced a so-called "Data fee", which is set by the respective data owner and must be paid by the data user. They thereby encourage data sharing and allow data owners to commercialise their data[75]. More details on NxtPort could be found in Section 2.5.1 Port of Antwerpen related to the Chapter 2.5 Overview of the selected Ports' ongoing digitalization and visibility initiatives.

Along with NxtPort, the novel special initiative ChainPORT launched by Hamburg Port Authority represents an important tool for increasing the maritime business efficiency by creating collaboration models between ports, introduction of smart technologies, and fostering the digitalized solutions. ChainPORT quickly becomes a network of other developed world ports, apart from Port of Hamburg as leading partner, such as: Los Angeles, Montreal, Barcelona, Antwerp, Rotterdam, Busan, and Singapore. The aim of this collaboration model is to overcome competitive relationships and to enable business cooperation beyond bilateral partnering, and to share global maritime market volumes and ICT benefits. On with a world map, one can see all the participating ports of the ChainPORT initiative[76]. By sharing the innovations and expertise on strategic topics, all ports involved in this cross-national partnership can exchange business experiences and operational knowledge in the form of best practices for several areas such as digital solutions applications, efficient use of port infrastructure and facilities, optimization of technical capabilities exploitation, efficient investment, and financial decisions.

The vision of this international association is "*A global network of interconnected logistics hubs that enables maritime stakeholders through innovation and digitalization, to achieve secure, efficient and sustainable door-to-door supply chains*." Following this vision, there some key objectives were defined[77]:

- Increasing interconnectivity among actors in maritime supply chain,
- Achieve best-in-class cyber resilience standards,
- Active shaping the maritime logistics by maritime policy makers communication,
- Involve employees and stakeholders in digital change educations.

Together with these objectives, ChainPORT is driven by values defined toward prioritization of digitalizing of all processes while the physical assets and investments in this area remain on secondary significance level, perception of ecosystem sustainably, and development of mutual trust and transparency among actors regarding challenges and best practice. To achieve the goals and act according to the values set out, the ChainPORT community has established several working groups for smart IT solutions, global maritime logistics dialogue, shaping the digital culture in port authorities, and development of educational schemes for employees in partner ports.

Specifically, ChainPORT provides many benefits to ports in case of crisis situations and management. Due to the COVID-19 crisis, solutions for adequate hygiene, distance measurement and solutions for different employees and external groups were implemented to limit the risk of infection, Pre-existing operational continuity plans were activated and adapted to the crisis. A new digital solution creating a fast lane for critical (medical) cargo, etc. Also, regarding the opportunities offered, ChainPORT aims to accelerate digital transformation through new technological skills acquisition and adoption among staff and partner companies, together with possibility that

Port authorities as digital leaders with a coordinating role in a post-crisis world could accelerate digital transformation across the port community regarding standardisation of data, processes, and procedures.

Additionally, during the pandemic the members of ChainPORT shared the best practise in leveraging the digital management solutions related to two clusters: protection of workforce and protection of supply chain. in the first one, it used internal communication via virtual reality (VR) and augmented reality (AR), drones and digital twins of port space, business continuity and redundant critical systems, smart wearables, electronic and automated labour dispatching, etc. in the second cluster, the fast-tracking critical supplies: from dock to market, open data sharing, external communication: social media communication strategies and port panels have been implemented [78].

1.6 Conclusion of the policy review

This chapter updates and further develops the review of the EU and International policies, initiatives and standards presented in deliverable 1.1, with focus on the challenges and changes that occurred during the ePIcenter project. Doing this is crucial in the context of rapid geopolitical change, which is leading to significant adjustments in transport policies and practices. This should be considered by the ePIcenter project partners, keeping in mind that the project scope was formed in a different geopolitical environment compared to today. Therefore, in this report particular attention was paid to the newest guidelines and provisions of recent EU policy documents.

The Global Gateway strategy is one of the most important documents in this respect. The document is seen as a new guideline for how the EU can construct more resilient connections and cooperation with the world. The EU has the ambition liaise with the world, adapting to the needs and strategic interests of different regions while remaining values driven.

Even though the Global Gateway documents state that it relies, among other sources, on the Joint Communication on Connectivity Europe and Asia (Join (2018) 31 final), some significant differences with those documents must be observed and properly evaluated. In the JOIN (2018) 31 final document, exceptional attention was directed toward China. Using the EU-China Connectivity Platform - an instrument established in 2015 - both sides sought to ensure synergies between the EU's approach to connectivity, including the trans–European transport network (TEN-T) and China's Belt and Road Initiative (BRI). That there was a lot of optimism at that time is well illustrated by the documents adopted at the EU-China Summit, which took place in Brussels on 8/9 April 2019. Many expectations arose from the decision to carry out the EU-China Joint study on a sustainable railway-based transport corridor between Europe and China.

Meanwhile, returning to the Joint Communication on Global Gateway (JOIN (2021) 30 final), China isn't mentioned at all among EU bilateral cooperation partners on connectivity. The Global Gateway will work in accordance with the following principles: democratic values and high standards, good governance, transparency, security-focused, and catalysing private sector investment. At the same time, it was emphasized that the EU has already concluded a Connectivity Partnership with Japan and India and intends to pursue a connectivity partnership with the ASEAN countries. Also, the EU will seek further collaboration with the US, Canada, and other likeminded partners.

Considering all this, the ePIcenter project faces a serious challenge which affects most work packages. On one hand, the ePIcenter project partners must complete the planned project tasks, including interoperability problems between the TEN-T corridors and the BRI network. On the other hand, the new EU policy guidelines on connectivity with third countries need to be duly assessed when preparing ePIcenter's final reports.

A vital part of international multimodal transport, the maritime mode of transportation of goods, mostly relies on special regulations adopted by International Maritime Organisation (IMO). One of these initiatives is concerned on establishing the National Maritime Transport Polices that will direct the overall maritime transport activities in national economies and support the achievement of Sustainable Development Goals (SDG) at state

level, strengthening maritime capacities and provide a resilient maritime framework consisted of maritime trade, economy, safety and security, intermodal land-sea connections, and environmental policy.

On top of maritime and fleet safety, the IMO provisions considered for this deliverable mostly relate to SOLAS Convention for prevention of lives and property at sea and Rotterdam Rules, which are designed to modernize international regime governing contracts for the carriage of goods by sea. Within the safety provisions, special attention is paid to the evaluation of the "Iridium Safety Cast" mobile-satellite system against the criteria for provision of mobile satellite communication systems, within the Global Maritime Distress and Safety System (GMDSS). Developing the e-navigation concept, the increased need for interoperability standards for safety of navigation using advanced satellite systems led to adoption of Quasi-Zenith Satellite System (QZSS) as a further part of WWRNS (Worldwide Radio Navigation System). The core idea of these advancements is seamless integration and harmonization of receivers for radio-satellite navigation systems and technologies into one common performance standard.

Specifically for the promotion of data harmonisation, the Facilitation Committee (FAL) established an IMO Data Set combined with the IMO Reference Data Model to integrate all relevant international standards used for maritime electronic business. Furthermore, IMO has adopted the Compendium, the tool that provides an efficient, electronic transmission of all this vital information in a way intended to minimize the burden on shippers, crews, agents, port authorities, and other stakeholders. To collect all necessary information for clearance of vessel in general, Facilitation Committee has adopted a FAL Convention that prescribes the documentation required to be submitted by involved stakeholders, with the following 7 forms: IMO General Declaration, Cargo Declaration, Ship's Stores Declaration, Crew's Effects Declaration, Crew List, Passenger List, Dangerous Goods Manifest.

Considering the maritime data exchange systems and ship reporting platforms for ports, it is important to emphasise the role of IPCSA (International Port Community System Association) as an important organization in shipping and port logistics related to the port systems community of users. On top of this, IPCSA prioritises new emerging technologies with maritime applications, such as Blockchain Bill of Lading, logistic visibility task force and, Network of Trusted Network – NoTN. Additionally, IPCSA provides a guideline on information and knowledge sharing concerning the implementation of new ICT technologies in port operations and the commercial sector. The exchange of ship- and maritime information is performed using various international data standards. In this deliverable we analyse the UN/EDIFACT standard – for international transactions in the public- and private sector, making the administrative- and trade procedures more efficient – and Extensible Markup Language (XML) which is commonly used in electronic messaging. This is important for the further development and functioning of a National Maritime Single Window platform for integrated ship reporting which is based on single submission and access of all national stakeholders to ships' activity information. Related to single submission, there are several platforms: Port Community System (PCS), Cargo Community System (CCS), Customs clearance systems, Freight Forwarding System (FFS), and Integrated Services for MSMEs in International Trade (ISMIT). The aim of these IMO recommendations and initiatives is to enable data harmonisation, simplification, and standardisation through four steps: capture, define, analyse, and reconciliate. Along with new digital solution platforms for maritime data harmonisation and collection in this deliverable, we pointed out two important ones:

1. NxtPort – a data utility platform established by Port of Antwerp and used for data exchange, management, and collection from various stages of transport and freight distribution flows.
2. ChainPORT – launched by Hamburg Port Authority used for increasing the maritime business efficiency with port collaboration models, smart technologies, and digital solutions.

Concerning the other new documents reviewed in the Policy Review chapter, it needs to be emphasized that their analysis was focused on assessing the project's potential to contribute to the implementation of new innovative measures promoted in the documents. In particular, the potential of the ePIcenter project to assist in the development of TEN-T networks in neighbouring third countries can be assessed quite optimistically. The

ability of the project to contribute to achieving the EU's goals in the field of digitalization also looks promising, as does the contribution to the development of interoperability between different information platforms.

2 Ongoing Digitalization & Visibility Initiatives

2.1 Introduction

This chapter provides an overview of the major digitalization and visibility initiatives relevant for the ePIcenter project. The chapter builds on the initial overview of the ePIcenter *Deliverable 1.1. – Initial Review of EU/Global Initiatives, Policies and Standards*.

In the chapter, authors focused on the main global solutions and selected European projects and funding mechanisms (putting special emphasis on initiatives supported by DTLF and ALICE platforms). Maritime Single Window and railway initiatives have been described in the separate sub-chapters.

The chapter concludes with practical examples from selected ports leading digital innovation initiatives. These best practices were selected based on online interviews with port representatives conducted by the ePIcenter Consortium specifically for this Deliverable. DTLF representatives have been also interviewed.

2.2 Overview of relevant Digital and Visibility Initiatives

2.2.1 Relevant global digital and visibility initiatives

Several ongoing digitalisation & visibility initiatives, both in terms of dedicated platforms and projects, increase the availability of real-time data. Many of these solutions are already established, continue being developed.

- **The International Maritime Organization IMO Compendium on Facilitation and Electronic Business** - tool for software developers that design the systems needed to support transmission, receipt, and response via electronic data exchange of information required for the arrival, stay, and departure of the ship, persons, and cargo to a port[157].

- **VTS Vessel Traffic Services** - shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.[158]

- **The WCO Data Model** – collaboration between World Customs Organization and IMO. WCO Data Model not only includes data sets for different customs procedures but also information needed by other Cross-border Regulatory Agencies for the cross-border release and clearance at the border. The WCO Data Model supports the implementation of a Single Window as it allows the reporting of information to all government agencies through the unique way it organizes regulatory information[159].

- **AIS data sources** such as MarineTraffic which provide APIs making available ship and barge data such as position, speed, voyage, port call events and ETAs[160].

- **5G Technology**: Digitalisation and visibility initiatives and projects should accelerate with the introduction of 5G communication tools and channels. The capabilities of 5G connectivity will likely allow the development of digitalisation and visibility tools in transport and logistics, such as real-time monitoring of traffic flows, ensuring security and safety and measures to perform operational management actions. 5G facilitates the “smart port” and “Ports 4.0” concepts, enabling all kinds of new applications within ports such as smart drones for real-time monitoring, real-time ship-to-shore communication for port-to-vessel traffic management, and just-in-time operations[161]. Currently, several major global operators from Orange, Ericsson to Huawei presented their official papers and statements on the use of 5G to create more productive and sustainable transport hubs.

- **Tracking and tracing containers** via RFID chips, wireless cellular and/or satellite links, and back-end info-communication systems.

- Additional Protocol to the United Nations Convention on the Contract for the International Carriage of Goods by Road (**CMR**) allowed the introduction of the Electronic Consignment Note (**eCMR**)[162].

- International Air Transport Association (IATA)'s e-AWB (**Electronic Air Waybill Resolution**) which removes the requirement for a paper Air Waybill document that constitutes the contract of carriage between the "shipper" and the "carrier" (airline).[163]

- There are several global tools that use real-time data to **alert ships to the presence of whales** e.g., Whale Alert is a global effort to reduce ship strikes and other human activities that threaten marine mammals. Network partners provide various areas of expertise including technology, research, and education to increase the effectiveness of whale conservation and protection measures[164].

2.2.2 European programmes and platforms facilitating digital and visibility initiatives.

Apart of the Horizon 2020 Programme, several European funding schemes and local (both national and private) collaboration platforms have enabled digital solutions which complement ePIcenter activities. Authors selected DTLF and ALICE platforms as best practices presented in separate sub-chapters.

- **SafeSeaNet** - EU platform for exchanging maritime information on ships and their cargo between EU member states, Norway and Iceland in order to ensure better and faster reaction to incidents and spills, and to permit early detection of high-risk vessels[165].

- **The Connecting Europe Facility** (**CEF**) funding instrument supervised by the European Climate, Infrastructure and Environment Executive Agency (CINEA) has financed significant transport and IT-related projects - e.g., ongoing iTerminals 4.0 – facilitating the adoption of 4.0 technologies and Internet of Things (IoT) solutions in the port sector [166].

- **Connecting Europe Facility Digital** (**CEF Digital**) - mechanism by EC European Health and Digital Executive Agency (HaDEA) facilitates the development of safe, secure, and sustainable high-performance infrastructure including Gigabit and 5G leading to the digitalisation of transport and energy networks[167].

- **The European Conference of Transport Research Institutes (ECTRI)** is an international organization founded in April 2003 by 15 national transport research institutes and universities of 13 European countries [168]. It was the first attempt to unite the forces of the foremost multimodal transport research centres across Europe and to thereby promote the excellence of European transport research. Today, as the leading European research association for sustainable and multimodal mobility, ECTRI includes 28 major transport research institutes or universities from 19 European countries (one of the ePIcenter Partners, TSI Transport and Telecommunication Institute from Latvia is an ECTRI active Member). Together, they account for more than 4,000 European scientific- and research staff in the field of transport. Linked to its establishment in Brussels, ECTRI is operating since January 2011 as an international non-profit association (AISBL) registered in Belgium and governed by Belgian law. ECTRI Members have been involved in over 300 Horizon 2020 and other transport related projects, and in 9 COST actions. The most relevant projects for ePIcenter include H2020 WE-TRANSFORM "Automation and Connected Mobility Impact on Employment in the Transportation Sector"; STORM "Smart freight TranspOrt and logistics Research Methodologies"; TANGENT "Enhanced Data Processing Techniques for

Dynamic Management of Multimodal Traffic Flows"; BOOSTLOG "Boosting impact generation from research and innovation on integrated freight transport and logistics system" and FUTURE-HORIZON "Future on-/off-road transport and mobility research, cross-border cooperation strategies, realization actions and procurement processes".

- **ECLIC neutral platform** - European Chemical Logistics Information Council aims at facilitating secured data sharing among industrial actors related to chemical logistics via an application platform allowing to transform the current manual and paper-driven logistics processes into more integrated, collaborative, electronic and real time processes enabled by data sharing. Currently it focuses on the eECD (EFTCO Cleaning Document) use case, but is also looking into other subjects such as supply chain visibility.[79]

- **Logit One** (an ePIcenter partner) is a platform focused on end-to-end visibility, high-quality data, and value-added services. Its aim is to boost efficiency and improve customer experience across the supply chain. The company's tool is the Logit One Platform (L1) for collaborative transport coordination, intermediation & visibility[80]

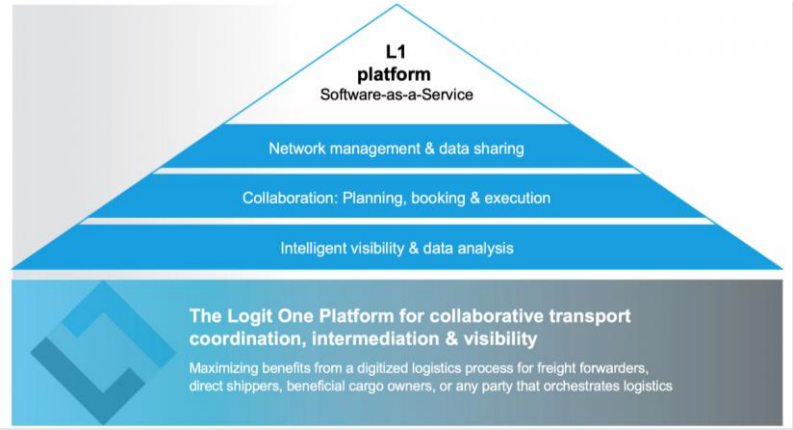

Figure 3. The Logit One Platform (https://logit-one.com/)

- **Forto start-up** (previously known as FreightHub) is a digital freight service and supply chain management provider headquartered in Berlin[81]. In 2020 they received a €20 million investment from The European Investment Bank (EIB). Forto's approach is to use precise real-time data to make the logistics process more transparent and efficient.

- **Gaia-X European Association for Data and Cloud AISBL** is the European data cloud which aims to make Europe independent of large IT groups from the USA and China. More than 300 organizations and companies are involved in the project. The project is controlled by a not-for-profit organization under Belgian law. The 22 founding members include, for example, Deutsche Telekom, SAP, Siemens, Bosch, and BMW as German companies [82].

- **Container xChange** based in Hamburg is online container marketplace which enables carriers, leasing companies, and logistics companies to tap surplus capacity on containers, vessels, trains, and trucks [83].

- European individual transport **Online Freight Exchange platforms** e.g., Freights Online (Greece) [84].

2.2.3 Digital initiatives supported by The Digital Transport and Logistics Forum (DTLF)

The work of DTLF's Subgroup 2 "Corridor Freight Information Systems" is supported by two EC Connecting Europe Facility (CEF) funded projects, FEDeRATED and FENIX, which allows testing and validation of the concept in real world conditions.

FEDeRATED is an EU CEF project for digital cooperation in logistics running until 2023, aimed at delivering the foundations for an interoperable business and administrative data-sharing infrastructure for freight transport and logistics. The FEDeRATED project consortium consists of 15 Partners and its platforms are using a practical Living Labs (pilots) structure. The pilots will lead to the validated Masterplan for an EU federated network of platforms concept and a prototype of a data sharing environment for business and public sector use[86].

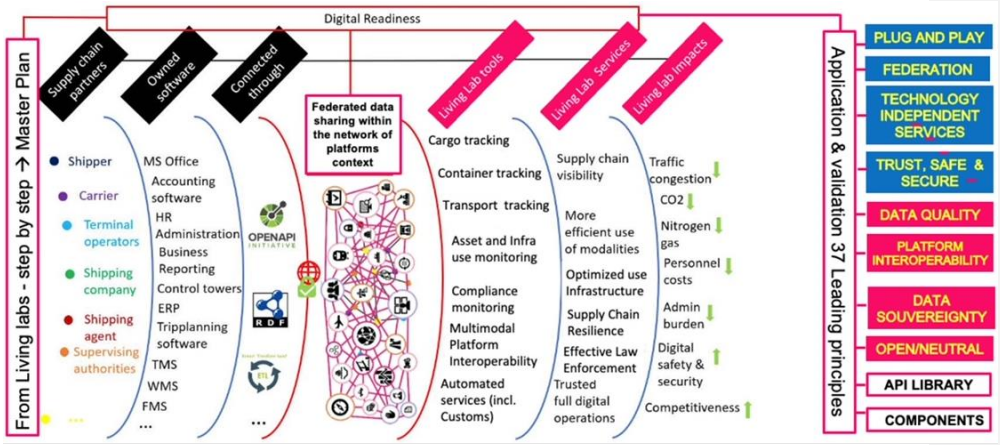

Figure 4. FEDeRATED Living Labs (http://federatedplatforms.eu/)

The second project, **FENIX** (A European Federated Network of Information eXchange in LogistiX) is another EC CEF initiative developing a federated architecture for data sharing, serving the European logistics community of shippers, logistics service providers, mobility infrastructure providers, cities, and authorities in order to offer interoperability between any individual existing and future platforms. The concept of FENIX comes from the work and recommendations of the EC DTLF to create a viable and valid federative network of platforms as enabler for Business to Administration (B2A) and Business to Business (B2B) data exchange and sharing by transport and logistics operators[87].

FENIX main objectives are:

- To establish a federated network of transport and logistics actors across Europe, enabling sharing of information and services needed to optimise TEN-T.
- To demonstrate the operational feasibility and benefits through the organised national pilots with focus on testing the achieved interoperability capabilities.
- To set up the EU corridor community building programme and to promote the benefits to the participants in terms of reduced costs and GHG emissions.

2.2.4 ALICE Platform, Alliance for Logistics Innovation through Collaboration in Europe

The European Technology Platform ALICE is aiming to develop a comprehensive strategy for research, innovation, and market deployment of logistics and supply chain management innovation in Europe[88]. The platform supports and assist the implementation of the EU Programs for research: Horizon 2020 and Horizon Europe in logistics. ALICE was officially recognized by the European Commission as a European Technology Platform in July 2013[89]. ALICE is an answer to the need for an overarching view on logistics and supply chain planning and control, in which shippers and logistics service providers closely collaborate to reach efficient logistics and supply chain operations.

ALICE was created in the frame of WINN project having the European Green Cars Initiative (logistics section) and EIRAC, European Intermodal Research Advisory Council, as background and supporting initiatives. Vision of ALICE corresponds with ePIcenter project goals: Physical Internet (PI) proposing a full consolidation of logistics flows from independent shippers (e.g., extended pooling) in logistics networks and the affordable transition of assets towards Zero 2050 emissions logistics. Recently, ALICE has introduced the Roadmap to the Physical Internet, one of the several Roadmaps presented in the figure 5 below [90].

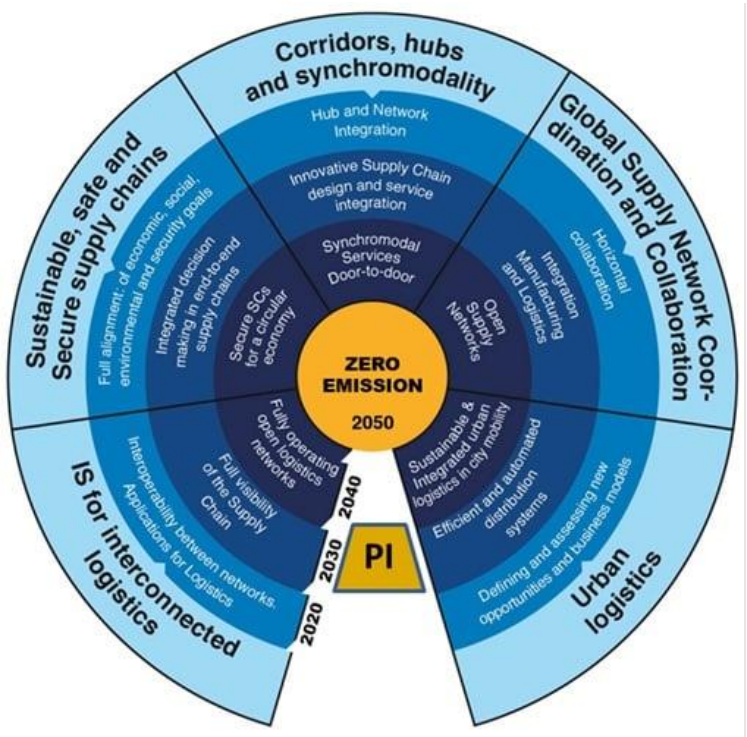

Figure 5. ALICE Physical Internet Concept (https://www.etp-logistics.eu/)

The ALICE Platform is currently actively involved in two Horizon2020 projects: BOOSTLOG (Boosting the impact of freight transport and logistics EU funded research) as the Leader[91] and ENTRANCE Matchmaking Platform as the Consortium Member[92].

2.2.5 Digital initiatives related to Covid-19 pandemic

The COVID-19 crisis has significantly changed consumer behaviour (e.g., increased use of the e-shopping) which influenced cargo flows patterns within supply chain. During the pandemic, due to limitations in airfreight (e.g., higher costs, limited capacity, local regulations) and sea-freight (blank sailings), shippers explored the rail option which has the benefit of being lower cost than air and having a faster transit time than maritime. This shift also challenged current rail connections, infrastructure, and capacities due to the unpredicted volume increase [93].

The operation of ports was of vital importance in facing the COVID-19 challenges. Ports ensured that the world's medical supplies, food, energy, raw materials, manufactured goods, and components crucial to the preservation of employment, continue to reach their destination [93].

UNCTAD Train for Trade COVID-19 recommendations for ports included steps such as:

- Boosting internet capabilities and accessibility inside and outside port areas for port workers and users.
- Increasing connectivity and data interoperability in Global Supply Chains by implementing Port Community Systems and taking advantage of Digital Ledger Technology such as Blockchain as promoted by the World Economic Forum (WEF).
- Developing shorter and more diversified supply chains supported by advanced automation and labour-protective relocations in line with climate change objectives.
- Reinforcement of port regional cooperation to build more resilient trade nodes to brace for future COVID-19 pandemic-like shocks.
- Design of new policies for resilient and inclusive ports to reach out to the most vulnerable people who are often dependent on the port communities' economic and social fabric.
- Engagement in innovative training approaches and well-being at all-staff levels leveraging technology [94].

It could be assumed that COVID-19 pandemic accelerated digital transformation and growth of Smart Ports, Industry 4.0, and the industrial internet of things (IIoT). Several COVID-19 solutions have been introduced temporarily, during times with high numbers of pandemic cases, yet lessons learned can have long-lasting impact on the pace of digital transformation. The COVID-19 pandemic has created a "sense of urgency" which should be viewed as a chance to promote and accelerate the digital transformation of ports. Looking beyond its essential role during this crisis, digitalization streamlines logistics processes between various actors leading to cost reduction, a better experience, and solid business continuity[95].

As response to COVID-19 crisis, the already discussed ChainPORT network has published Digital Playbook "Leveraging Digital Solutions for Crisis Management" with experiences from five ports: Hamburg, Montreal, Barcelona, Antwerp and Los Angeles [96].

Several presented cases from ports included:

- Port of Hamburg - the use of drones to detect port-related accidents and video platform PortTalk.
- Port of Montreal – the use of smart wearable devices to protect employees from the corona-virus and bracelets monitoring the social distancing rules.
- Port of Barcelona – creation of a replica of control tower to avoid interrupting vessel traffic, Portic data exchange on container traffic.
- Port of Antwerp – implementation of the video conferencing with Virtual and Augmented Reality technologies to provide a more real and immersive interaction between workers. Tools to prevent cybercrime. Introduction of smart bracelets for workers[97].

- Port of Los Angeles - the Medical Optimizer development, a data system that supported the city's logistics, linking suppliers of medical products related to COVID- 19 with the teams and organizations that required them, associating medical inventory systems with the information systems of the city and the port. Moreover, Port Pilots application (developed before the sanitary crisis), became an effective tool to comply with safety distance recommendations. It assigned tasks to the pilots remotely, facilitating staff rotations, schedules, and other relevant information.

ChainPORT recommendations for the Covid-19 reality:

- Employee safety.
- Digital solutions and the use of collaborative platforms and tools made teleworking easier, allowing employees to work safely. It also allowed port routines to carry on thanks to the remote control of activities.
- Digital twins and drones.
- While lockdown lasted, access to the port facilities was restricted. Digital twins made 3D tracking possible without the need for personnel to be physically present.
- Open data sharing.
- Shared learning is the most positive outcome derived from a crisis, as innovation and best practices can foster the development of new solutions.
- Fast-tracking critical supplies: from dock to market.
- Logistics as frontline role in emergency response. Demonstrated leadership among ports during the pandemic included acting as coordinating bodies for the supply of critical cargo or implementing tech-based fast-track solutions.

There are plenty of relevant IT solutions which supported smoother transportation during the COVID-19 pandemic, mostly presented as user-friendly apps. For example, The Galileo Green Lane application developed by the European Union Agency for the Space Programme (EUSPA) with the use of European Union funds and the technical support of FoxCom and SpaceTec Partners is monitoring the traffic situation at TEN-T border crossings. It provides border officials and transporters visibility on the border situation, allowing them to see which borders are under a higher load [98]. The other solutions include e.g., Ubi app (Vessel Operations/Container tracking) developed by Hutchinsons Ports[99], or Covid-19 Restrictions Online Tracker[100].

2.3 Maritime Single Window

2.3.1 General overview and definitions

Today, innovations and new technologies based on digitalization are advancing at a surprising speed and having an impact worldwide. However, this technological advance enables efficiencies to be made in the maritime transport logistics chain system, as well as improved data availability in the monitoring and measurement of port performance. For this reason, it is essential to have online systems in place to exchange information smoothly, and to provide assurance in matters of cybersecurity.

Another initiative in the maritime digital data exchange framework is the Single Window concept that allows parties involved in trade and transport to lodge standardised information and documents with a single-entry point to fulfil all import, export, and transit-related regulatory requirements. The EU Reporting Formalities Directive (RFD) in force since 2015 simplifies and harmonises the administrative procedures applied to maritime transport through National Single Windows for reporting formalities from ships arriving in and/or departing from ports. The RFD is planned to be superseded by the European Maritime Single Window environment (EMSWe) that it is currently expected to apply from 2025. At the same time, the IMO member states agreed on a mandatory requirement[101] for national governments to introduce electronic information exchange on 8 April2019 to make cross-border trade simpler and the logistics chain more efficient for the more than 10 billion

tons of goods traded by sea annually across the globe between ships and ports. In support of this, the IMO Facilitation Committee (FAL)is ensuring that the digital data exchange process is supported by appropriate and compatible international standards and definitions. In line with this, the EU VAT eCommerce Regulations will come into effect in 2021[102].

Certainly, Single Windows becomes a main platform for facilitating the integrated flow of trade and trade information in the world economy. This trend will increase the complexity of and make more demands on Single Window projects. Consequently, there is an increasing need for implementers of Single Window to establish further international collaboration to develop common inter-connectivity strategies, policies, data harmonization and standards to ensure the evolution of globally networked Single Windows. Once implemented, the Maritime Single Window system is expected to assist governments to adopt best-practice governance models for trade data interconnectivity, technical standards interoperability policies and innovative digital architectures. This will also enable adoption of appropriate software infrastructure to ensure lean interconnectivity with existing e-platforms on port-related operations, such as Port Community System (PCS) or/and Customs Information Systems.

To further develop a submission portals and platforms for single reporting in various trade and transport business processes, it emerged a need for maritime and trade authorities to have an advanced and specially integrated platform for facilitating the reporting formalities from ships and cargo carriers. Herewith, in the annex to the FAL Convention, a general single window is defined as a facility that allows submission of standardized information covered by the Convention to a single entry point. The facility is generally understood to be based on electronic data transmission and relies on system software to distribute the data submitted to the receivers in accordance with the system rules and user agreements[103].

Furthermore, UNECE Recommendation No.33 defines a single window as an electronic facility providing trade facilitation measures that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfil all import, export and transit-related regulatory requirements. Individual data elements should only be submitted once electronically [104].

Therefore, the designation “National Single Window” would indicate that there is only one official Single Window, and all government agencies should participate within this framework based upon the provided guidance in UNECE Recommendations, beside N°33, also the N°34 and N°35[105] to streamline processes and eliminate any redundancies. The National Single Window should also be mandated to represent the interests of the country in interoperability initiatives, notably those outlined in Recommendation N°36[106]. The term "national single window" (NSW) is used in two different contexts:

- As the only single window solution nationally. This implies that all single window operations are performed through one NSW; and
- As a portal between international data exchange systems and national trade data management systems.

The National Single Window, through a single entry point, enables a trader to submit all trade declarations and all relevant information to the various authorities for processing and approval only once, and in a single data format. The single entry point may be operated by one of the participating government agencies; it may also be established as an independent body (public-private, public, or private). All the participating agencies and entities need to have a specific IT legacy system to be able to exchange electronic messages for National Maritime Single Window (NMSW). Several government agencies may already have existing ICT systems in place to perform their required processes. These may coexist with the SW system for a certain period and be integrated progressively. During such transition phases, it is important to harmonize the data requirements and message exchange protocols as much as possible. Beside the governmental agencies legacy systems, the private sector may also have developed ICT solutions to facilitate cross-border procedures in the business-to-business environment[107]. These systems have been defined within the UNECE as Single Submission Portals (SSP), in detail described in previous sections.

The term "maritime single window" (MSW) can be defined as an information system that covers maritime and port administrative procedures, such as port entry/departure declaration, notice of security reports, and other related information between private sectors and public authorities. MSW provides a one-stop service for maritime and port administrative procedures nationwide. In other words, MSW is a single window in the scope of maritime and port fields. This system handles nautical safety and security issues related to ship clearance into national waters and port. The FAL forms are typically the data format used by this single window. The MSW is normally operated by the maritime authorities and used by ship agents and sometimes shipmasters[108].

Apart from NSW and NMSW there are other important types of SW, briefly describes in following lines. The term "[trade/customs] single window" ([TSW/CSW]) can be defined as an information system that covers procedures related to exports and imports goods such as customs clearance. Sometimes for some countries, [TSW/CSW] may act a role of an MSW as well. Secondly, Port Single Window (PSW) provides local level information about a vessel to the authorities at port level. PSW systems may be connected to a higher level NSW or MSW. In the latter case, PSW systems may play the role of single point of access for NSW regarding reporting formalities. PSW can also be part of the wider PCS in a Port.

Specifically, the term "port community system" (PCS) can be defined as a computerized system that simplifies information exchanges between non-public authorities in a port. This typically includes functionality also found in single windows, such as databases, message exchanges, etc. The definitions used in other literature vary somewhat between authors and context. Exchange of information with governmental parties could also be part of the scope of a PCS - and may be connected to a higher level NSW or MSW. A PCS is a modular system with functionality designed to provide all the various sectors and players within a port community environment with tools specific to them, thus delivering a tightly integrated system. Developed for port users by port users, a PCS encompasses exports, imports, transhipments, consolidations, hazardous cargo, and maritime statistics reporting. In parallel with the global development and establishment of national Single Windows, Port Community Systems (PCS) have been implemented in major ports around the world, such as Le Havre, Felixstowe, Barcelona, Rotterdam, and Hamburg. A PCS is conceptually like a Single Window, although it focuses more on logistics than on the regulatory dimension of trade. It is an electronic platform that connects the multiple systems operated by a variety of organizations that make up a seaport or airport community. It is shared in the sense that it is set up, organized, and used by firms in the same sector – in this case, a port community[109].

Particularly, Port Management Information System (PMIS) is sometimes used by the harbour master or other maritime authorities in a single or group of ports to keep track of ship movements, tug, and pilot usage etc. This system may be integrated with PCS.

Finally, another important thing about NMSW is its interconnectivity with other SW and other electronic devices and systems for maritime and transport data exchange. The relation scheme between all mentioned systems in the national framework is depicted on the figure 6 below[110].

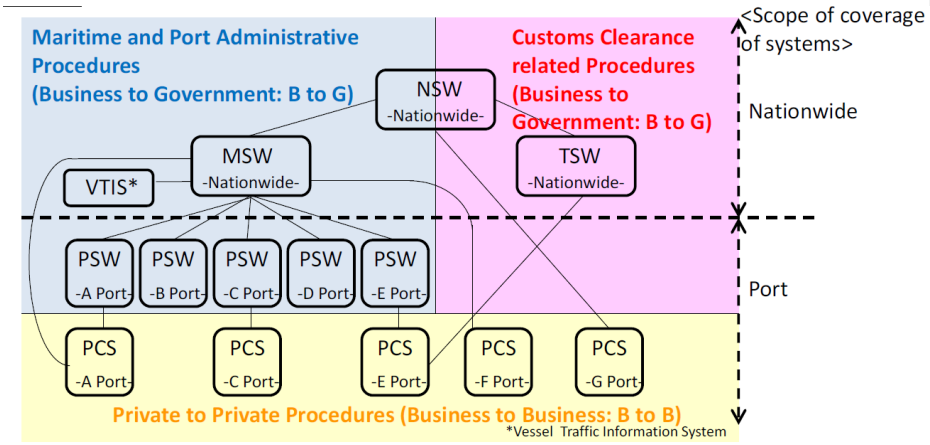

Figure 6. Conceptual relations between each single window system in national framework

Specifically, the Vessel Traffic Information System (VTIS) is often used to keep track of ship movements in and around national waters and may also include transit traffic. It is used for supervision of traffic, by Vessel Traffic Services and ship reporting systems. It typically uses Automatic Identification System (AIS) base station networks, AIS satellites or Long-Range Identification and Tracking System (LRIT), as well as ship reports as its input data[111].

Ports are increasingly obliged to promote a higher visibility, enhanced environmental awareness, and improved responsiveness to avoid disruptions and cascading effects, having a negative impact on related logistics chains. This includes establishing an electronic single window to fulfil import, export and transhipment-related regulatory requirements, such as EU-Directive 2010/65/EU on reporting formalities for ships arriving in and/or departing from ports. Main objectives of NSW implementations are the streamlining, harmonization, and coordination of reporting formalities and procedures mainly by electronic means. Therefore, the adoption of IT/IS greatly enhances its implementation. The stage of an NSW implementation is dependent on its current scope of connecting involved companies, authorities, and countries through the exchange of information[112]. Along with other information technologies in port, NMSW takes one of the core and top positions in general ort system enabling other technologies smooth and consistent performance, as depicted in the figure 7 below[112]..

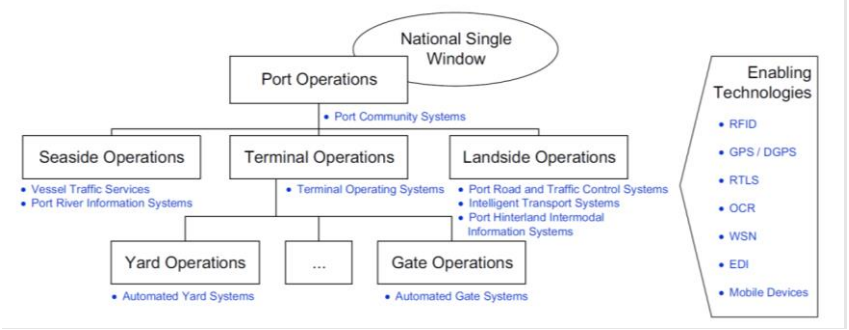

Figure 7. Classification of port-related information systems

2.3.2 Establishment of National Maritime Single Window

Recently, the FAL Committee, at its forty-fifth session (1st to 7th June 2021), approved the Guidelines for setting up a maritime single window, summarized in further lines.

The stated Guidelines were issued with the purpose to further facilitate the administrative procedures in shipping business, making them easier and reducing the number of steps to spare time, increase digitalization and accuracy of performed services, reduce many efforts and materials, and foster single integrated approach to relevant vessel data and information within user community related to maritime transport. This inclusion in a "single window" environment is seen as an effective way of delivering Standard 1.3*bis* (FAL Convention) and addressing the overall administrative burdens on shipping. In this regard, a single window environment should be implemented based on these Guidelines. Also, it should be noted that these guidelines do not develop any standard for implementing a single window, but they are just pointing to different internationally recognized standards that are available and can be utilized as appropriate.

The main characteristics of a single window environment, at least between individual ports within the same country, are harmonization, standardization, and interoperability, avoiding proprietary technology and/or data models, and supporting the goal of international interoperability between single window environments in the future. Even the top responsible institutions in maritime transport area, such as United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), the World Customs Organization (WCO) and other organizations, provide only the basic definitions, models, data harmonization or road maps towards implementation of a single window environment, a particular country that is introducing the NMSW, faces with many difficulties in establishment of single window environment, especially in maritime reporting element covering. In this regard, the goal of the adopted Guidelines is to help creating the environment that will be able to manage:

1) simplified electronic means of clearance of ships in maritime transport,
2) standardization of logistic activities, interface, and information in overall marine transport,
3) improved maritime logistics efficiency and strengthened maritime logistics competitiveness of IMO Member States.

In general, the first step for implementation of NMSW is to define the target user community and its features, capabilities, needs and goals. The target audience of these Guidelines are public authorities or Administrations responsible for developing or modifying environments for a Maritime Single Window (MSW) and Contracting Governments that encourage the introduction of MSW environments to the public authorities etc. As known, the single window environment consists of several stakeholders, parties which interact among themselves including carriers, freight forwarders, principals, ship agents. These parties are obliged and responsible to perform procedures of documentation reporting and forwarding the filled papers to each other. For instance, the clearance process assumes necessary permits (written, electronic or informal) to allow a certain step to be performed such as entering/leaving the port, berthing/unberthing, cargo and passengers control, loading/offloading the cargo and passengers, importing/exporting the cargo. The main documents that cover mentioned clearance steps are cargo manifest, bill of lading, waybill and other FAL documents [118]. Further to these documents, every party involved in NMSW community, need to cooperate using fundamental Information technologies such as Electronic Data Interchange (EDI), UNECE-UN/EDIFACT [119], electronic signature and seal.

Further to the mentioned conditions, NMSW is constrained with technical standard requirements imposed by several following entities:

- IMO: Facilitation Committee (FAL), cooperation with Member States about setting the MSW,
- World Health Organization (WHO), related to health standards and regulations,
- World Customs Organization (WCO), with the developed WCO DATA Model, containing the set of carefully combined data requirements that are supportive and updated to meet the procedural and

legal needs of cross-border regulatory agencies such as customs, controlling export, import and transit transactions,
- World Trade Organization (WTO), with goal is to ensure that trade flows as smoothly, predictably, and freely as possible,
- United Nations Economic Commission for Europe (UNECE),
- United Nations Conference on Trade and Development (UNCTAD),
- United Nations Commission on International Trade Law (UNCITRAL),
- UN Centre for Trade Facilitation and Electronic Business (UN/CEFACT),
- International Organization for Standardization (ISO),
- SMDG is a non-profit foundation, run by and on behalf of companies and organizations working in the maritime industry, with container terminals, ocean carriers, elated companies, and organizations,
- Transportation Data Coordinating Committee (TDCC) and Accredited Standards Committee (ASC X12),
- Organization for the Advancement of Structured Information Standards (OASIS) – ebXML,
- PROTECT Group, with aim to harmonize the implementation of the UN/EDIFACT standard messages for vessel reporting in the different ports.

The implementation of a Single Window generally entails the harmonization and alignment of the relevant and most recent trade documents and data sets. To ensure compatibility with other international systems and applications, these documents and data models must be based on international standards and recommendations. Whenever electronic data interchange is involved, the harmonisation, simplification and standardization of all data used in international trade is an essential requirement for smooth, automatic operation of the Single Window. The harmonization of data used by different participants in their legacy system can be one of the biggest challenges for automated Single Window implementation. UNECE trade facilitation recommendations (such as UNECE Recommendations N°1 and N°18) contain valuable information on Single Window implementation, as do the UN/CEFACT data libraries and reference data models[113].

Particularly related to National Maritime Single Window and trade business data harmonization, the purpose of the International Trade and Business Processes Group (TBG) is to be responsible for private- and public-sector business requirements and content. This is achieved by initiating developments in the areas of process analysis, best practices, and international trade procedures. Where appropriate, the UN/CEFACT Modelling Methodology (UMM) is used to support the development of trade facilitation and electronic business solutions. TBG17 (Core Component Harmonization), one of the UN/CEFACT groups, is responsible for consistency and harmonization of core components across business domains and sectors, contributing to a concise and well-defined glossary of business terms and business data semantic definitions and to the structuring of data exchanges.

An important part of the single window design is to harmonize the representation of data between the different authorities and users of the single window. This is discussed in the WCO Data Model on Single Window Data Harmonization (WCO Data Model). The FAL Compendium contains cross references to all the FAL forms and data elements occurring in each. This cross reference also contains maps to the corresponding data element in the WCO Data Model[114].

To summarize, Single Window projects also involve some form of business process redesign, document simplification and data harmonization. Individual aspects of the implementation include policy planning, setting the legal and institutional framework, undertaking a business process analysis, simplifying trade documents, organizing the data harmonization for the Single Window, and managing the project, as shown in the figure below [115].

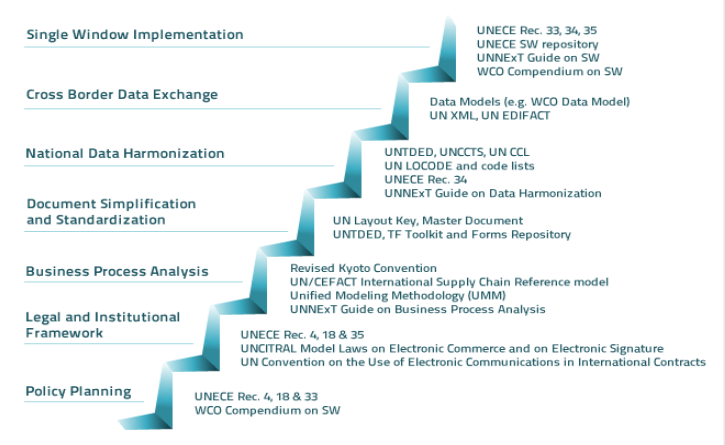

Figure 8. Single Window Step-by-Step approach

2.3.3 Relevant models of NMSW development and governance

A Single Window should represent close cooperation between all parties involved in cross-border transactions, including governmental authorities and agencies as well as the trading community. Facilitation can be greatly enhanced if Governments identify and adopt relevant information and communication technology (ICT) for a Single Window. Based on these premises and being the main requirement for the implementation of Directive 2010/65/EU, the general and conceptual regional model of NMSW should look as depicted on *Figure 9*. [116]

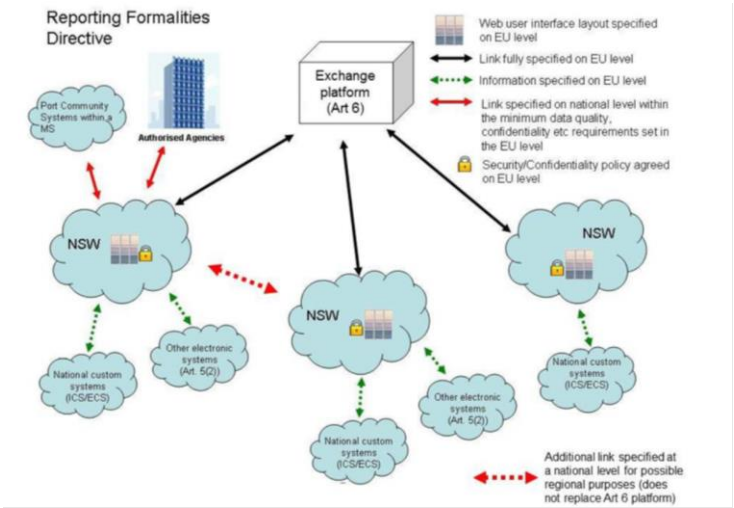

Figure 9. Fundamental conceptual model of NMSW with related components

This Conceptual Model illustrates that the NSW consists of an environment whereby ship data providers can submit information electronically either through a user interface or a system-to-system interface. Port

Community Systems could be included as part of this environment if they respect the same requirements of the NSW with respect to the services delivered to comply with Directive 2010/65/EU. The business processes used by the shipping industry for submitting notifications, updating data in the notifications, and receiving receipt and acknowledgement messages from the relevant authorities concerned via the NSWs should be harmonised at EU level.

Furthermore, as proposed in EC National Maritime Single Window Guidelines, the NMSW general configuration of the system and its relations with other Member States NMSW systems covers the following components for information flow within national requirements for NMSW:

a) the submission of information by the shipping industry (e.g., ship master, operator, or agent) and the receipt of decisions from authorities.
b) the distribution of the received information to the authorities and the submission of their; decisions to the shipping industry; and
c) the exchange of relevant information between Member States via the SafeSeaNet system.

Within the general system configuration, depicted on Figure 10, there are many possible ways of how to define the architecture of an NSW as each Member State will have its own unique requirements and conditions. The national architecture will, for example, depend on[116]:

a) whether the NSW must be linked to other authorities' systems or authorities will only access information through an NSW user interface.
b) whether the national SSN system will form part of the NSW solution, or it will continue to be a separate system but linked on a system-to-system basis.
c) which legacy systems will be included within the NSW environment?

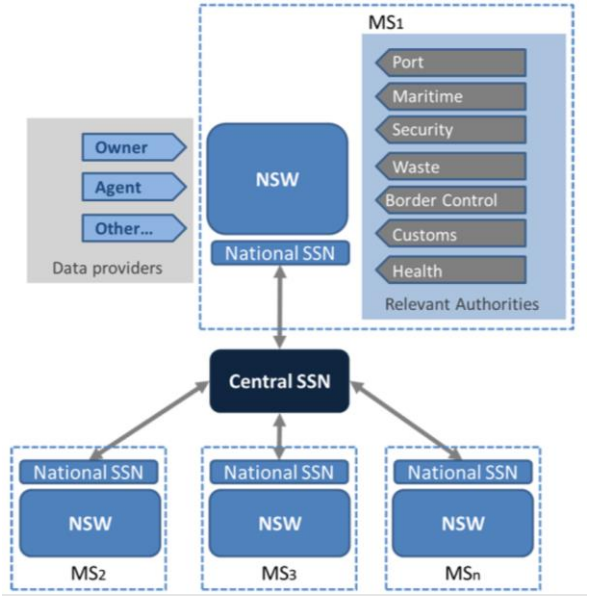

Figure 10. NMSW system configuration including SSN

Practically, as known from the figure above, the NMSW system and business consists of three major parties:

- Data providers,
- NMSW Leading Authority,
- Other relevant authorities.

First and most important role in this system have ship data providers since they are responsible to submit the ship notifications and other relevant information as required by FAL Forms. All the reporting formalities deal with information that concern details of the ship: its particulars, voyage, generated waste and the persons and cargo carried on board. The Directive states that "Member States shall ensure that the master or any other person duly authorised by the operator of the ship provides notification". Therefore, the Directive does recognise that in many cases the reporting obligations may be carried out either by ship owners/operators or by agents authorised by the ship owners/operators. This is also in compliance with the FAL Convention which determines that formalities are "either signed by the master, the ship's agent or some other person duly authorized by the master or authenticated in a manner acceptable to the public authority concerned".

After the relevant data and information are submitted by shipping companies, the second most important component in the NMSW system chain is the NMSW Leading authority which manages the data and overall system platform for reporting. The lead agency requires a clear governmental mandate (often through domestic legislation) that empowers this agency to orchestrate all cross-border agencies' requirements for import, export, and transit. It must be a very strong organization with the necessary vision, legal authority, and political backing, such as a National Trade Facilitation Body or a dedicated Single Window coordination body[117].This organization must have the appropriate political support, legal authority, human and financial resources and links to the business community. This authority is fully responsible for:

- confirmation to the data providers the receipt of the data,
- distribute or make available the data to the relevant authorities,
- provide the users (ship data providers and authorities) of the NSW with the appropriate user authentication,
- authorise and specify interface requirements for ship data providers who may transmit data to the NMSW,
- define the mechanisms to ensure the credentials of the users.

Thirdly and subsequently to second stage NMSW leading authorities, the required vessel information and data go to legacy systems of the other relevant authorities. Article 4 of the Directive states that the ship is to provide "the information required under the reporting formalities to the competent authority designated by that Member State". The relevant authorities described below are those authorities which require access to or directly receive the information that is transmitted via the NSW. These authorities are Port Authority, Security, Health, Customs, Waste, Border Control, and other authorities.

Considering the experiences of the past 20 years of national Single Window development and the parallel development of concepts such as sector specific Single Windows and Port Community Systems, it is essential that national Governments, regional and international organizations as well as key stakeholders from the international private-sector community collaborate in key initiatives to support and guide the development of an integrated strategy for a globally networked Single Window.

2.3.4 Architecture and layout of NMSW

The methodology for establishing and setting up the technical system of NMSW is mostly based on the underlying principles of a recently developed information technology called Service-Oriented Architecture (SOA). SOA is a software design methodology for implementing an information system comprising interoperable, reusable services. In other words, SOA implements a distributed information system so that services can be discovered and used within multiple, separate subsystems across several business domains. Flexibility is enhanced through

the loose coupling of services. Interoperability is enhanced across heterogeneous software applications by using a well-known standard for defining and accessing these services. That combination, flexibility, and interoperability enable agile adaptation to rapidly changing business environments. This technical methodology covers the overall process and method for implementing a single window. It is a technical methodology for the design, implementation, and operation of a single window system for maritime transport business in a detailed manner. That process has five phases: planning, analysis, design, implementation, testing, and delivery. These phases are shown in Figure 11, which also shows the detailed tasks for each of the five phases [120].

In principle, a single window system for maritime transport business should be scalable in its structure and, to the extent possible, reusable. It should be based on analysed and applicable business processes and low-level functions as simple service components. They can be used as it is or composed (assembled) into more complex services as needed. The SW system should be designed in such a way that users can access it using standard communication protocols. NSW systems should provide a harmonized interface for international data exchange with other (N)SW and systems operated by the maritime transport industry.

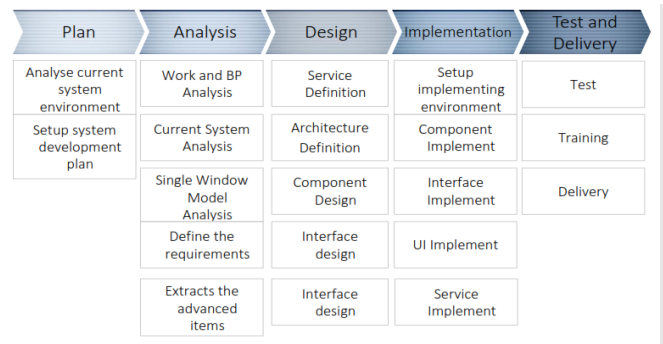

Figure 11. Single window service development and implementation methodology

Every NMSW architecture must fulfil several required technical and operational features. First and maybe the most important is the interface between ship data providers. Ship Data Providers may submit notifications (initial, updates, cancelations) and receive receipt and acknowledgment messages through a system-to-system interface or through a user interface. The whole information flow (notifications, receipts, acknowledgments) related to a single ship port call must be associated to an identifier of the port call. The identifier must be unique for each ship call in the ports of the Member State and guaranteed by the NSW. The “voyage number”, found in the FAL forms, may also be considered to identify a ship call. The voyage number is provided by the Ship Data Provider in the original notification and in all update notifications. The NSW will make the distinction between notifications sent before arrival (“arrival notifications”) and notifications sent before departure (“departure notifications”). Arrival notifications and Departure notifications regarding the same ship port call can have distinct identifiers.

Further to the information exchange, the NMSW data must satisfy all the quality standards, meaning that the data provider is responsible for the quality of the data transmitted to the NSW. The establishment of common data quality validation rules are important because the NSW is the entry point for all the information which is processed at national level and exchanged with other Member States via SSN. It is important to bear in mind that the relevant parts of information transmitted through the NSW should also be made available in the national SSN where the quality data standards are already established. Also, Member States must comply with the requirements of the SafeSeaNet Interface and Functionality Control Document (IFCD) where the data quality

requirements are set. In terms of these provisions Member States should ensure that the agreed automatic data quality rules for SSN are applied prior to notifications being sent to the central SSN system [121].

Due to the rapid evolution of technologies during the last decade and the exponential rise in the possibilities of exchange and storage, it is recommended to have an open architectural vision geared to the future. Central topics for this approach are the following:

- modular design and standardised interfaces.
- ensure interconnection with ships/agent for reporting.
- ensure interconnection with authorities and entities having autonomous systems.
- exchange with stakeholders/users not having (own) computer systems.
- compensate for the absence, the poor quality or the high costs of telecom links; and
- ensure continuity of the service.

The FAL Convention encourages the use of modern information and communication technology and electronic exchange of information, including electronic data interchange (EDI), to transmit information related to maritime transport. The use of electronic data interchange is a central part of the conceptual architecture [122].

As already recognized, NMSW represents an integral and common information framework with single point of data entry for all documents needed by the relevant governmental maritime authorities and distributed among involved stakeholders. Responsible maritime authorities need to identify the maritime transport stakeholders for an efficient formal documentation submission according to the national law and initiated a plan for an integrative maritime system design development accordingly. Considering the existing legacy ICT systems and available technologies used in regular operations of all involved institutions, the following structural approach proposes an indicative NMSW architecture design and deployment. Model assumption is that the NMSW system is following the Service Oriented Architecture (SOA) concept, where software and hardware systems are independent, with embedded scalability and reusability of its modules. Furthermore, the use of Enterprise Service Bus (EBS) is recommended for the NMSW data processing, as a software architecture model for distributed computing. It is used to facilitate the implementation of communication between mutually interacting maritime software applications in a SOA environment. In terms of the physical layout and components, and considering immediate availability of suitable venues in most relevant cases, NMSW system consists of the following essential elements:

- NMSW administrator's office,
- Data Centre #1 (location #1),
- Data Centre #2 (location #2),
- Education/Presentation centre.

The MSW administrator's office should be separated from other premises with NMSW servers/equipment. Data Centre #1 is a primary location of all NMSW hardware and network equipment (Web service servers, database servers, backup server, and network infrastructure) necessary to establish MSW operations with sufficient capacity to store all data backup to hard drives and then offload to tapes. This centre must be networked to Data Centre #2, via the Internet using a separate media data link and a logical tunnel. Data Centre #2 plays the role of redundant location with all hardware and network equipment in case that Data Centre #1 fails to perform MSW functionalities due to any reason. The general layout containing the key IT components is shown in the figure 12 below.

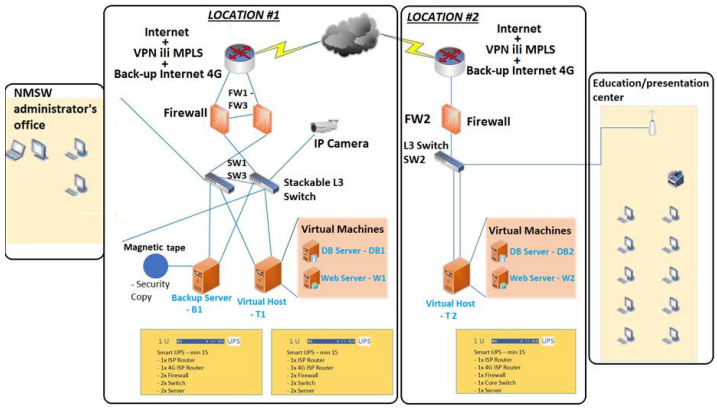

Figure 12. NMSW design proposal: hardware and network perspective

2.3.5 Benefits, sustainability, and security of NMSW platform

The objective of NMSW is to make trading easier both for private-sector operators and government agencies. It is not meant to only dematerialize existing paper processes, since the establishment of an electronic system for a Single Window means that main goal is to achieve trade facilitation not just an ICT system enhancement. The implementation of a Single Window has proven to be highly beneficial for both Governments and trade. For Governments it can bring better risk management, improved levels of security and increased revenue yields with enhanced trader compliance. Trading communities benefit from transparent and predictable interpretation and application of rules and better deployment of human and financial resources, resulting in appreciable gains in productivity and competitiveness. Any implementation of a Single Window should result in a visible reduction in the time and cost of doing trade [123]. This includes the enhanced risk management as well, being the fact that single entry point for data and information submission of reports structured according to FAL Forms will decrease the risk of data mistakes, losses, missing and inaccuracy.

The NSW can improve the processes of the authorities and may lead to a better organisation of existing governmental procedures, while at the same time promoting a more open and simplified approach to the way in which authorities operate and communicate with industry. For example, as the shipping industry will submit electronically all the required information, which is automatically made available to all authorities entitled to have this information, more effective systems can be employed by the authorities to carry out quicker and more accurate validations. This should also result in better co-ordination and co-operation between the authorities involved in ship clearance procedures.

The main benefit for the shipping industry is that they will have a single point for the submission of all required information to all authorities involved in ship clearance procedures. Furthermore, the use of NSWs facilitates the provision of up-to-date information to the industry. As the NSW enables authorities to process submitted information, both faster and more accurately, ships should benefit from faster clearance and release times, enabling a faster turnaround in ports. In addition, the improved transparency and increased predictability can further reduce the potential for corrupt behaviour from both the public and private sector [124]. Generally, the summarized comparative benefits for both administration and shipping industry are given in the Table 1.

Table 1. *Summarized benefits of NMSW implementation*

Benefits of NMSW for administrative bodies	*Benefits of NMSW for related shipping industry*	*Benefits for trade*

• more effective and efficient deployment of resources. • Provides a 360-degree view of every shipment/consignment entering, leaving, and transiting through the country. • correct and increased revenue yield. • improved compliance. • enhanced security. • increased integrity and transparency.	• cutting costs through reducing delays. • faster turnaround times. • more effective and efficient deployment of resources. • increased transparency. • savings in the costs for implementing reporting tools.	• Tangible cost savings. • Faster clearance and release. •Predictable application and explanation of rules. • More effective and efficient deployment of resources; •Increased transparency.

As identified in recent research by Tijan et al. (2019), all major aspects of the sustainability principles, namely economic, environmental, and social seaport sustainability enhancements are directly derived and attributed to introduction of NSW/NMSW. Furthermore, cross-component benefits of MNSW implementations were also identified, resulting in creation of the synergy effect and positive impact on the seaport business. Some of the identified effects are [125]:

- Reduction or elimination of paper documents contributes not only to the economic seaport business sustainability in terms of reduced costs or time for providing operations, but also to the environmental sustainability through reduced demand for logging and deforestation, which is a typical example of synergy effect crossing individual stakeholder lanes.
- The MNSW, as the "single entry point" system, reduces time-consuming activities in seaport business by enabling the reuse of already entered data which finally contributes to the economic sustainability of seaport business. Further benefits are achieved through reduction of the fee charges, increasing stakeholders' liquidity and financial position.
- Decreased time affects the environmental sustainability aspect through the elimination of unnecessary movements, enabling the efficient use of natural resources and decreasing emissions.
- Enforcement of the "single entry" principle via MNSW enables improved communication and information exchange between stakeholders and eliminates the differences between individual systems and input errors during information and document exchange. MNSW also provides common regulations (legal framework) which simplifies communication and information exchange between stakeholders.

Governance between the government agencies and stakeholders is required to ensure that when legislation changes the SW can be updated without affecting the operation. Specifically, there should be clear guidance on data protection and privacy of information to ensure all national, regional, and international regulations are complied with. All the information included in the reporting formalities is considered as "unclassified" and no special security measures should be taken. Nevertheless, this information shall be considered as sensitive and shall be protected from unauthorised access or disclosure. Overall, when considering a SW, the legal framework and governance is critical and should be developed so that there are clear responsibilities and liabilities for the system development, maintenance, and operation[126].

For the electronic transmission of the reporting formalities, carried out by the master or any other duly authorised person, there is no need for a signature. Member States shall develop mechanisms to ensure the non-repudiation and traceability of actions performed by all persons accessing the NSW by means of both automated systems (system interface) or the user interface.

Member States are responsible to implement a reliable authentication mechanism to uniquely identify the persons accessing the NSW. The NSW shall give the possibility to verify the history, location, or application of the information by means of documented recorded identification: user identification, timestamp, action performed.

Information provided by another Member State via SSN is considered as provided by a trusted data provider. The protection of personal data at national level (NSW) shall be in line with national legislation for data protection and with Directive 95/46/EC. The protection of personal data at central level shall be in line with Regulation (EC) No 45/2001 on protection of data by the Community Institutions and bodies [126].

2.4 Ongoing visibility and digital initiatives for the railway sector

2.4.1 Overview

On ongoing digitalization and visibility initiatives in railway sector are touching many aspects of railway operation system. One part of work is focused on software technology where systems that support railway operation in sharing information about traffic status, and issues on railway infrastructure. Second part is hardware that generate information in automated way, and in future.

One of the most important initiatives of ongoing digitalisation are:

- Automating Train Operation (ATO) is an operational safety enhancement device used to help automate the operation of trains. The degree of automation is indicated by the Grade of Automation (GoA), up to GoA level 4 (where the train is automatically controlled without any staff on board). ATO is primarily used on automated guideway transit and rapid transit systems where it is easier to ensure the safety of humans. On most systems, there is a driver present to mitigate risks associated with failures or emergencies. In future this technology can provide information about real time train localisation [1].

Table 2. *Levels of automation [1]*

Grade of automation	Train operation	Description
GoA 0	On-sight	No automation
GoA 1	Manual	A train driver controls starting and stopping, operation of doors and handling of emergencies or sudden diversions.
GoA 2	Semi-automatic (STO)	Starting and stopping are automated, but a driver operates the doors, drives the train if needed and handles emergencies. Many ATO systems are GoA 2.
GoA 3	Driverless (DTO)	Starting and stopping are automated, but a train attendant operates the doors and drives the train in case of emergencies.
GoA 4	Unattended train operation (UTO)	Starting and stopping, operation of doors is all fully automated without any on-train staff. It is recommended that stations have platform screen doors installed.

- Traffic management system (TMS) - Rail Traffic Management Systems are systems designed to support managing the inherent complexity of rail services and rail networks by providing an integrated and holistic view of operational performance, enabling rail operational staff to better balance the sometimes competing demands of aspects such as track access and train crew resources when taking decisions. Rail Traffic Management Systems support railway operations processes and procedures, and are systems based on the concept of a single, integrated, and consistent set of operational data, enabling high levels of rail operations efficiency [2].
- Digital automating coupling (DAC) is technology that connects wagons so that they form a train. In this type of coupling is that this connection, or coupling procedure, is automated. Uncoupling at DAC Level 4 is partially automated and should be in use by 2030. What's more, DAC Level 4 provides wagons with a continual electricity supply and consistent data connection. This will make it possible in the future for wagons to communicate with each other and with the locomotive. DAC has different levels according to their stage of development [3].

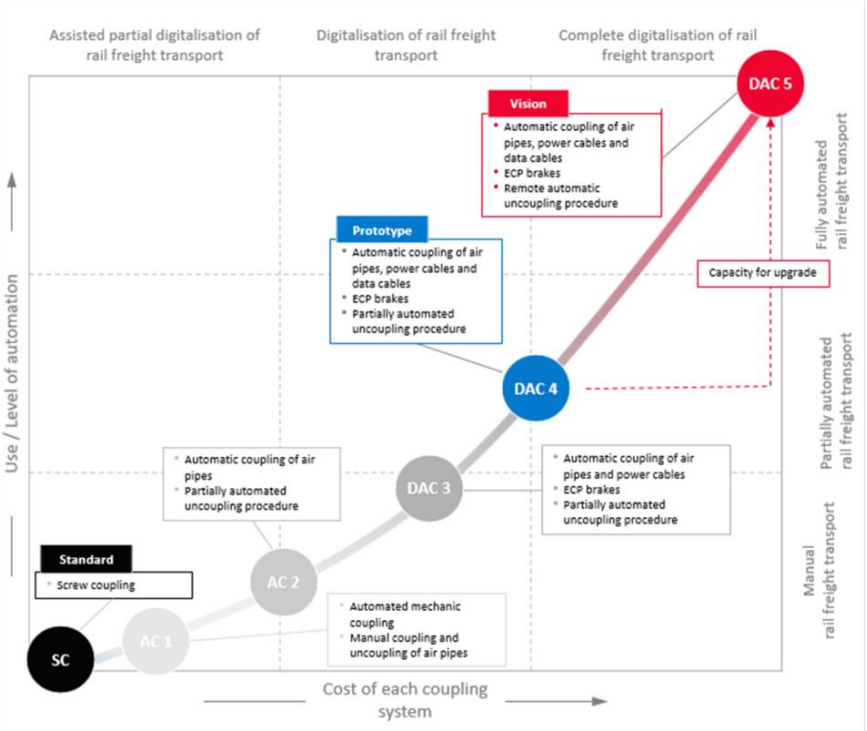

Figure 13. Levels of DAC [3]

- European Rail Traffic Management System (ERTMS) - a single European signalling and speed control system that ensures interoperability of the national railway systems, reducing the purchasing and maintenance costs of the signalling systems as well as increasing the speed of trains, the capacity of infrastructure and the level of safety in rail transport. the European Rail Traffic Management System (ERTMS) is a single European signalling and speed control system that ensures interoperability of the national railway systems, reducing the purchasing and maintenance costs of the signalling systems as

well as increasing the speed of trains, the capacity of infrastructure and the level of safety in rail transport [4],

- Future Railway Mobile Communication System (FRMCS) - the future worldwide telecommunication system designed by UIC, in close cooperation with the different stakeholders from the rail sector, as the successor of GSM-R but also as a key enabler for rail transport digitalisation [5].

Structure of use case ongoing digitalization & visibility initiatives in this work is presented in the figure below

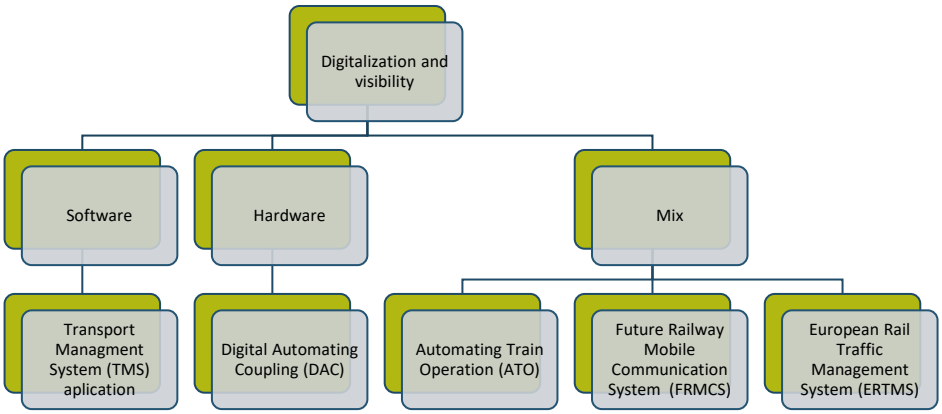

Figure 14. Classification of initiatives in work

In the next section there are described initiatives connected with ongoing digitalization & visibility initiatives for railway sector. Initiatives are divided by funding scheme of the project:

- Shift2 Rail Joint Undertaking initiatives,
- Europe's Rail Joint Undertaking initiatives,
- International union of railways initiatives,
- Connecting Europe Facility initiatives

2.4.2 SHIFT2Rail Joint Undertaking

Shift2Rail is HORIZON 2020 Joint Undertaking for railway sector. The work conducted within the Shift2Rail framework is structured, around five asset-specific Innovation Programmes (IPs), covering all the different structural (technical) and functional (process) subsystems of the rail system. Figure 2 shows the Shift2Rail program structure.

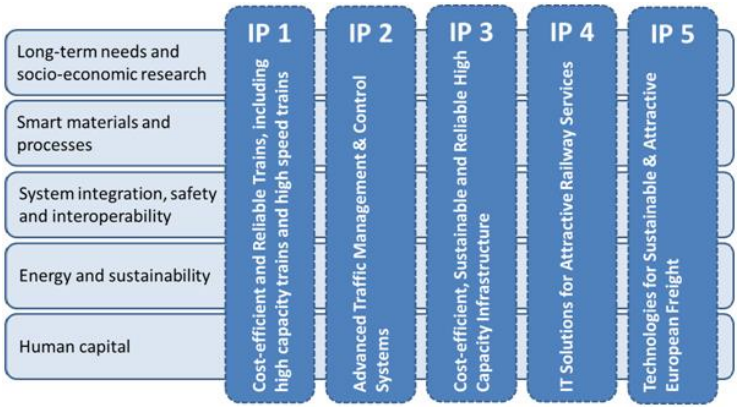

Figure 15. Shift2Rail topic breakdown [6]

Interactions between the various IPs is of major importance, given that technological developments in one part of the system could lead to changes in performance or even create barriers in another part of the system managed by another actor.

In addition, cross-cutting activities will also include research on long-term economic and societal trends such as customer needs and human capital and skills, which must be considered by the different IPs.

Sustainable growth of the rail sector requires a dedicated and balanced approach addressing specific common research and innovation (R&I) challenges, while integrating and demonstrating cooperation between stakeholders across the whole rail value chain.

Responding to these challenges will require different types of activities, including:

- demonstration activities
- research and technological development activities
- other supporting activities.

In addition to these three types of activities that are funded and conducted directly by the Shift2Rail JU, the members of the Shift2Rail JU will be required to conduct additional activities with a view to leveraging the effect of the R&I activities undertaken within Shift2Rail.

2.4.2.1 cOmmunication Platform for TraffIc ManAgement demonstrator

Table 3. *Project: OPTIMA*

cOmmunication Platform for TraffIc ManAgement demonstrator (OPTIMA)			
Scope:	Traffic management system (TMS)		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 2 249 897,50	from 12/2019 to 02/2023	Jose Bertolin UNIFE	http://www.optima-project.eu/

In this project systems that offer precise, real-time traffic information are fundamental for effective traffic management in the railway sector is being developed. Advanced software solutions provide successful traffic management operations.

The EU-funded OPTIMA project is designing and developing a communication platform to manage the connection between several services supporting transportation management system (TMS) applications.

The platform will link TMS applications with infrastructure systems such as traffic control, maintenance, energy management and signalling. The platform will consolidate real-time data from the railway business service, test the connection of several rail business services with external services and provide a perfectly documented communication platform for supplementary projects. OPTIMA is advanced by a consortium of research institutions, industrial stakeholders and infrastructure managers specialising in traffic control and management.

2.4.2.2 SMART-RAIL: Smart supply chain oriented rail freight services

Table 4. *Project: SMART-RAIL*

SMART-RAIL: Smart Supply Chain Oriented Rail Freight Services (Grant agreement ID: 636071)			
Scope:	Traffic management system (TMS)		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 5 999 213,00	from 05 2015 to 05/2018	Mr Paul Tilanus TNO	https://smartrail-project.eu//

A European consortium of 19 research and commercial partners aims to improve rail freight services offered to shippers, focusing on reliability, lead time, costs, flexibility, and visibility. The SMART-RAIL project looks at the European rail freight system, integrating existing and new knowledge that originates from various parts of this system. This integrated knowledge will support collaborations across the European market so that systems can further innovate and optimize their operations.

SMART-RAIL is one of the lighthouse projects of SHIFT2RAIL and contributes to Innovation Programme 5.

2.4.2.3 FR8RAIL: Development of Functional Requirements for Sustainable and Attractive European Rail Freight

Table 5. *Project: FR8RAIL*

FR8RAIL: Development of Functional Requirements for Sustainable and Attractive European Rail Freight (H2020-S2RJU-CFM-2015-01-1)			
Scope: DAC			
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 3 478 222,51	from 09 2016 to 07/2019	TRAFIKVERKET - TRV	https://projects.shift2rail.org/s2r_ip5_n.aspx?p=FR8HUB

The FR8RAIL project proposal is submitted as part of the Shift2Rail Research and Innovation Action. Within the FR8RAIL project proposal there are eighteen European partners. The main aim of the FR8RAIL project proposal is the development of functional requirements for a sustainable and attractive European rail freight.

These objectives of FR8RAIL are A 10 % reduction in the cost of freight transport measured by tonnes per Km. A 20 % reduction in the time variations during dwelling and increase attractiveness of logistic chains by making available 100 % of the rail freight transport information to logistic chain information systems.

The objectives of the FR8RAIL project will be achieved by developing several vital areas within freight rail. There are six main areas of work that form the backbone of this proposal's approach in achieving the development of functional requirements for a sustainable and attractive European rail freight. The work areas are:

1) Business Analytics, KPIs, Top Level Requirements,
2) Condition Based and Predictive Maintenance,
3) Telematics & Electrification,
4) Running Gear, Core and Extended Market Wagon,
5) Automatic Coupling,
6) High level System Architecture and Integration.

The outcome of FR8RAIL and its deliverables are expected to positively contribute to and support the Shift2Rail goals set out in the Strategic Masterplan and the Multi Annual Action Plan viz. to strengthen the role of rail in the transport system, and in particular freight rail transport.

2.4.2.4 Accelerated DAC transformation to full digital rail freight operations in Europe

Table 6. *Project: DACcelerate*

Accelerated DAC transformation to full digital rail freight operations in Europe (Grant agreement ID: 101046657)			
Scope:	DAC		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 2 171 998,02	from 01/06/2021 to 31/12/2022	Filip Kitanoski Kompetenzzentrum - Das virtuelle Fahrzeug Forschungsgesellschaft GmbH	https://projects.shift2rail.org/s2r_ip5_n.aspx?p=DACCELERATE

The objectives of DACcelerate for laying the foundation for an effective and cost-efficient DAC roll-out and for full digital rail freight operations in Europe are:

- Systemic EDDP implementation for accelerating the adoption of a European DAC solution
- Harmonized European DAC specification ready for product development, integration into operations and for the EU regulatory Framework (TSI)
- European Migration Strategy for effective roll-out and full integration by 2030
- Impact Assessment and Attractiveness: Assessment of the wider socio-economic benefits of a DAC introduction for network capacity and contribution to the targets of the EU Green Deal; Preparation for the transformation of job profiles and required new skills for shaping attractive new workplaces
- DAC Impact awareness by stipulating broad engagement of sector actors and all EU Member States

2.4.2.5 X2Rail-1: Start-up activities for Advanced Signalling and Automation Systems

Table 7. *Project: X2Rail-1*

X2Rail-1: Start-up activities for Advanced Signalling and Automation Systems (S2R-CFM-IP2-01-2015)			
Scope:	ETCS ATO		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 18 090 998,97	from 09/2016 to /06/2021	SIEMENS MOBILITY GMBH	https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-1

The X2Rail-1 project aims to research and develop six selected key technologies to foster innovations in the field of railway signalling and automation systems towards a flexible, real-time, intelligent traffic management and decision support system.

The actions to be undertaken in the scope of X2Rail-1 are related to the following specific objectives:

- To overcome the limitations of the existing communication systems by adapting radio communication systems which establish the backbone for the next generation advanced rail automation systems.
- To improve the usable track capacity by introducing more Automatic Train Operation (ATO) systems and Moving Block systems.
- To innovate the signalling architectures towards more decentralized and less cost intensive systems by incorporating Moving Block systems and Smart Wayside Objects.
- To minimize energy consumption and to improve train punctuality through more extensive use of Automatic Train Operation (ATO) systems.
- To increase innovation in the field of lab testing by developing architectures for new lab test systems and simulations for control, command and communication systems in order to reduce costs.
- To ensure security among all connected signalling and control systems by developing new cyber security systems dedicated to railways.

To ensure the backward compatibility of ERMTS/ETCS technologies, notwithstanding of the required functional enrichment of the future signalling and control systems.

2.4.2.6 X2Rail-2: Enhancing railway signalling systems based on train satellite positioning, on-board safe train integrity, formal methods approach, and standard interfaces, enhancing Traffic Management System functions

Table 8. *Project: X2Rail-2*

X2Rail-2: Enhancing railway signalling systems based on train satellite positioning, on-board safe train integrity, formal methods approach and standard interfaces, enhancing Traffic Management System functions			
Scope:	ETCS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 30 152 828,03	from 09/2017 to 04/2021	Gianluigi Fontana Hitachi Rail STS	https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-2

Considering the nature of signalling and automation systems, X2Rail-2 aims to improve the performance at a railway system level by introducing new functionalities at sub-system level as well as on the architectural level that should revolutionize the signalling and automation concept for the future.

X2Rail-2 follows a holistic system approach to create the building blocks for Shift2Rail IP2. Thus, the outcomes at individual technology level will be combined to bring a benefit at system level.

The key technologies within X2Rail-2 cover GNSS application in Railway and advanced technologies for implementing new signalling and automation functionalities. These functionalities are addressed in individual but interconnected work streams, each focusing on different key technologies such as safe on – board systems, TMS, etc.

To enable a rapid ramp up of these new technologies, new lab test strategies and environments are addressed as well in cooperation with ongoing IP2 projects (e.g.: X2Rail-1), facilitating the approval and time-to market procedures. To make best use of technical innovations developed and provided by other sectors, X2Rail-2 consists also of non-railway domain partners that will provide knowledge for possible adaptation of relevant and emerging technologies to the railway system.

2.4.2.7 X2Rail-3: Advanced Signalling, Automation and Communication System (IP2 and IP5) – Prototyping the future by means of capacity increase, autonomy, and flexible communication

Table 9. *Project: X2Rail-3*

X2Rail-3: Advanced Signalling, Automation and Communication System (IP2 and IP5) – Prototyping the future by means of capacity increase, autonomy and flexible communication (S2R-CFM-IP2-01-2018)			
Scope:	ETCS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 38 728 459,46	from 06/2021 to 12/2022	Bettina Doetsch THALES DEUTSCHLAND GMBH	https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-3

The project aims to continue the research and development of key technologies to foster innovations in the field of railway signalling, telecommunication, testing methodologies and Cyber Security, as part of a longer term Shift2Rail IP2 strategy towards a flexible, real-time, intelligent traffic control management and decision support system. X2Rail-3 will also explore Virtual Coupling, an innovative concept capable of operating trains much closer to one another (inside their absolute or relative braking distance) and dynamically modifying their own composition on the move.

The actions to be undertaken in the scope of X2Rail-3 are related to the following specific objectives:

- To improve line capacity and to achieve a significant reduction of the use of traditional train detection systems by means of the introduction of the Moving Block together with train positioning.
- To overcome the limitations of the existing communication system by adapting radio communication systems which establish the backbone for the next generation advanced rail automation systems.
- To ensure security among all connected signalling and control systems by developing new cyber security systems dedicated to railways.
- To analyse new signalling concepts (Virtual Coupling) that potentially would be able to improve line capacity, reduce LCC and enhance system reliability.
- To improve standardization and integration of the testing methodologies reducing time to market and improving effectiveness in the introduction of new signalling and supervision systems.
- To ensure the evolution and backward compatibility of ERTMS/ETCS technologies, notwithstanding of the required functional enrichment of the future signalling and control systems.

2.4.2.8 X2Rail-4: Advanced signalling and automation system - Completion of activities for enhanced automation systems, train integrity, traffic management evolution and smart object controllers

Table 10. *Project: X2RAIL-4*

X2RAIL-4: Advanced signalling and automation system - Completion of activities for enhanced automation systems, train integrity, traffic management evolution and smart object controllers (S2R-CFM-IP2-01-2019)			
Scope:	TMS ETCS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 41 109 699,98	from 12/2019 to 02/2023	Philippe Prieels ALSTOM TRANSPORT S.A.	https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-4

The railway sector is constantly innovating, transforming traffic management and control systems. The EU-funded X2Rail-4 project will build on previous research on key technologies within the following Technology Demonstrators (TDs).

It will develop railway line capacity increase by integrating and testing Obstacle Detection tools and environment sensors and will develop complete On-Board Train Integrity system prototypes applicable in both passengers and cargo trains with or without wired communication. Additionally, the project will design a communication platform for the management of communication and data exchange between different services. It will also develop a prototype offering a wireless system for data exchange between trackside equipment and signalling instruments with reduced maintenance costs and required cabling.

2.4.2.9 X2Rail-5:Completion of activities for Adaptable Communication, Moving Block, fail safe Train Localisation (including satellite), Zero on site Testing, Formal Methods and Cyber Security

Table 11. *Project: X2Rail-5*

X2Rail-5: Completion of activities for Adaptable Communication, Moving Block, Fail safe Train Localisation (including satellite), Zero on site Testing, Formal Methods and Cyber Security **S2R-CFM-IP2-01-2020**			
Scope:	TMS ERMTS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 33 890 375,44	from 12/2020 to 05/2023	Axel Wodtke Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	https://projects.shift2rail.org/s2r_ip2_n.aspx?p=X2RAIL-5

The "Advanced Traffic Management & Control Systems" pillar (IP2) focuses on control, command and communication systems and tackles the high-level Shift2Rail objectives. These include evolving requirements for new functionalities and to expand the level of standardization in an increasingly challenging economic climate.

The pillar (IP2) challenge is to increase functionalities of the existing signalling and automation systems and related design and validation processes providing a more competitive, flexible, real-time, intelligent traffic control management and decision support system, whilst addressing all four market segments and maintaining

backward compatibility to the existing European Rail Traffic Management System (ERTMS) and especially its European Train Control System component (ETCS).

X2Rail-5 aims to bring to conclusion the research and development of some key technologies to foster innovations in the field of railway signalling, automation, telecommunication, testing methodologies and Cyber-Security, as part of a longer term Shift2Rail IP2 strategy towards a flexible, real-time, intelligent traffic control management and decision support system. The actions undertaken in the scope of X2Rail-5 are related to the following specific objectives:

To improve line capacity and to achieve a significant reduction of the use of traditional train detection systems by means of the introduction of the Moving Block together with train positioning, train integrity and train length. To overcome the limitations of the existing communication system by adapting radio communication systems which establish the backbone for the next generation advanced rail automation systems.

To achieve a significant reduction of the use of traditional train detection systems by means of the attainment of an absolute and safe train positioning system based on a multi-sensor concept, where GNSS is the preferred technology. To ensure security among all connected signalling and control systems by developing new cyber security systems dedicated to railways. To improve standardization and integration of the testing methodologies and formal methods application reducing time to market and improving effectiveness in the introduction of new signalling and supervision systems.

To ensure the evolution and backward compatibility of ERMTS/ETCS technologies, notwithstanding of the required functional enrichment of the future signalling and control systems.

2.4.2.10 TAURO: Technologies for the AUtonomous Rail Operation

Table 12. *Project: TAURO*

TAURO: Technologies for the AUtonomous Rail Operation (S2R-CFM-IPX-01-2020)			
Scope:	ATO		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 4 559 803,03	from 12/2020 to 05/2023	Javier Goikoetxea Construcciones y Auxiliar de Ferrocarriles, S.A.	https://projects.shift2rail.org/s2r_ipx_n.aspx?p=tauro

Throughout the history of transportation, very few inventions have had the same impact as rail transport. One of the oldest and most established means of transportation, railways still provide efficient transportation of freight and passengers, but they stand to benefit from cutting-edge technology. The EU-funded TAURO project will shape the future of European rail transport by developing the technologies required to make autonomous rail transport a reality. It will achieve this by working on state-of-the-art systems for environmental perception, remote operation, automatic monitoring, and diagnostics, and easing the transition to these new autonomous control systems. The goal is to shape the future of rail services in Europe.

The high-level objective of TAURO is to identify, analyse and finally propose suitable founding technologies for the future European automated and autonomous rail transport, to be further developed, certified, and deployed through the activities planned for the European Partnership for Transforming Europe's Rail System.

To achieve this, TAURO is divided into four technical WPs, following the scope of the call, that each deal with separate system elements, with each contributing to the overall goal of the project. These four areas of work are:

- Environment perception for automation,
- Remote driving and command,
- Automatic status monitoring and diagnostic for autonomous trains,
- Technologies supporting migration to ATO over ETCS.

These technical WPs will be supported by a comprehensive dissemination and exploitation WP that will guarantee the results from TAURO are communicated to the necessary stakeholders, standards and regulatory bodies to ensure that the future policy and technical decisions are taken on the basis of the science and research performed in TAURO, and more important, who guarantee the coherence with other Shift2Rail ongoing activities and assure a seamless bridging between TAURO and the next initiative within Horizon Europe, Transforming Europe's Rail System.

2.4.2.11 SMART: Smart Automation of Rail Transport

Table 13. *Project: SMART*

SMART: Smart Automation of Rail Transport (S2R-OC-IP5-01-2015)			
Scope:	ERTMS ATO		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 999 598,75	from 10/2016 to 09/2019	Danijela Ristic-durrant UNIVERSITAET BREMEN	http://www.smartrail-automation-project.net/

This project has received funding from the Shift2Rail Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under

SMART main goal is to increase the quality of rail freight, as well as its effectiveness and capacity, through the contribution to automation of railway cargo haul at European railways.

To achieve the main goal, SMART will deliver the following measurable objectives:

- complete, safe, and reliable prototype solution for obstacle detection and initiation of long distance forward-looking braking,
- short distance wagon recognition for shunting onto buffers,
- development of a real-time marshalling yard management system integrated into IT platform available at the market.

The SMART prototype solution for obstacle detection will provide prototype hardware and software algorithms for obstacle detection. The system will combine two-night vision technologies - thermal camera and image intensifier with multi-stereo vision system and laser scanner to create fusion system for short (up to 20 m) and long range (up to 1000 m) obstacle detection during day and night operation, as well as operation during impaired visibility. By this planned fusion of sensors, the system will be capable, beside reliable detection of obstacle up to 1000 m, to provide short range (< 200 m) wagon recognition for shunting operations with a +/- 5 cm distance estimation tolerance.

The real-time marshalling yard management system will provide optimization of available resources and planning of marshalling operations to decrease overall transport time and costs associated with cargo handling. The yard management system will provide real time data about resources available over open and TAF/TSI standard data

formats for connection to external network systems and shared usage of marshalling yards between different service providers.

2.4.2.12 SMART2: Advanced integrated obstacle and track intrusion detection system for smart automation of rail transport

Table 14. *Project: SMART2*

SMART2: Advanced integrated obstacle and track intrusion detection system for smart automation of rail transport (S2R-OC-IP5-02-2019)			
Scope:	TMS ATO		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 1 708 737,50	from 01/12/2019 to 30/11/2022	Danijela Ristic-durrant UNIVERSITAET BREMEN	https://smart2rail-project.net/

SMART2 project will build on the results achieved in project SMART by advancement, innovation, and implementation of SMART2 on-board long-range all-weather obstacle detection (OD) and track intrusion detection (TID) system. Two new systems will be also researched, innovate, and developed: advanced SMART2 trackside (TS) /airborne OD&TID system.

All three systems will be integrated into a holistic OD&TDI system via interfaces to central Decision Support System (DSS). A holistic approach to autonomous obstacle detection for railways would enable increased detection area including areas behind a curve, slope, tunnels, and other elements blocking the train's view on the rail tracks, in addition to a long-range straight rail-tracks OD. The data recorded will be processed to inform DSS about possible obstacles and track intrusions in their fields of view. DSS will integrate information coming from three OD&TID sub-systems and will make final decision on OD&TID and will suggest possible actions for the train control. SMART2 platform will be flexible and open for interfacing additional OD&TDI modules based on future technologies.

SMART2 project aims at developing a working prototype of the foreseen holistic OD&TDI that will be evaluated in different real-world railway use-case scenarios. The SMART2 vision of holistic approach to the obstacle and track intrusion detection in railways is illustrated below.

2.4.2.13 SPRINT: Semantics for PerfoRmant and scalable INteroperability of multimodal Transport

Table 15. *Project: SPRINT*

SPRINT: Semantics for PerfoRmant and scalable INteroperability of multimodal Transport (H2020-S2RJU-2018)			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€ 1 999 500,00	from 12/2018 to 12/2020	Stefanos Gogos UNION DES INDUSTRIES FERROVIAIRES EUROPEENNES - UNIFE	http://sprint-transport.eu/

The concept of Interoperability Framework (IF) is at the core of the Shift2Rail Innovation Programme (IP) 4, and it is the key concept for facilitating a seamless travel experience for users across borders and transport modes. The IF enables the technical interoperability of heterogeneous, multimodal transport-related services by relieving applications from the task of locating, harmonizing, and understanding multiple and independent data and event sources, services, etc.

A series of past and ongoing projects related to Shift2Rail IP4 (IT2Rail, ST4RT, GOF4R, CONNECTIVE) have developed and are refining and extending a set of core concepts and technologies that are part of the IF.

The Semantics for Performant and scalable Interoperability of multimodal Transport (SPRINT) project will improve key aspects of the Shift2Rail IF to bring the market uptake of the multimodal transport ecosystem envisioned by IP4 closer to reality. In particular, the project will address the following specific challenges posed by the objectives of TD 4.1 (Technical Demonstrator 4.1, as defined in the Shift2Rail Multi-Annual Action Plan):

- Improve IF performance and scalability to sustain a large deployment.
- Simplify/automate all the necessary steps needed to integrate new services and sub-systems in theIP4 ecosystem.

2.4.2.14 OptiYard project: Optimised Real-time Yard and Network Management

Table 16. *Project: OptiYard*

OptiYard project: Optimised Real-time Yard and Network Management			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€1 499 000	from 10/2017 to 10/2019	Jean-Michel Evanghelou UIC	https://optiyard.eu/

To meet the needs of S2R and Horizon 2020, OptiYard will design optimised processes for managing marshalling yards and terminals, considering their interaction with the network. The processes considered are those that must be performed in real-time, to guarantee on-time delivery and operational efficiency, for single wagon transport.

OptiYard addresses critical operational points of the transport chain (both rail marshalling yards or as transfer points to other modes) to improve capacity and reliability. Most importantly, these improvements will enhance competitiveness whilst increasing service reliability and customer satisfaction by providing accurate and updated information. Real-time interaction between yard and relevant network IT systems will allow for software based planning and ultimately optimisation of single wagonload and block train operational processes.

If rail is to play an increasing role in sustainable European freight transport, the freight network will need to offer enhanced connectivity between key EU transport corridors and hence there will be need to manage increasing numbers of train movements and shunting operations through freight marshalling yards at strategic locations. OptiYard will provide enhanced decision support that can be directly applied to achieving enhanced yard capacity and efficiency.

The lack of full integration between yard and network is a current weakness, and one that increase as more real-time data becomes available, because we will miss the opportunities to realise the benefits of such improved data. Hence, there needs to be much more progress in developing the integration of information systems and

control systems between the yard systems and the network systems. It is in this field where OptiYard offers the most exciting possibilities.

Large rail freight marshalling yards are complex operations which present major challenges to achieving operational efficiency, such that managing them effectively even in a stand-alone mode is a challenging task, for which sophisticated scheduling systems are required. The arrival and departure of freight trains to/from the yard are closely linked to the operations of the wider network eco system, making some of the yard operation processes (shunting, marshalling, and departing train dispatches) more time-critical than others.

Thus, a key challenge to the future success of yard management lies in the real-time information exchange between the yard and the relevant network eco system, and the interactive responses between the yard and the network managements. With such information capabilities, yard operations could be rescheduled at short notice to take account of perturbations on the network, such as the delayed arrival of an incoming freight train, allowing rapid re-optimisation of yard operations. Real-time network information could also be used to identify more accurate departure times for trains leaving yards, again allowing for beneficial rescheduling of yard operations. Hence, we develop a holistic approach to providing a real-time decision-making framework for optimising yard operations and the yard-network interface.

The main objective of OptiYard is to improve capacity and service reliability by focusing on Yard Operations, namely by providing an optimised decision support system for Yard Managers. Specifically, OptiYard will address the following objectives:

- Automate yard management optimisation: an innovative algorithm to automate and optimise the organisation of the processes to be performed in a marshalling yard will be delivered.
- Real-time interaction with the surrounding railway network: a novel decision support tool for automated ad-hoc timetabling and traffic management to include the yard management in a globally optimised system will be produced.
- Simulate intelligent real-time yard operations: the project will build on a state-of-the-art yard simulation platform compatible with short term innovations, to achieve improved modelling and communication system, and to integrate optimised decisions into the real-time simulation.
- Improve information and communication processes: new effective structures for the flows of data towards and from the terminals, necessary for communication and information sharing between infrastructure managers and railway undertakings for yard management will be defined.
- A technical demonstrator in the form of a fully functional software module will be built to show how the developed intelligent real-time simulation can provide concrete and validated optimal decision support for dispatchers in yards, with a link to network management.

2.4.3 Europe's Rail Joint Undertaking

Europe's Rail partnership, the successor to the current Shift2Rail Joint Undertaking, has been officially announced today by the European Commission as part of a proposal for the set-up of 10 new European Partnerships under the Horizon Europe programme. All the partnerships share the objective of achieving a climate neutral and digital Europe.

Europe's Rail Joint Undertaking will build on the successful results of Shift2Rail's work with its members and partners to speed up the development and deployment of innovative technologies. It will focus on digital innovation and automation to achieve the radical transformation of the rail system needed to deliver on the European Green Deal objectives. By improving competitiveness, it will support European technological leadership in rail.

2.4.3.1 DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers

Table 17. *Project: DESTINATION 1*

DESTINATION 1 – Network management planning and control & Mobility Management in a multimodal environment and Digital Enablers **EU-RAIL JU Call Proposals 2022-01 (HORIZON-ER-JU-2022-01)**			
Scope:	TMS		
Total Project Value:	**Deadline date**	**Coordinator:**	**Project website:**
€ 54 300 000,00	23 June 2022	-	https://ec.europa.eu/

In the context of Network management planning and control & Mobility Management in a multimodal environment, the objective is to research, develop and deliver the functional requirements, associated specifications, and operational and technological solutions to enable a common future European Traffic Management layer. This shall include the requirements to achieve uniform train operations; ticketing services may also be considered part of such endeavour. This will enable the design of future network and capacity management, planning, and control.

To accelerate the European approach, research and innovation in the Flagship Project stemming from this topic shall also consider early implementation of common functions and approaches starting from existing national TMS. A dynamic network and traffic management at European scale, built upon a harmonised functional system architecture to ensure agile, borderless, and mixed-traffic operations, is the target solution that the various legacy TMS should migrate towards.

This extends the capacity planning at European level and enables the automatic management of cross-border rail traffic. Improved service offers, operations and capacity utilization are reducing the inefficiencies of the door-to door services and enhancing the competitiveness of rail-based mobility chains.

To achieve the overall objective of a dynamic European traffic management, several improvements have been identified and described in the Europe's Rail Multi-Annual Work Programme

When the railway system becomes fully digital and connected, the availability of real-time and historical data from across the whole system will unlock a whole range of new possibilities. However, a fully digital connected rail system will be characterized by a complex landscape comprising multiple heterogeneous systems and interactions.

2.4.3.2 DESTINATION 2 – Digital & Automated up to Autonomous Train Operations

Table 18. *Project: DESTINATION 2*

DESTINATION 2 – Digital & Automated up to Autonomous Train Operations **(EU-RAIL JU Call Proposals 2022-01 (HORIZON-ER-JU-2022-01))**			
Scope:	ATO		
Total Project Value:	**Deadline date**	**Coordinator:**	**Project website:**

€ 54 300 000,00	23 June 2022	-	https://ec.europa.eu/

2.4.3.3 DESTINATION 3 – Intelligent & Integrated asset management

Table 19. *Project: DESTINATION 3*

DESTINATION 3 – Intelligent & Integrated asset management **(EU-RAIL JU Call Proposals 2022-01 (HORIZON-ER-JU-2022-01))**			
Scope:	TMS ERMTS F		
Total Project Value:	**Deadline date**	**Coordinator:**	**Project website:**
€ 46 300 000,00	23 June 2022	-	https://ec.europa.eu/

The financial and, to a certain extent, environmental costs associated with designing, building, constructing, operating, maintaining, and decommissioning rail drive also its capacity to compete and offer attractive services for the clients, passengers, and supply chain. Therefore, rail asset management is a key area for research and innovation.

In the vision of the future rail asset management, assets status evolution information will be integrated with TMS (Traffic Management System) to improve services, reducing unavailability by limiting the impact of in-service failures and/or providing alternative solutions without cost impacts, and increasing safety. Moreover, the available information combined with AI (Artificial Intelligence) and digital twins will introduce intelligence to the management and optimize the overall life cycle and operation of the rail system.

The selected proposal for funding under this Destination will be a Flagship Project of Europe's Rail with significant expected impacts, which require an integrated sector systemic approach. Proposals should therefore set out a credible pathway (including an exploitation plan) to contributing to all the following expected impacts as described in the Master Plan.

2.4.3.4 DESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services

Table 20. *Project: DESTINATION 5*

ESTINATION 5 – Sustainable Competitive Digital Green Rail Freight Services **(EU-RAIL JU Call Proposals 2022-01 (HORIZON-ER-JU-2022-01))**			
Scope:			
Total Project Value:	**Deadline date**	**Coordinator:**	**Project website:**
€ 40 600 000,00	23 June 2022	-	https://ec.europa.eu/

The objective of this Destination is to make rail freight more attractive through better services to the European supply chain by the following threefold: Increasing capacity in a smart way for all types of rail freight transport (e.g. with Digital Automatic Coupler (DAC) and other technological and operational solutions), Improving cross-border operation (cross border implies an important share of freight traffic and it expected to grow) and finally a better multimodal service offering. In addition to all these, this destination aims to contribute, if necessary, in the delivery of harmonization by means of contributing on the definition of European Standards.

Those objectives should be addressed aiming to deliver solutions in the following areas:

Full digital freight train operations enabled by key technologies for transforming the European Rail Freight sector which will increase productivity (time and cost reduction), efficiency (through process automation) and service quality, all of that leading to an increase of competitiveness. Together with a "smart" increase of capacity, more freight traffic can be shifted to the European rail system, significantly contributing to the EU Green Deal. The development of innovative freight assets (e.g., innovative freight wagons, last mile solutions, terminals) allow to further improve the competitiveness of rail freight by reducing LCC [Life Cycle Costs LCC], operational costs and increasing automation.

A seamless rail freight with a significantly reduced average transportation time based on an agile, interoperable and open environment within integrated and harmonized European mobility networks which interacts with other businesses; an environment in which companies can optimize their operations; for railway undertakings and intermodal operators, this results into higher productivity, better capacity utilization, improved planning possibilities and, through the reduction of cross-border barriers and multimodality, faster transport handling, altogether resulting into higher reliability. In addition, comprehensive multimodal and transparent customer information in combination with easy booking and managing functions, lead to an increase in customer satisfaction and easier access to rail-based services. Being based on harmonized European data this leads to higher predictability and planning possibilities.

2.4.4 International Union of Railways (UIC) Initiatives

The International Union of Railways is the worldwide organisation tasked with promoting rail transport and developing the railway system to support the strategy of its members (which include rail operators, infrastructure managers and railway service providers).

2.4.4.1 SFERA: Smart communications for efficient rail activities

Table 21. *Project: SFERA*

SFERA: Smart communications for efficient rail activities			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
N/A	Completed	Jerzy Wisniewski UIC	https://uic.org/projects/sfera-smart-communications-for-efficient-rail-activities

Standardisation DAS (Driving Advisory Systems) languages is required for broader implementation, reduced costs and facilitating exchange of data for Traffic Management Systems.

Current energy costs for EU railways total about 6,000 million Euros per year. Average savings are 5% to 10% for simple DAS solutions, between 8% and 12% for connected DAS to TMS (Traffic Management Systems) (c-DAS)

rising to >10% for level 3 solutions (manage conflicts, harmonise traffic flow, integration of energy efficiency into system-wide train schedules).

Current implementation in the European Railway Sector very low (1-3%), the remaining potential market still to be exploited is very high. Automatic word wrap

This project is required to help the sector reach key energy & carbon targets of the UIC-CER Sustainable Mobility Strategy. The project will focus on implementation of the conclusions from previous EU funded projects including MERLIN, Rail Energy and ON-TIME.

The project is needed to be able to reduce operating costs, reach the energy efficiency and CO2 emission commitments of UIC members, keep the competitive advantage compared to other main major modes of transport and help the EU achieve its legal commitment to reduce carbon emissions.

To achieve these objectives, railway sector needs to keep improving, implementing the latest technologies, and developing standards to manage interfaces related to energy, including smart grids, innovative power supply infrastructure, smart energy procurement, energy consumption monitoring systems, timetable optimisation, regeneration of energy and eco-driving.

2.4.4.2 FRMCS: Future Railways Mobile Communications Systems Solutions

Table 22. *Project: FRMCS*

FRMCS: Future Railways Mobile Communications Systems Solutions			
Scope:	TMS FRMCS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
N/A	ongoing project	Dan Mandoc	https://uic.org/projects/future-railways-mobile-communications-systems-solutions

The UIC FRMCS project aims at defining the successor of GSM-R, a successful system selected in the 90s out of existing technologies, as the basis of the new European Railways Digital Radio System.

As GSM-R is based on public GSM standard, the same constraints on technical life cycle apply, so that GSM-R support is expected up to year 2030 at least (according to the official information provided by GSM-R suppliers).

Considering an expected period of at least 10 years to define all the technical details for the successor and complete the migration concept, the changes in TSI and the legislative work for Europe, UIC started the first investigations on the GSM-R inheritor in 2010 with more refined details and a solid work programme structure from Jan 2014, within a three years UIC funded project.

During the initial phase of the European project, clear needs of participation from members out of Europe popped up. In addition, synergies with other stakeholders such as urban transport organizations and Tetra and Critical Communications Association (TCCA) was considered.

This first phase of FRMCS was in line with the UIC strategy of building up and strengthening harmonized Railway radio communications systems in Europe, keeping the pace with the technological advance, while preserving interoperability and protecting Railways' investments.

The second phase of the development of the new radio system, as it is already the case for the GSM-R, must be managed in a Worldwide environment and shall be based on relevant world standardization bodies, notably: ETSI, 3GPP and ITU.

2.4.5 Connecting Europe Facility (CEF) Initiatives

The Connecting Europe Facility is a key EU funding instrument to promote growth, jobs and competitiveness through infrastructure investment at European level. The CEF programme contributes to the implementation of the Trans-European Transport Network (TEN-T) by financing key projects to upgrade infrastructure and remove existing bottlenecks whilst also promoting sustainable and innovative mobility solutions. These projects cover all EU Member States and all transport modes (road, rail, maritime, inland waterways, air), as well as support transport co-modality, logistics and innovation.

Nine transport corridors and specific horizontal priorities have been established to focus on pan-European integration and development.

2.4.5.1 The Train Information System

Table 23. *Project: TIS*

The Train Information System			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
-	-	-	http://tis.rne.eu

The Train Information System, supported by the CEF programme, aims to provide real-time Europe-wide real time data with data taken from the Infrastructure Managers systems. Train Information System is a web-based application that supports international Train Management by delivering real-time train data concerning international (partly national) passenger and freight trains.

The relevant data is obtained directly from the Infrastructure Managers' systems. The system is already fully TAF/TAP TSI -compliant and was, in addition, a frontrunner in terms of implementing this sophisticated framework. The system supports mostly internationally active Railway Undertakings and terminal operators in steering their logistical chains and it also provides support to Rail Freight Corridors by providing proper reports for Train Performance Management.

Currently TIS handles over 5.8 million single train runs per year.

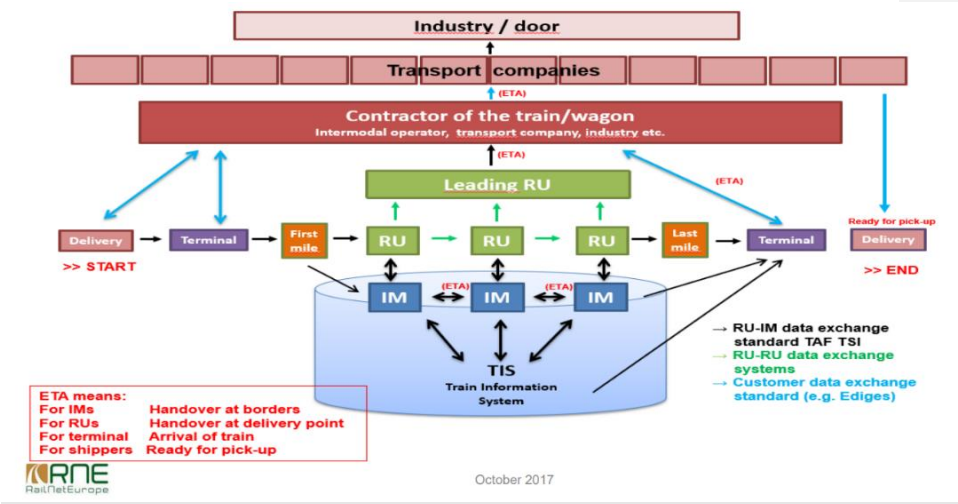

Figure 16. How TIS works [7]

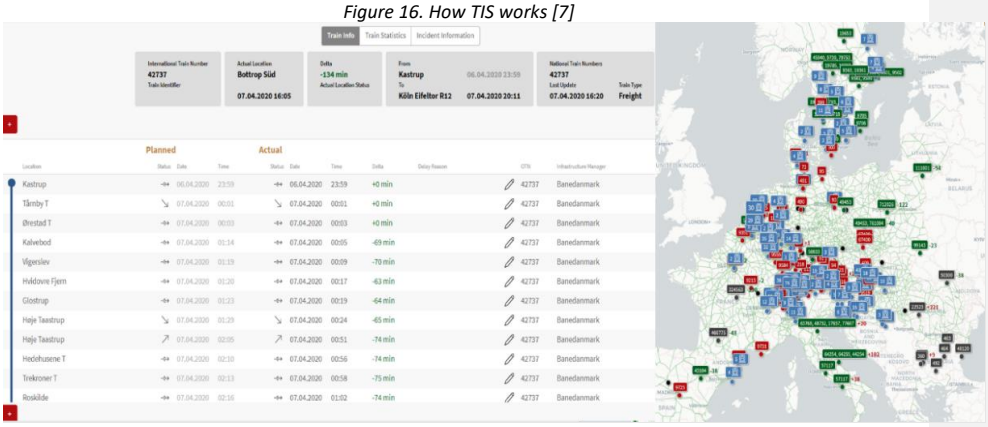

Figure 17. Interface of TIS [7]

TIS provides the following features in real time:

- Real-time train traffic data via the Internet (contracted timetable, forecast, running advice, delays),
- Real-time train information in the TIS graphical interface shows real-time visualisation of international trains (network overview, space-time diagrams, train run reports, etc.),
- Collection and exchange of railway traffic data from/with European traffic management systems,
- Incident management.

Benefits of the TIS graphical interface:

- Optimisation of train disposition,
- Optimisation of resource allocation (time, financial means, rolling stock and staff),

- Steering of the logistical chain,
- Strong sales argument towards RU's customers: 'The RU knows the position of the train.

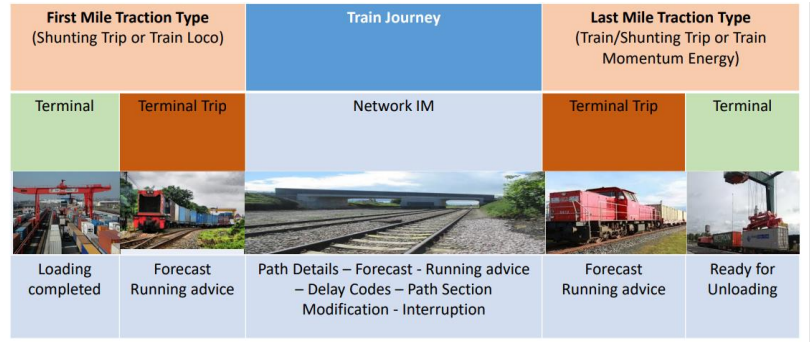

Figure 18. Information along the Train Journey [7]

2.4.5.2 Freight2Rail

Table 24. *Project: Freight2Rail*

Shifting Freight2Rail – Innovative international TT process and increased real time t&t for customer satisfaction			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
	from 06/2017 to 12/2020		http://www.rne.eu/

The Action was a study with pilot activities and its main objective was to implement innovative IT processes, communication standards and a harmonised IT landscape in the field of international rail infrastructure management for the benefit of the entire European rail sector. This objective was achieved through:

- Implementation of a redesigned international rail timetabling process.
- Improvement of a temporary capacity restrictions tool for coordination and publication of capacity restrictions on the rail network.
- Implementation of further developments in the train information system for an early exchange of information and as precise as possible calculation of the estimated time of arrival.
- Implementation of "big data" platform that will connect all international RailNetEurope and national IT applications to support the international railway business.

The results of the Action positively affected the rail community and competitiveness of the rail freight transport by stimulating modal shift.

2.4.5.3 VTG Rail Europe status oriented and predictive maintenance

Table 25. *Project: VTG*

VTG Rail Europe status oriented and predictive maintenance (2018-DE-TM-0022-M)			
Scope: TMS			
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€31 206 000,00	from 01/2019 to 12/2023	VTG Rail Europe GmbH (Germany)	http://www.rne.eu/

This rail interoperability Action will be implemented along all nine TEN-T Corridors. VTG is one of Europe's major wagon hire and rail logistics companies, with a fleet of more than 80,000 rail cars operated all over Europe.

The Action consists of equipping 15,000 rail freight wagons with sensors and/or wayside monitoring on their safety-related parts, namely the brake system, the wheelset and/or wagon overall condition, representing a substantial market share of rail freight transport in Europe.

The expected benefits are increased availability of the fleet due to reduced downtimes of the wagons, simplification of rail transport management, increased safety level through actively controlled repair status and monitoring of the wagons, decreased greenhouse gas emissions through avoided transports to repair workshops, and at the end increased competitiveness of rail as a transport mode.

2.4.5.4 ELETA: Electronic exchange of Estimated Time of Arrival information

Table 26. *Project: ELETA*

ELETA: Electronic exchange of Estimated Time of Arrival information (2016-EU-TA-0185-S)			
Scope:	TMS		
Total Project Value:	**Duration:**	**Coordinator:**	**Project website:**
€1 429 076,00	from 09/2017 to 12/2019	Koninklijk Nederlands Vervoer (Netherlands)	https://ec.europa.eu/inea/en/connecting-europe-facility/cef-transport/2016-eu-ta-0185-s

ELETA is a co-financed project under Connecting Europe Facility (CEF), launched in September 2017, which aims to demonstrate the advantages of exchanging the Estimated Time of Arrival (ETA) data within the whole rail supply chain management.

ELETA, which is the acronym for "Electronic Exchange of ETA information" scopes 12 selected intermodal transport relations, which are operated by the Combined Transport operators CEMAT (Italy), Hupac (Netherlands), Inter Ferry Boat (Belgium), Kombiverkehr (Germany) and Rail Cargo Operator (Austria).

The project is the result of an agreement of the rail sector to provide information on Estimated Time of Arrival (ETA) to their contract partners, including terminals and intermodal operators under the protection of confidentiality clauses.

ELETA should encourage and facilitate the efforts developed by the sector, but also by Member States and the European institutions to overcome legal, operational and technical obstacles in the electronic exchange of ETA information. The duration of the project is 24 months and its budget amounts 2.8 million euro. The project is coordinated by UIRR and Koninklijk Nederlands Vervoer (KNV).

Preparatory activities in the period between submission of the application and the official starting date 1 September 2017 have been conducted in close cooperation with Rail Net Europe (RNE) and in liaison with the terminals, infrastructure managers and railway undertakings directly involved.

ELETA's partners will work together with stakeholders through the ETA taskforce and specific events such as Rail Freight Day (7th December 2017, Vienna) where the first outcomes will be presented. The project partners will establish an External Expert Advisory Board, composed of experts interested in sharing their knowledge on the ETA developments.

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2.5 Overview of the selected Ports' ongoing digitalization and visibility initiatives

2.5.1 Port of Antwerp / NxtPort (BE)

The aim of Port of Antwerp (PoA) is to become a climate neutral port by 2050 and achieve a digital transition[128]. There are several successful and ongoing initiatives in terms of digitalization and visibility which are touching areas of sustainability, circularity, connectivity, smart solutions, and mobility. To increase its sustainability, PoA has developed such projects as NextGen District - the circular economy hub, or iNoses – the system identifying harmful gases and emissions in port.

In terms of digital solutions, PoA has introduced The Antwerp Port Information & Control Assistant (APICA) - digital 3D port map with real-time information, also acting as decision support mechanism.

The other smart solutions developed in PoA include the Antwerp Port Information and Control System (APICS) which manages the monitoring of shipping traffic to, from and within the port, tug operations, lock planning, berth management, cargo handling, registration of dangerous goods etc.; the BTS (Barge Traffic System), RTS (Rail Traffic System) and Terminal planner platforms aim to simplify communication between the various players in the logistics chain. This ensures transparency of information and promotes a rapid and up-to-date flow of information. In addition, the APICS Barge App allows barge skippers to reserve a lock and consult the available

berths in real-time. Thanks to direct linkage between the Central Broker System (CBS) and the port's own operational systems, only one application is needed for uniform communication.

Collaboration is the key to Port of Antwerp's digital innovations and is visible in the number of ambitious projects.

Previously discussed NxtPort initiative (one of the partners in ePIcenter) has the main aim is to unlock the potential of sharing existing data amongst the port's players [129].The NxtPort Data Utility Platform allows faster, more cost-effective, as well as more efficient transfers of data between the different players. NxtPort aims to increase operational efficiency, safety, and revenue. A second means to unlock the huge value at stake is to allow market applications to be built upon the existing data. In the result, the data within the port is not only shared in a better way, but the combination of existing data will lead to innovative solutions as well.

NxtPort's Bulkchain is a collaborative platform built on NxtPort technology, dedicated to build the Breakbulk port of the Future. The platform allows participants to work together on the administrative processes to ship breakbulk cargo. By sharing data on shipments early in the supply chain, efficiency of the entire process increases, at the same reducing time spent and administration efforts. In the end, all parties involved benefit from working together through the NxtPort platform[130].

C-Port is the network of systems and solutions for electronic communication in the Port of Antwerp which comprises the exchange of data between companies and authorities, between companies and between authorities and offers services regarding nautical functionalities, cargo and logistics, dangerous goods and customs. All types of freight and transport modes are supported. Moreover, C-Port guarantees an efficient electronic message and information exchange in the support of the day-to-day administrative and operational activities [131].

Another NxtPort solution - Certified Pick up (CPu) is a neutral, central data platform providing the supply chain with a digital, secure, and optimized cargo release and pick-up process in the Port of Antwerp. This is achieved by capturing and enriching container information - originating from different parties - on the Certified Pick-up platform, to generate an encrypted digital key with which the final carrier can retrieve the container [132].

The Port of Antwerp, The City of Antwerp, the Antwerp Police, and the Antwerp Fire Department worked on the private 5G Network "Minerva". This network would increase the speed, reliability and security of the port authority, the police and the fire brigade's digital applications. The network is not dependent on public providers and is thus better protected against potential breakdowns [133]. Port of Antwerp also cooperated with the Orange operator on the new 5G standalone-powered Industry 4.0 campus network [134].

Port of Antwerp works closely together with The Beacon, a community of innovative companies, start-ups, and research institutions. The Beacon has been established in 2018 by six large organizations – the City of Antwerp, the Port of Antwerp, Lantis, University of Antwerp, Agoria and Imec. It is the platform that catalyses innovation in areas of Ports & Logistics, Mobility, Industry, Smart Buildings and Smart Cities [135]. The Beacon acts as hotspot where major technology providers in Internet of Things and Artificial Intelligence, top researchers, start-ups, and scale-ups collaborate on innovative, sustainable solutions.

The Plug and Play Maritime founded by City of Antwerp, CMB, DXC Technology, Euronav and Port of Antwerp is supporting international start-ups to test new maritime technologies [136].

One of the recent collaboration cases is Horizon 2020 'Portable Innovation Open Network for Efficiency and Emissions Reduction Solutions (PIONEERS)' project lead by the Port of Antwerp, with the participation of the ports of Barcelona, Constanta and Venlo and other research Partners. The project aims to develop real life green ports and reinvent all areas of port operations, including terminal operations, concession agreements, transportation, connections, fuels, and models for cooperation and energy generation, storage, and consumption [137]. PIONEERS addresses the challenges faced by European ports to reduce their environmental impact while remaining competitive in a sector characterised by continuous growth. Renewable energy generation and deployment of electric, hydrogen, and methanol cars are among the initiatives, as are retrofitting

building and heating networks for energy efficiency, implementing circular economy concepts in infrastructure works, automation, and the deployment of digital platforms to promote modal shift and ensure optimized vehicle, vessel, and container movements.

The last PoA initiative mentioned in this section is the project under the EU SESAR 3 Joint Undertaking Programme [138]. Port of Antwerp is the Advisory Board Member of the SAFIR-Med (Safe and Flexible Integration of Advanced U-space Services for medical Air Mobility) which aim is to is to achieve safe, sustainable, socially accepted and socially beneficial urban air mobility. [139]

2.5.2 Port of Montreal (CA)

Port of Montreal [140] (PoM) is member of ChainPort since 2017. One of this newest ChainPort's Working Groups, chaired by Port of Rotterdam, is called "Connected Ports" and it aims to share best practices and data exchange (e.g., from navigational assistance to ships) between ports and their customers. PoM is still in the best practices exchange process within this Working Group.

The other important aspect for PoM is membership in the innovation project: TradeLens (blockchain-enabled digital shipping platform established as Maersk-IBM joint venture). PoM joined TradeLens in 2018 as one of the first port members in North America [141]. TradeLens is a platform for exchanging container-related data between ocean carriers, freight forwarders, customs, port authorities and cargo owners. PoM has visibility of containers going through port, all the way from their booking. If container is e.g., coming from India to Toronto, it can be seen from the moment of its booking including all transport milestones. TradeLens is certainly one of the best practices in data standardization, it uses UN/LOCODES location codes. Customers like ocean carriers usually send EDI reports on origin- destinations and some data analysing is sometimes needed – TradeLens makes these analytics much easier, VGM are other data formats are also standardized worldwide. This is one of the most advanced initiatives. In Europe there is IPCSA (International Port Community Systems Association) which has similar objectives, but it is not controlled by central entity as in the TradeLens' case. In TradeLens, Maersk has commercial control on the data, also for monetizing purposes.

Since 2018 PoM collaborates with one of the leading port innovations accelerators and has accomplished several overlooked projects. Port is working with two different speeds: with skilled consultants and experts to deliver something faster and bigger and with start-ups working slower on some innovations. The focus is on developing, jointly with the start-ups, new products with perhaps less maturity, but for smaller price. Innovations are being tested, so technology could be brought to the next level. PoM is focused on fluidity, cyber security, sustainable growth and improving port systems, so any types of projects in those areas are welcomed.

PoM has partnered with University of Montreal specialized with technology, with many skilled engineers. The focus is on deep learning, machine learning and new technologies. PoM is trying to engage with start-ups, find common problem and work on solution suitable for port's needs. The working process is usually between 3-8 months to develop the product (depending on the complexity of the issue). PoM is then looking for the final customer of the product inside the port, so the technology could be brought to the next level. Regarding port' success stories, PoM has worked with company which helped to build very complex 3D model of the port with the use of drones. It allows customers to virtually visit the port, shown data can be also directly labeled.

The other example is machine learning technique which analyses containers through port cameras, the project has been successful and implemented in other ports e.g., Barcelona.

The Collision Lab start-up (developed by Centech - business incubator that supports the creation and commercialization of high-tech companies by offering coaching programs for start-ups and large companies), is a membership-based program and PoM pays membership yearly to be part of this initiative [142]. PoM has their own operational budget to run projects. They do not take shares and equity in start-ups as can be seen in other accelerators around the world, it is more arm's length solution, with proper contracts.

Next step for PoM is to connect the accelerator with the other ports. There are early discussions (through ePIcenter) with four other ports interested in linking their ecosystems together. This vision would lead to global maritime start-up community. It also expands global talent pool as each city has different specialty e.g., Montreal is recognized for Artificial Intelligence ("A.I. hub"). Port of Antwerp, through ePIcenter, will work with PoM to digitize and optimise the transatlantic trade flows between both ports.

PoM has built formal performance monitoring program and decided to brand it giving a name. In North America there is very little transparency about port performance. Canada and Australia are now becoming global leaders in measuring port performance and publishing it. Many ports worldwide do measure port performance but are not transparent in public data sharing. Ports like PoM, Vancouver, Prince Rupert Halifax etc. have sophisticated dashboards that show customers how well they perform in terms of truck processing etc. On the webpage there is monthly scorecard with ca. 12 indicators categorized in 3 different families telling stories about Montreal gateway. PoM measures trucks, maritime and rail activities. Montreal's strength is rail – PoM is the only North American container port to operate its own and well performing railway. With measured metrics, PoM goes from monthly to weekly scorecard and by the end of 2021 data should be published at a weekly level. When it comes to the real time monitoring, PoM has the Trucking PORTal– free web / mobile app that truckers can access and see truck turnaround time on dashboard in real time. It gives truckers not just real time congestion levels, but also machine learning predictions. Those algorithms can calculate congestion levels 24hrs in advance – which is real added value meeting needs of truck drivers, allowing them to better plan their services and optimizing routings with the best, non-peak hours for the port gates. This was accompanied by the initiative to extend gate hours and have night gates which increased truck traffic by almost 25%. Three years ago, PoM handled 1800 trucks a day while in July 2021 there have been 2200 trucks per day (earlier that year there were even 2500 trucks per day). Before, this number of trucks could not be processed and now PoM can process more trucks and maintain same levels of service. This technology really helped to keep gates fluid by informing truck drivers about congestion levels.

Port of Montreal is now building similar application for rail, also with the use of artificial intelligence to dictate optimal rail movements. As rail operator, PoM is building trains at the port and deliver them to railways/market. They take containers, build trains on site and then 2 railways servicing PoM come to pick them up and deliver goods to Calgary, Edmonton, Toronto, Chicago directly from the port. The tool should be 2022 deliverable founded by national government.

2.5.3 Port of Vancouver (CA)

Port of Vancouver (PoV), Canada receives 50% funding for the visibility program from the federal government (National Trade Corridor Fund) while another 50% is funded by the Port and its stakeholders [143]. The Port is looking for the new initiatives once the tracking program is in place. Optimization, supply chain visibility program and digitalization are the crucial factors of port's further growth and conditions to receive national funding for new investments. PoV has recently applied for national funding on the project dealing with blockchain for container examinations and active vessel traffic management.

PoV is currently discussing its visibility strategy with its internal and external stakeholders to prepare new initiatives on optimization/digitalization. All containers going through Vancouver would be tracked soon (95% by the end of 2022). The new data management platform is currently under development in collaboration with railways.

The PoV's success stories include such tracking programs as „West Coast Supply Chain Visibility Program" (formerly known as the Supply Chain Visibility Program). The program is a multi-phase, multi-year initiative to develop and implement a series of operational planning and optimization tools tailored to participating industry members. The goal of this program is to increase capacity and operating efficiencies across the Western Canadian supply chain. Transition and broadening data sets for goods movement; development and integration of a variety

of analytics, forecasting and complex economic modelling capabilities into the system and determining how learning can inform national standards and subsequent projects are the key points of the Program for 2022.

2.5.4 Porto do Açu (BR)

Porto do Açu (PdA), Brazil has been developed in partnership with Port of Antwerp International and benefits from its private ownership in terms of projects flexibility [144]. The port tries to use best practices from abroad regarding e.g., Single Window, port community system and implement projects with the support of such platforms as Procomex, the NGO alliance for modernization of foreign trade in Latin America. Porto do Açu does not handle large amounts of containers, so their priorities differ from the other ports analysed in this chapter. The biggest challenge in Brazil is to educate government and private stakeholders what does „digitalization" mean for the maritime industry.

Both paper and digital documents are still in use on the national level which creates double bureaucracy while some end users e.g., customs still do not see benefit of digitalization. Despite this fact, Porto do Açu has already implemented several crucial digital initiatives: the Paperless Port concept, E-Transport Declaration for trucks, or Centralized Payment system for taxes, duties, and other charges. The pilot project - Port Community System (provided by Procomex, funded by UK Prosperity Fund and with the assistance of Hamburg Port Consulting) to run in Santos, Rio de Janeiro, Suape and Paranagua Ports is the current focus with the aim to integrate shipping industry, cargo owners, trucks, railways and combine maritime sector with the hinterland. "Smart Port" Digital Growth Masterplan for Port of Açu has been developed by Radix consultancy in collaboration with HPC -Hamburg Port Consulting, University of Houston and UTC Overseas. Its goal is to develop a 5–10-year vision for the technological platform of the Port and its ecosystem, focused on the optimization of operations, attraction of new businesses that are technologically aligned, and the establishment of a technological governance plan and systems architecture [145]. PdA expects to generate greater efficiency, reduction in the time of shipments/landing and connection of all clusters and production steps, such as movement statistics, availability, maritime safety data, customer specifics, and engagement with all stakeholders in the ecosystem. The Digital Masterplan will include the proposal to digitize the different stages of the logistical process and attract new business to the productive port. Radix consultancy has conducted a thorough analysis of the current asset structure; a survey of essential technology for the future vision as a Digital Port; the establishment of a technological governance plan; the architecture design recommended for the business systems; as well as its role in developing and implementing the solutions.

The other factor facilitating digital initiatives is the Brazil Export annual event, which started as an event for the Brazilian maritime industry where both public and private stakeholders for Brazilian foreign trade area are discussing Trade Facilitation and Port Digitalization[146].

2.5.5 Port of Algeciras (ES)

The Port of Algeciras has implemented Algeciras Port Digital Innovation Strategy with the aim to develop the Next Generation Port Concept: intelligent (data-driven and innovation culture), synchromodal (operational excellence and seamless integration within logistic chains) and green (energy transition and carbon neutral) and to strengthen the role of Port Ecosystem Orchestrator as Port Authority [147]. The digital and innovation roadmap has defined such actions as: New Port Community System (Teleport 2.0); an advanced system for analysing and predicting the behaviour of moored/docked vessels under the influence of met ocean and weather conditions on cargo operations productivity (PROAS); an IoT environmental platform for monitoring in real time the quality of air and the impact of port operations on the environment; Algeciras Next Port Operations and Digital Twin with embedded advanced analytics (predictive and prescriptive based on ML/AI) and simulation techniques to optimize cargo flow through its supply chains (supply chain intelligence) and be ready to offer tailor-made services [148].

Port of Algeciras' Algeciras Digital Innovation Labs are focused on the application of solutions based on 5G, IoT and AI in the logistics and industrial sector around Algeciras Bay but with global scalability. An open innovation framework enables the collaboration and co-creation between innovative companies, research institutions, universities, and start-ups. A Port-Living Lab delivers both a digital and operational environment for developing real testbeds and experimentations on the port-logistics sector [149]. Port of Algeciras is also the member of previously presented The European Technology Platform ALICE.

2.6 Conclusion concerning digitalization and visibility initiatives

Among digitalised platforms for trade and transport data submission and reporting, the National Maritime Single Window (NMSW) presents one of the most comprehensive systems for interconnecting all maritime stakeholders to share information regarding import-export trade flows and access relevant ships- and cargo reports. This system is described in detail by UNECE and the FAL Convention. It providesstandardized forms for reporting shipping information through a single entrypoint. To fulfil the requirements, the NMSW allows participants to submit all relevant standardized information and documents in a system with a single entry-point. Specifically, the system handles nautical safety- and security issues related to ship clearance into national waters and ports. It is adopted a on national level as a unique platform for data submission, mandatory for both public- and private national maritime sector and connected with other Single Windows (e.g. for customs and other). Along with FAL documents and forms, each involved organisation in NMSW should cooperate based on information technologies such as Electronic Data Interchange (EDI), UNECE-UN/EDIFACT, electronic signature and seal.

The implementation of a NMSW process involves several steps. It begins with policy planning, legal- and institutional framework shaping, analysis of business processes, considerations on document simplification and standardization, harmonisation of national data, and data exchange among cross-border partners. For this purpose, several models for NMSW conceptualisation and governance have been developed, comprehending a NMSW-platform as the centre of the system, with legacy IT systems as connected components from relevant participating authorities within a member state (port, maritime, security, waste, border control, customs and health), ship owners, agents and other data providers. In technical sense, the NMSW is mostly based on a Service-Oriented-Architecture (SOA), which enables the data sharing- and other services to be used within multiple, separate subsystems across several business domains.

Concerning the architectural blocks, a NMSW system consists of the following essential elements:

- NMSW administrator's office
- Data Centre #1 (location #1)
- Data Centre #2 (location #2)
- Education/Presentation centre

The benefits of NMSW for maritime administrations, the shipping industry and trade partners are: improved compliance, enhanced security, higher integrity and transparency, cost-savings for information- and resource transfer, and faster clearance and release of ships and cargo.

3 Relevant International Standards & Regulations

3.1 Introduction

This chapter contains applicable standards and regulations relevant for international multimodal containerised and large freight movements to ensure ePIcenter remains compliant. The focus lies on area's which are the most relevant to the use cases within the ePIcenter demonstrators. This chapter builds upon the initial list provided in Deliverable 1.1 of the project.
This chapter is not intended as a detailed review of the standards and regulations, but as an input for the use cases to allow for compliance check where relevant.

3.2 General Relevant Standards and regulations

ISO 9001 [150] sets criteria for quality within an organisation. IT has the goals of ensuring that products and services are consistently provided in a way that ensures customer, applicable statutory and regulatory requirements, as well as enhancing customer satisfaction. It is stated in a generic way that can be applied to all organisations as well as all product and services.

The **EN 12507** [151] guidance notes on the application of ISO 9001 to the road transportation, storage, distribution, and railway goods industries. This European Standard provides guidelines for the application of ISO 9001, Quality management system, to the provision of freight transportation services by road and rail, including storage and distribution activities. Operating procedures should address the requirements of legislation applicable, e.g., speed limits and driving time according to the European Regulation or ADR/RID Directives.

EN 14310 [152] Declaration and reporting of environmental performance in freight transport chains is a Technical Report, which is a guideline for preparing environmental declarations and reporting. The guideline recommends the content and structure for documentation and evaluation of environmental performance in freight transportation. It is applicable to freight transport purchasers and freight transport operators.

EN 13011 [171] Declaration of quality performance in transport chains. This European Standard is intended to be a tool for the definition, declaration and control of services involved throughout the transport chains. It can therefore be used by both shippers and providers within the framework of their contractual relationship, to define and declare the relevant performance conditions. A purpose of this standard is to facilitate the provision or information by the transport industry to assist shippers to meet their obligations under the Directive of Packaging and Packaging Waste (94/62/EF).

Further, this European Standard specifies requirements for making declarations regarding the quality of performance of a goods transport service. EN 13011 standard incorporates by dated or undated reference, provisions from other publications (EN 12830, EN 13485, EN 13486, EN 22248, EN 22872, EN 22873, EN 28318, EN 28768).

EN 13876 [153] Code of practice for the provision of cargo transport services. This European Standard specifies in the form of a Code of Practice' the management controls and key performance indicators necessary for the effective and efficient management of customer's cargo throughout the transport process. Code of Practice strongly recommends that the service provider carry out regular self-assessment of performance against defined criteria with the objective of continually improving the quality of services provided and is prepared in a manner which facilitates independent audit of the service provider's performance to give confidence to customers that the integrity of performance measurement is maintained.

The **GLEC Framework** [154] from the Global Logistics Emissions Council is developing methods for comparing greenhouse gas emissions across different modes of transport.

ISO 14007 [169] provides a framework for companies to determine and report the costs and benefits of environmental aspects of their businesses. The guidance on how to carry out cost-benefit analyses for different environmental options is interesting. Related to this is **ISO 14008** [170] "Monetary valuation of environmental impacts and related environmental aspects". It describes methods for valuing environmental aspects and impacts, providing the essential data that feeds into such cost-benefit analyses.

ISO/IEC 27009 [173] has been updated recently, making it easier for businesses to address information security, cybersecurity, and privacy protection.

3.3 Modular Containers

Modular containers need to be compliant with existing container standards, defined in **ISO 6346** [175]. As they can function in 20' HC (size code 25G1) and 40' HC (size code 45G1) setup, they will need to be certified for both configurations.

A **CSC plate** is the certification that a container is secure and standard and can be used in international maritime transport of commodities. A solution for the fact that containers will need to be certified for both configurations has investigated, and the decision was made to have two plates on each modular container. One for both possible configurations.

The goal of modular containers is to integrate them into existing standards as seamlessly as possible when it comes to their interaction with the existing logistic chains. Within the work package, investigation of any additional impact, and its mitigation, will be investigated. For example, handling of the changing container identification numbers for customs processes.

3.4 Dangerous goods & Chemicals

SQAS (Safety & Quality Assessment for Sustainability) [176] is a system of uniform third party assessments to evaluate the performance of Logistics Service Providers and Chemical Distributors. SQAS assessments cover quality, safety, security, environment, and CSR (Corporate Social Responsibility). The SQAS assessment reports allow chemical companies to evaluate their logistics service providers according to their own standards and requirements. SQAS is a key element of Responsible Care in logistics operations. **Cefic** [177], the European Chemical Industry Council, manages the SQAS system and ensures its integrity.

The Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) [181] specifies the compliance requirements for the transport of dangerous goods by road, both for the vehicle doing the transport and (annex B) the goods themselves (annex A). On 1 January 2021, a revised consolidated version has been published as document ECE/TRANS/300, Vol. I and II (ADR 2021). Regulations for other modes of transport follow a consistent structure **United Nations Recommendations on the Transport of Dangerous Goods**, **Model Regulations, the International Maritime Dangerous Goods Code** (IMDG) [182] (by the IMO – see below), the **Technical Instructions for the Safe Transport of Dangerous Goods by Air** [179](of the International Civil Aviation Organization, ICAO) and the **Regulations concerning the International Carriage of Dangerous Goods by Rail** (RID) [183](of the Intergovernmental Organisation for International Carriage by Rail, OTIF)

The International Maritime Dangerous Goods (IMDG) Code [182] or **The International Convention for the Safety of Life at Sea (SOLAS)** [178], deals with various aspects of maritime safety The carriage of dangerous goods in packaged form shall comply with the relevant provisions of the International Maritime Dangerous Goods (IMDG) Code which is considered and extension to the provisions of SOLAS chapter VII.

Furthermore, the **International Convention for the Prevention of Pollution from Ships** [180], as modified by the Protocol of 1978 relating thereto (**MARPOL**), which contains mandatory provisions for the prevention of pollution by harmful substances carried by sea in packaged form, prohibits the carriage of harmful substances in ships except in accordance with the provisions of MARPOL Annex III, which are also extended in the IMDG Code.

The **IMDG Code** was developed as an international code for the maritime transport of dangerous goods in packaged form, to enhance and harmonize the safe carriage of dangerous goods and to prevent pollution to the environment. The Code sets out in detail the requirements applicable to each individual substance, material, or article, covering matters such as packing, container traffic and stowage, with reference to the segregation of incompatible substances.

ISOPA, the European Diisocyanate & Polyol Producers Association [184], is working to continuously increase standards of loading, transport, unloading and storage of diisocyanates. They developed a programme that includes a set of guidelines that reflect best practices of ISOPA member companies.

ECTA, the European Chemical Transport Association [185], sets standards for the transport and logistics of chemical goods in Europe to improve efficiency, safety, and security, as well as the environmental and social impact of the industry. They develop best practices, organise joint studies, etcetera.

EN 12798 [186] Quality management system requirements to supplement EN ISO 9001 for the transport of dangerous goods regarding safety. This European Standard specifies quality management system requirements, supplementary to those of EN ISO 9001, for the management of safety in the field of the transport of dangerous goods by road, rail, and inland navigation.

Directive 2008/68/EC [187] on the inland transportation of dangerous goods lays down common rules for safe and secure transport of dangerous goods within EU countries for transport by road, rail, and inland waterways.

Council Directive 95/50/EC introduces a uniform EU-wide system of checks on vehicles transporting dangerous goods by road.

3.5 Food

Regulation (EU) 2017/625 [192] handles official controls and activities for food and feed law, animal health and welfare, plant health and plant protection products.

Commission Implementing Regulation (EU) 2019/1793 [193] adds increased controls for specific goods to the previous regulation.

3.6 Arctic Shipping

The IMO **Polar Code** [191], or the International Code for Ships Operating in Polar Waters is mandatory under the International Convention for Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). It covers the design, construction, equipment, operations, training, search and rescue and environmental protection matters relevant to ships operating in Arctic waters.

Other, local-, and international standards and regulations can also be applicable to arctic shipping. Additional information is available in ePIcenter Deliverable 1.6 on Arctic and New Trade Routes – Opportunities.

3.7 Rail

ERA [189], the European Union Agency for Railways assists the European Commission in the development of legislation concerning Transport of Dangerous Goods.

RID was mentioned earlier in this chapter in the section regarding dangerous goods and chemicals.

Specifically for the **Chine-Europe rail** connection, it is worth mentioning that transport of dangerous goods using this connection was not allows. However, due to increasing demand of batteries for electric vehicles, removal of this restriction is being worked on [190].

In intermodal transport the **UIRR** [194] (International Union for Road-Rail Combined Transport) is continually active in standardisation.

3.8 Relevant Data exchange standards

The **EDIFACT** [195] standard provides a set of syntax rules to structure, an interactive exchange protocol and provides a set of standard messages which allow multi-country and multi-industry exchange of electronic business documents. EDIFACT is widely used across Europe, mainly because many companies adopted it very early on. EDIFACT has seen some adoption in the ASPAC region however there are currently more XML based standards being used in this region today. The latest version is based on **UN-EDIFACT Directory D10.A.** [196]

The EDIFACT standard was developed by UN. The work of maintenance and further development of this standard is done through the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) under the UN Economic Commission for Europe.

For shipping, **IMO's FAL forms** [197] are relevant, especially:

- IMO General Declaration (FAL form 1)
- Cargo Declaration (FAL form 2)
- Dangerous Goods (FAL form 7)

The IMO has other initiatives that can support harmonisation and data exchange, such as the **IMO Compendium** [200] with the **IMO Data Set** and **IMO Reference Data Model**.

Messages used by River Information Systems such as **ERINOT** [198], **BERMAN** [199], etc. are relevant for inland waterways.

The Connecting Europe Facility Project **FENIX** [201], is working on common protocols for supporting data sharing services and interconnecting the different digital platforms.

The **Digital Container Shipping Association (DCSA)** is working on and releasing standards for the container shipping industry.

The European Commission is taking an active role in working towards standards for blockchain, for example through the **StandICT** initiative in which representatives of the ePIcenter project also participate [203].

The **WCO Data Model** [204] includes data sets for customs procedures and other cross-border regulatory agencies.

GS1 standards [205] are currently under development. The GS1 Industry & Standards Event provides working groups with opportunities to accelerate the development of the GS1 system of standards and guidelines, to collaborate with industry partners and to discover innovative business solutions.

Specifically relevant for the rail-related cases, could be the **GS1 standard EPCIS** [206]. This standard enables rail operators, infrastructure companies and even cargo owners to share information about the physical location and

movement of individual rail vehicles and entire trains as they travel from country to country. EPCIS can support additional, rail-specific requirements as implementations grow, ensuring end-to-end visibility for all stakeholders.

The e-Freight standards described in **ISO/IEC 19845** [207] are relevant to support integration between the multimodal logistics optimisation activities in ePIcenter and third-party systems. For example, the following e-Freight messages are of relevance:

- Transport Service Documents (TSD)
- Transport Equipment Plan Request (TEPR)
- Transport Execution Plan (TEP)
- Transportation Progress Status Request (TPSR)
- Transportation Progress Status (TPS)
- Transportation Status Request (TSR)
- Transportation Status (TS)

Multimodal logistics optimisation makes use of vector mapping and routing data, for which there are several standard formats available. Open datasets such as **OpenStreetMap** [208] are available, and **MID/MIF** [209] format is commonly used and will be considered for ePIcenter.

The **ISO/IEC 21823** [173] standard relating to IoT could be of relevance, addressing transport interoperability and focussing on information exchange, peer-to-peer connectivity, and seamless communication both between different IoT systems.

3.8.1 EFTI Regulation

On 15 July 2020, the European Parliament and Council published the **regulation (EU) 2020/ on electronic freight transport information (EFTI)** [1]. This regulation was based on recommendations from the DTLF initiative, who is also responsible for the implementation of this regulation by 2024. The objective of the EFTI Regulation is to provide a uniform legal framework at Union level requiring competent authorities to accept relevant freight transport information, required by legislation, in an electronic form. This should lead to the simplification and greater efficiency of exchange of legally required information between authorities and economic operators. The regulation defines 1) the conditions in which competent authorities are required to accept regulatory information when this is made available electronically by economic operators and 2) the rules on the provision of services related to making this regulatory information available electronically by economic operators.

In short, the economic operators are required to make the information available based on data processed on a certified eFTI platform and eFTI certified service provider and a secure connection to the data source.

The authorities are required to accept the regulatory information made available and (if applicable by national law) validate the information electronically.

It further stipulates the functional requirements for both eFTI platforms and service providers in terms of authorised access, security, interoperability, processing and operation logging, technology standards.

The regulation should be implemented by August 2025. The DTLF initiative supports this process.

3.8.2 Single Window

In general ISO standards related to transportation framework, amongst which one can be distinguished ISO/TR 13185-1 (2012), -2(2015), -3(2018), -4(2020); ISO/TR 17187:2019; ISO/TR 17261:2012; ISO/TR 17267:2009; ISO 18495-1:2016; ISO/TS 20452:2007; ISO/TR 25100:2012 (https://www.iso.org/ics/03.220.01/x/), as well as

Regulation (EU) No 1315/2013 (TEN-T) and **Regulation (EU) 2019/1239** establishing a European Maritime Single Window environment.

For the Single Window, the **ISO 28005** standard is significant and has two parts:

- **ISO 28005-1** [210] Security management systems for the supply chain -- Electronic port clearance (EPC) -- Part 1: Message structures.
- **ISO 28005-2** [211] Security management systems for the supply chain -- Electronic port clearance (EPC) -- Part 2: Core data elements.

These standards supply mechanisms to implement an XML based NMSW system, covering requirements in the FAL Convention as well as various other reporting requirements.

Also, by realization of the Maritime Single Windows it is expected to have a more simplified implementation of the FAL Convention and its forms; faster and easier way of receiving and sending forms, which maritime agents enter the system; forwarding documents according to priority, i.e., institutions; lack of administrative capacity within the state; the amount of funds; interinstitutional barriers.

Further to the mentioned advantages, the challenges and obstacles are visible in the following example: Italian NMSW "UIRNet". Efficient administrative procedures, already present in several European ports (e.g., "pre-clearing" activity), cannot be easily implemented in Italian ports due to the co-existence of several authorities with their own administrative and information systems within the seaport. Due to this issue, it is difficult to improve sustainability/sustainable business because of increased costs, increased waiting time etc. The issue may be solved through the unification of the control and information systems (so-called "one-stop-shop") of the different authorities and with the simplification of the administrative procedures improving the coordination of the several public bodies involved. Furthermore, most Single Window and total logistics chain systems will in the future have to be aligned with significantly increased requirements of the proposal for a Regulation of the European Parliament and of the Council establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU (COM (2018) 0278 – C8-0193/2018 – 2018/0139 (COD)). If the above-mentioned issues were solved, every party involved (both commercial stakeholders and administrative authorities) could benefit from the implementation of a Single Window (reducing costs, reducing average processing times, increasing service predictability, etc.), therefore increasing sustainability.

3.9 Conclusion concerning standards and regulations

This chapter listed some relevant international standards & regulations, with attention to what will be the most relevant in the demonstrators (where possible). It will be used as a reference for the different use cases in the demonstrators where it is needed to select the most appropriate standard and ensure that ePIcenter solutions remain compliant with applicable regulations.

4 Conclusion

The European Union, acting as one of the key players in global economy and market, identified essential target sectors which have a huge potential to impact the further overall development of European countries. To provide leadership and give development directions, the EU – through its governmental structure – adopted many regulations and policies that foster economic activities by integrating maritime-, land-, and air transportation with new technologies and standards to ensure market resilience and growth.

This deliverable reviewed the most prominent Initiatives, policies, regulations, directives, and standards that were adopted by the EU Parliament and global organisations in the transportation domain which have an impact on the ePIcenter project goals and activities. Brief elaborations covered the European Great Deal, the TEN-T network, DTLF, AI communication, CEF etc. giving the most important insights on current EU regulations in the transportation networking domain with the aim of determining the path for growth of the EU economy, based on transport sustainability and supply chain network extensions, and using advanced technological achievements.

The deliverable also reviews relevant IMO initiatives for maritime transport policy, fleet safety provisions, navigation, communication and maritime search and rescue competences together with maritime data exchange and harmonisation, as well as FAL Convention required documentation. An analysis was provided of the IPCSA mission, single submission recommendations, international maritime transport and trade facilitation and elaboration using very efficient platforms such as NxtPort and ChainPort.

In the frame of ongoing digitalisation and visibility initiatives specific focus has been put on the Maritime Single Window, as a relevant data exchange standard. A general overview and definitions regarding the establishment of a National Maritime Single Window was provided. Further to a NMSW introduction, the specific models of NMSW development and governance were discussed together with a proposed architecture and layout, and including the benefits, sustainability, security of a NMSW platform.

Considering the specific topics of the chapters, more detailed conclusions were provided at the end of each chapter.

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